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Analysis of soil nutrient and water relationship of Ogbujilekwe stream watershed in Nimo, Njikoka, Anambra State

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Abstract

The study on the assessment of soil/water nutrient relationship was carried out at Ogbujilekwe stream watershed in Njikoka, L.G.A. of Anambra state. The objectives of the study were to ascertain the level of soil nutrients of the watershed, with respect to depth, and to find out the relationship between the Phosphorus and Nitrogen in the watershed, with the Phosphate and Nitrate in the nearby stream. The watershed was delineated into three catchments and each, having three depth, 1, 2, 3, which ranges from 0- 20, 20-40 and 40- 60. The experimental design used for this research work was a randomized complete block design. The soil nutrients investigated include organic matter carbon, nitrogen, and phosphorus. Also, the pH of the samples was tested. The result showed that soil nutrients were concentrated at upper depth and reduced with an increase in depth. Both the soil nutrient and water samples were significant ($p<0.05$) and Phosphorus was the most significant. The result from correlation analysis showed that Phosphorus on land were positively correlated with phosphate in water. There is, therefore, a need to enforce conservation measures on the watershed to avert future eutrophication.

Keywords: Soil Nutrient; Water Relationship; Organic Matter; Correlation Analysis

1. Introduction

Soil nutrients are those elements in the soil that helps to improve the fertility of the soil. It includes both the macro and microelements that the plants need for their proper functioning. Soil organic matter is a major source of soil nutrients, and comprises all remains of plants and animals on the soil, in their various levels of decomposition. Soil organic matter is synthesized by soil organisms and plays a major role in the maintenance of soil fertility by providing foundations for crop production to prosper, as it influences a wide range of soil properties such as increasing the soil's natural ability to provide high plant nutrients, improving the water retention capacity of the soil, support the microbial population, increase in soil aeration and humus content of the soil. The process of deforestation of watersheds especially for continuous tillage reduces the organic matter and other nutrients in the soil and unless appropriate measures such as reduced tillage practices, crop rotation, use of cover crops and application of farmyard manure/fertilizers are put in place to reverse the trend. Soil organic matter and soil nutrient depletion are among the major forms of soil degradation (Gol, 2009). Increasing soil organic matter will positively influence soil fertility. The factors that influence the rate of

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decrease of soil organic matter ranges from soil type and physical properties of the soil such as vegetation cover, slope, and soil management practices. Soil organic matter below 3.4% is considered below. Soil organic matter consists of carbon, hydrogen and oxygen with a small amount of other elements. Soil organic carbon is another measurable component of soil organic matter. Soil organic carbon (SOC) refers only to the carbon components of organic compounds. Soil organic carbon plays a major role in soil systems by regulating soil fertility and water retention (MEA, 2005) as well as mitigating climate change [1]. The accumulation of soil organic carbon in the organic layer of the soil proceeds through a predictable pattern that is related to the interacting effects of temperature and moisture content [2, 3]. Sustainable management of soil and most importantly soil organic carbon is very beneficial to soil functions that support plant productivity. Organic carbon for agricultural soil usually ranges from 0.7 % to 4 % although SOC can be as low as 0.3 % for desert soil and as high as 14% in highly fertile soil. Soil containing more than 18 % of organic carbon is referred to as organic soil. Forest soils usually constitute a large pool of carbon, but anthropogenic influences such as the use of fire to remove soil cover, deforestation, tillage and grazing, lead to immediate loss of soil organic carbon from the carbon pool which may significantly increase the concentration of greenhouse gas (GHG) in the atmosphere. Inorganic matter is another source of soil nutrients. The major sources of inorganic nutrients in watersheds are the intensive use of nitrogen (N_2) from agriculture and heavy discharge of phosphates (P) from sewages. Nutrient delivery from the watershed is controlled by hydrologic processes, especially the availability of water to deliver nutrients from the source area to the downstream ecosystem [4, 5]. The relationship between nutrient inputs and yield at the watershed scale is mediated by natural (e.g. soil, rivers and lakes) features of hydrologic networks that control the transport of nutrients from source areas to receiving areas [6, 7].

2. Material and methods

2.1. Study area

This study was carried out in Ogbujilekwe stream watershed in Njikoka, Anambra State. The watershed is used for the commercial farming of vegetables.

2.2. Experimental design

The experimental design used in this research work is randomized complete block design (RCBD).

2.3. Sampling technique

The sampling technique used for the collection of both soil and water samples is random sampling.

2.4. Data collection

The data collected for this work include the percentage of organic matter, organic carbon, nitrogen, phosphorus and soil pH. Also for the water sample, only the data for Phosphate and Nitrate were collected.

Statistical analysis: the data collected were analyzed using correlation analysis.

2.5. Nitrogen Determination

5g of dry soil sample was weighed and placed in a conical flask. The samples were digested using concentrated sulphuric acid and then heated until a clear solution appeared. The samples were then carried to a distillation apparatus (Kjehdal Flask) for the distillation process.

$$\% \text{ Nitrogen} = \text{Titre value} \times 0.01 \times \text{atomic mass of nitrogen} \times 4$$

Where 0.01 = normality of the acid

2.6. Phosphate determination

This was carried out using standard methods 4500 – P.B.5 and 4500 – PE [8].

2.7. Determination of organic matter content

The organic matter content and organic carbon of the soil samples were determined using the weight loss by ignition method [9]. The mass of an empty clean crucible was weighed and soil samples were oven-dried at 105°C 5g each of the dry soil samples was then put into the crucible and placed in a muffle furnace. The samples were then heated to 400°C so that the organic matter will be burnt off. The amount of organic carbon was then measured and correlated with organic carbon.

$$\% \text{ Calculation } = \text{ Determination of organic matter content } = \frac{Mo}{Md} \text{ x } 100$$

Where; M_o= mass of dry soil – the mass of ash Md= mass of dry soil

2.8. Determination of percentage organic carbon

5g of soil sample was weighed into the platinum crucible, then placed in a muffle furnace and heated at 700°C for 4hr. The samples were cooled in desiccators after burning, the sample was then weighed.

2.9. Soil pH

The soil pH was determined using an electric pH meter.

2.10. Water Parameters

Water samples were collected at three different points, the containers were opened at the depth of 20- 30cm, below the surface of the water facing upstream and cocked when filled. A control was also collected from another part of the stream far from the part of the watershed where there was no planting. The water samples were carried to the laboratory, for analysis to check the Phosphate and nitrate contents.

2.11. Phosphate and Nitrate analysis of the water samples

2.11.1. Phosphate

Exactly 100ml of the homogeneous and filtered sample was placed into a conical flask, and the same volume of distilled water served as a control. (1ml) of 18 M H_2SO_4 and 0.89 g of ammonium sulphate were added to both conical flasks and gently boiled, keeping the volume of 25 - 50 cm^3 with distilled water. It was then allowed to cool, and one drop of phenolphthalein indicator was added to neutralize to a faint pink colour with 2M NaOH solution. The pink colour was discharged by gradual addition of 2M HCl, and the solution was made up of water. For colourimetric analysis, 20ml of the sample was combined with 10ml of combined reagent and shaken, and then left for 10 minutes before checking absorbance at 690nm on a spectrophotometer with 20ml of distilled water and the result was read.

2.11.2. Nitrate

A known volume of the sample was pipetted into a porcelain dish and evaporated to dryness in a hot water bath. 2ml of dilute sulphuric acid was added to dissolve the residue by constant stirring with a rod. Concentrated solutions of NaOH and distilled water were added with continuous stirring to make it alkaline. This was filtered into a nester tube and made up to 50ml with distilled water. The absorbance was read at 416nm using a spectrophotometer.

3. Results

Table 1 Mean values from analysis of soil nutrients at different depths (0-20, 20- 30, 30- 40)

Soil Sample	Depth	pH	% of Organic Matter	% of Organic Carbon	% of Nitrogen	% of Phosphorus
Arep	1	7.7067	16.750*	9.798*	1.579	24.743*
	2	6.6700	16.086*	9.367*	1.377	34.900*
	3	6.7700	15.933*	9.110*	1.276	28.533*
Brep	1	8.9233	16.300*	9.727*	3.133*	31.333*
	2	9.7000*	12.200*	7..500*	2.960*	23.533*
	3	9.0667	7.9000	7.140*	2.427*	18.667
	1	7.3200	14.93*	8.333*	3.600*	34.033*

Crep	2	7.1000	9.200	5.423	3.340*	29.533*
	3	7.0400	7.831	5.093	2.723*	38.233*
Control catchment A	1	8.233	10.4832*	5.333	1.993	22.800
	2	7.143	8.12353	5.423	2.313	18.233
	3	6.4333	8.433	5.093	2.500	15.300

*Significant at 0.05 level of significance

The result of the mean values of soil nutrients and phosphate/ nitrate of water samples are presented in Tables 1 and 2.

Table 2 Mean and standard deviation of Phosphate and Nitrate concentrations of water samples

Sample	% of Phosphate	% of Nitrate
Control	1.157±0.319	18.020±1.300*
Arep	1.240±0.219	18.580±0.819
Brep	1.649±0.129	21.493±0.699*
Crep	1.754±0.452*	17.903±0.325

Results in Mean ± standard deviation, *Significant at 0.05 level of significance

4. Discussion

The result from statistical analysis showed that the soil Sample from the upper catchment was the most significant especially AR2d1 and AR2d2. This implies that organic matter, soil organic carbon, soil nitrogen and phosphorus are more concentrated at the upper catchment otherwise known as the forested area with little or no anthropogenic influence. Also considering depth, it could be depicted or seen that most of the variables/nutrients studied were more concentrated at the upper depth d1 (0-20 cm), and decreased at lower depths. Also from statistical analysis, the phosphate and nitrates in the water samples were significant, but phosphate was the most significant element. Also from correlation analysis, phosphate in water and phosphorus in the soil had a positive correlation.

5. Conclusion

The results implied that organic matter is more concentrated in an area with less or without the interference of human activities like farming. Also, Phosphate appears to be the most significant soil organic element found in both the soil and water found in this area. There is, therefore, a need to check the use of phosphate fertilizers in the watershed to protect the aquatic lives and prevent eutrophication.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there was any conflict as regards the research work as well as this publication.

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