SPATIAL VARIATION OF THE QUALITY OF RAINWATER IN UGHELLI NORTH, DELTA STATE, NIGERIA

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ABSTRACT

This study examined the spatial variation of the quality of rainwater harvesting in Ughelli North. For purpose of data collection, seven (7) experimental sites representing the rural and urban areas in Ughelli North were used to collect rainwater samples. The samples were taken to the laboratory for physico-chemical characteristics analysis The data was analysed using the paired t-test. The study revealed that there is a significant variation in the quality of rainwater harvested from the rural and urban areas of Ughelli North at t-value of 2.39 which is greater than the critical table value of 1.89. It is anticipated that the increase in physico-chemical content of harvested rainwater in the urban areas in Ughelli North is attributed to high rate of industrial atmospheric pollution from rubber processing industries and fumes of automobile These gases flared in the urban areas not only produces excessive heat but also causes gaseous pollutants in the atmosphere known as particulate matter which adversely affects the quality of rainwater. It s therefore recommended that rainwater harvested in urban areas of Ughelli North should undergo purification.

Keywords: Rainwater, Pollution, Harvesting, and Ughelli North

1. Introduction

The demands on potable water supply are escalating in line with increasing population growth, particularly in urban areas, along with increases in industrial and commerce activities (Ahmed, Ardner, and Toze, 2011). Rainwater harvesting is a technology used to collect, convey and store rainwater for later use from relatively clean surfaces such as a roof top, land surface or rock catchment. The water is generally stored in a rainwater tank or directed to recharge groundwater. The harvest ranges from capturing runoff from rooftops or local catchments, capturing of seasonal floodwater from local streams and conserving water through watershed management. In recent times however, there has been an increasing consensus on the need to revisit and revive rain water harvesting, as a water source to meet fresh water needs.

The quality of rainwater, which has been properly collected and stored, is expected to be substantially free from minerals and most of the common pollutants that are present in the atmosphere, yet it is polluted mostly in the urban areas as a result of increased anthropogenic activities. Similarly, in the rural environment where industrial activities are low, production of gases such as carbon monoxide, hydroqen sulphide and hydrocarbons marginally affect the quality of rainwater. People living in remote and water-scarce areas are mostly the poorest people within a country (Nijhof et al, 2010).

As population of the world increases irrigation, the most water consuming human activity, as well as domestic water usage increases, leading to water supply crisis in different region. Among other available alternative sources for water supply, rainwater harvesting has become the most

economical solution for the water crisis (Boers and BenAsher, 1982). Succinctly, climate change is aggravating this situation reducing the quality of rainwater for drinking purposes.

In Urban areas of Ughelli North where there is an increased pollution activity, the consequence of this is the emission of carbon dioxide, methane gas and other associated gases (Okoh, 2000). There is an increasing concern that gas flaring activities may be inadvertently changing the climate of the globe through the enhanced greenhouse emission of Carbon IV Oxide and other gases causing an increased, temperature of the earth surface (Watson, 1990). These gases emitted into the atmosphere accumulate and when there is rainfall it combines with the rain resulting to acid rain. The effects of acid rain resulting from the reaction of water with Nitrogen IV Oxide, Nitrogen Monoxide, Sulphur (IV) Oxide and Carbon (IV) Oxide to form Sulphuric, Nitric and Carbonic acids are prevalent in gas flaring environment.

In Ughelli, gas flaring is a source of air pollution which affects the quality of rainwater. Similarly, the residents are being faced with the acute problem of water supply, which necessities them getting their domestics water supply. There have been complaints of high incidence of particles in their sources of water soon after every down pours. Others asserted that the acid in the rain water has led to high acidity in river and well water content. Thus, there is still contention on the influence of rain on other water sources.

Inspite of Governmental involvement in solving water scarcity, there are still the problems of availability of portable water. From the above neglect and problems, the study of spatial variation of the quality of rainwater in Ughelli North in Delta State set to assess the occurrence of acid in rainwater, and the variation in rural rainwater quality from the urban rainwater quality in Ughelli North. Focus will he placed on Ughelli, because it is an area of high anthropogenic activity. This research is geared towards providing information on the quality of rainwater harvesting in the study area.

2. Study Area

Ughelli North is situated in the Niger Delta region which is rich in oil and gas. It lies between latitude 5°13’N and latitude 545N of the equator and longitude 545’E and longitude 612E of the Greenwich Meridian (see Figure1). Ughelli North is characterized by hydromorphic soils, which is a rnixluie of coarse alluvial and colluvial deposils The area is drained by River Othurekpo, Ase River and River Ethiope. The climate is of the tropical equatorial climate with a mean daily maximum temperature of about 30C ind a minimum of 28C, average relative humidity of about 60%-98% and annual rainfall amount of between 3000mm to 3500mm. Generally, two major wind systems influence the climate of Ughelli North. These are, the northeast trade wind blowing cold dry air from the Sahara and the southwest trade wind blowing cold moist air from the Atlantic. The South-West wind prevails almost throughout the year, from March-October, while the North-East trade wind is responsible for the cold dry period (Harmattan) which influences the area for about tour months (November-February).

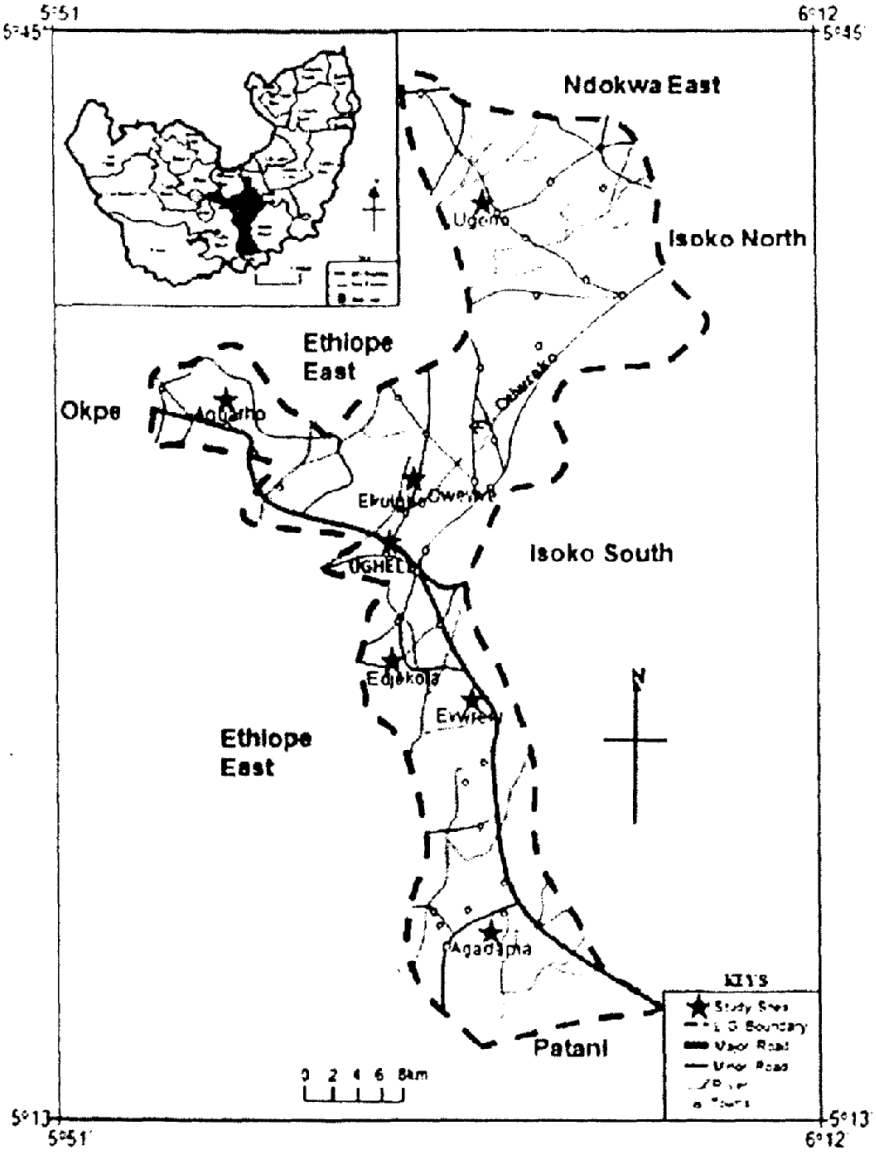

Figure 1: Map showing study area

This brings about two types of seasons within a year; the rainy and dry seasons, respectively. The vegetation is that of the tropical rainforest belt characterized by dense vegetation cover consisting of evergreen forest of tall trees with undergrowth of climbing plants that are closed together along the streams and creek channels and this normally typifies primary vegetation. Also, the presence of grassland with sparse trees and shrubs typified the secondary vegetation pattern within the vegetation belt.

3. Conceptual Issues

The impact of man's activities on the environment is negative and this involves interfering or changing the natural state of the environment. The concept of Ecology by Tansley (1935), explains the influence of man on the ecosystem. The concept is ideal in man- environmental relationship, including the relationship of plants and animals to their environment and of the

influence of man on the ecosystem. In recent years many people have become aware of man's abuse of his environment. Man pollutes the air, the water he drinks as well as the soil.

Similarly, man learnt to release great reserves of energy to build machine and to create vast quantities of exotic products including plastic and automobiles. In this man has violated and contradicted nature, yet man himself is inexorable and utterly dependent on nature. This concept is relevant to this study because it has been used to explain how man's anthropogenic activities have affected the quality of rain water harvested through gas flaring. Tansley (1953) opined that the activity by man affects the river water and rainwater quality negatively, the water quality, for drinking and other usage is reduced; plant and aquatic life is destroyed. If these activities are not checked in the future, there might be lack of potable clean water from rain harvesting.

4. Materials and Method

The study adopted the experimental design which involved laboratory analysis of harvested rainwater samples. In doing so, seven (7) experimental sites were selected from both the rural and urban areas of Ughelli North using the existing clans (Ughelli, Agbarha, Ogor, Orogun, Evwreni, Agbarho and Uwheru). The rainwater samples were collected in the month of September when the rain is at its peak using an open space method. The samples were collected using a cylindrical flask attached with a funnel at a height of 2m above ground level to void splash of sand particles in an open space. The rainwater samples were collected at time lapse of lOmins from the commencement of rainfall from four rural areas (Ugono, Owevwe, Edjekota and Agadama) and three urban areas (Agbarho, Ughelli and Evweni) in Ughelli North. In all a total of seven (7) samples were collected and taken to the laboratory for analysis in a cooler containing ice blocks to ensure that the rainwater is not contaminated before the analysis, The physico-chemical characteristic of the harvested rainwater was analysed. The data on the quality of rainwater harvested were averaged from records of the designated areas. The Paired ttest analysis was used to test the hypotheses stating that there is no significant difference in the quality of rainwater harvested from the rural area and urban area.

5. Laboratory Analysis

Analyses of parameters were based on the principles and procedures outlined in standard methods for the examination of heavy metals in water and wastewater samples (APHA, 1995) To achieve this, the physiochemical (pH, Total hardness, Chloride, Turbidity, Total Dissolved Solids, Zinc, Nickel, and Copper) properties of the various water sample were analysed. Turbidity was assessed by first adjusting the water length of 750mm (for turbidity). Then a 25m1 corvette was filled with the water sample to the 25ml mark. Subsequently this was placed inside the Hach Spectrophotometer and the turbidity reading was taken immediately. For Total Dissolved Solids (TDS) the Hach TDS meter was put on the reading zeroed and then electrode dipped into the water sample and reading recorded appropriately. Conductivity was assessed by putting on the Suntex conductivity meter, adjusting the reading portions and dipping the electrode into the water sample and appropriate reading taken The pH tester was standardized with buffers of pH 4 and 7 prior to usage. Subsequently, this was dipped into the water sample to take the pH reading of the water sample. A total suspended solid (TSS) was determined using

weight loss technique. To assess the levels of the heavy metals, a portion of all the water samples (50m1) were initially subjected to fixing using concentrated nitric acid and concentrated hydrochloric acid in a ratio of 1:10 respectively which was meant to digest particulate matter inside the sample by heating carefully in a water bath to obtain thick yellow solution, and later was cooled and made-up to l00ml with distilled water. After this fixing, the samples were directly analysed using the Bulk Scientific AAS. For each heavy metal, specific concentration standard was run to prepare a calibration curve from which the concentration of the heavy metal was read directly from the AAS VDU system.

6. Results and Discussion

Table 1: Mean and range of harvested rainwater quality in rural/urban Ughelli North

Parameters	Unit	Urban Areas		Rural Areas		
		Mean	Range	Mean	Range	WHO Standards
pH	-	5.45	6.7-6.2	6.54	6.9-5.8	6.5-8.5
Total hardness		30.20	48-0	19	33-15	100
Chloride	mg/l	20.21	23-17	10.45	20 -10.2	250
Turbidity	NTU	9.11	4.8 -11.6	1.01	1.15-4.9	5.00
Total Dissolved solid (TDS)	Mg/l	60.1	98-41	44.7	65-29	100
Zinc	mg/l	0.04	106-52	0.02	0.03-0.02	0.05
Nickel	mg/l	0.02	0.06-0	0.03	0.04-0.02	0.07
Copper	mg/l	0.04	0.04-0	0.01	0.02-0.00	2

From Table 1 the pH values recorded in the rural area are generally within the WHO acceptable limits of 6.5-8.5 thresholds. This is evident from 6.54 mean pH value that is within the 6.5-8.5 WHO threshold. However, the low pH mean value 5.45 recorded in urban areas in Ughelli North could be attributed to the high rate of industrial atmospheric pollution from rubber processing industries and fumes of automobile. This implies a high acidic nature in built up areas as opined by Efe (2006). The low pH values in the urban areas increases the concentration of some dissolved metals in the harvested rainwater, increasing the toxicity of these metals. Unlike many organic contaminants that loose toxicity with biodegradation, metals cannot be degraded further and their toxic effects can be long lasting. The total hardness values of water samples analysed were within the maximum limits of WHO standards of l00mg/L. This is seen from the mean of 30.2 total hardness recorded in urban area and mean of 19 total hardness recorded in the rural area.

Chloride ion impacts a salty taste to water The chloride ion content in urban area ranges from l7mg/L23mg/L with a mean value of 20.21mg/l while, the rural ranges from 10.2mg/L2Omg/L with a mean value of 10.45mg/L and the both were within the maximum limit of the WHO standard of 250mg/L. The mean turbidity values of the harvested rainwater samples collected from the urban areas is 9.11 NTU which is greater than the turbidity values of the rural areas which is 1 01 NTU. However, the rural rainwater quality is within the limits of WHO acceptable standard of 5 NTU

Total Dissolved Solids (TDS) concentration of harvested rainwater in the urban area had a mean of 60.1 and a mean of 44.7 in the rural area which are within the maximum limits of l000mg/L

acceptable by WHO. Zinc concentration in the urban and rural areas of Ughelli North was generally within the maximum limits of 0.05mg/L standard of WHO. This is evidently from the mean of 0.04 and 0.02 zinc concentration in harvested rainwater quality. Nickel concentrations in urban areas were higher than that of the rural areas. Moreso, the copper concentration in the harvested rainwater was also higher than that of the rural areas. However, the concentrations of Nickel and copper were below the acceptable WHO standards Succinctly, the increase in the physicochemical properties of the urban area is attributed to increased air pollution from industries and automobile.

Table 2: Paired t-test

		Paired Differences						
		Mean	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1	Rural harvested rainwater quality - Urban harvested rainwater quality	-5.42	2.27	-10.79	-.05352	-2.39	7	048

Table 2 shows the calculated t (2.39) is greater than the critical table (189) at P< 0.05 arid thus, the model is significant. Thus, there is a variation in the quality of rainwater harvested from the rural and urban areas of Ughelli North.

7. Conclusion and Recommendation

This study has revealed a spatial variation in the quality of rainwater harvested from the urban areas and rural areas in Ughelli North. The pH, turbidity values, Nickel and Copper concentrations in urban areas were higher than that of the rural areas. Succinctly, the increased pH values in the urban areas increases the concentration of some dissolved metals in the harvested rainwater, increasing the toxicity of these metals. This increase is attributed to the high rate of industrial atmospheric pollution from rubber processing industries and fumes of automobile in the urban areas. It is safe to conclude that the gas flaring activities in the urban areas not only produces excessive heat but also causes gaseous pollutants to be present in the atmosphere as particulate matter which may adversely have effect on the rainwater quality; thus, making it acidic. In view of improving the quality of rainwater harvest in Ughelli North, it is recommended Government environmental laws should be adhered to in the designing and location of flaring stacks, rainwater harvested in urban areas of Ughelli North should undergo purification and Government should provide potable drinking water for her citizens.

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