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ASSESSMENT OF THE QUALITY OF RAIN WATER COLLECTEDFROM DIFFERENT CATCHMENT ROOFS IN UGHELLI, DELTA STATE, NIGERIA

USHURHE, OCHUKO & ORIGHO, THADDEUS

ABSTRACT

The purpose of this study was to assess the quality of rainwater consumed by the inhabitants of Ughelli from different catchment roofs. Sixteen samples of rainwater were collected from different catchment roofs in the area. The rainwater were analysed for physical chemical parameters such as pH, temperature, turbidity, dissolved oxygen, biochemical oxygen demand, total dissolved solids, total suspended solids, sulphate, nickel, lead, iron and zinc. The results of the laboratory analysis revealed that most of the parameters examined showed satisfactory concentrations when compared with the WHO acceptable limits; except for pH, dissolved oxygen, Lead, and Iron contents. Also, the hypothesis tested proved that there was significant variation in the quality of rainwater harvested from the different catchment roofs in the area. Rainwater from the different catchment roofs in the area can be harvested for domestic consumption.

INTRODUCTION

Rainwater harvest is the process of collecting rainwater and its storage for use. The concept of rainwater harvest or its use during the rainy season is not new particularly as supplement to water from streams and rivers (Olorunfemi and Arohunsoro, 2000). Archeological evidence attests to the capture of rainwater as far back as 4000 years ago and the concept of rainwater harvesting in China may date back to 6000 years. Ruins of' cisterns built as early as 200BC for storing run-off from hill sides for agricultural and domestic purposes are still standing tall in Israel (Gould and Nissen-Peterson, 1992). Increase in population, urbanization and inefficient pipe borne water supply has made rainwater collection a veritable source of water supply (Schiller, 1982). Today, in many developing countries of Africa, where housing standard has improved and impermeable roofs are constructed, rainwater harvesting system are becoming increasingly used. Rain water harvested has been successfully harnessed for domestic water requirement in Kenya and Tanzania (Schiller, 1982) and in Sierra Leone (Nissen-Peterson, 1982 and Jayakaran, 1988). In Zimbabwe, between 80 and *85* percent of all measurable rainfall is collected and stored for use (Morgan, 1990).

In Nigeria, the concept of rainwater harvesting or its use during the rainy season is not new particularly as a supplement to water from streams and rivers (Morgan, 1990). Most inhabitants in the urban centres of Nigeria depend on rainwater. Rainwater according to Efe (2006) is one of the purest sources of water supply. But the desire for technological breakthrough and improved standard of living has placed pressure on its use.

Ughelli is one of the largest urban towns in Delta State in terms of physical and total population of people. By *virtue* of this fact, it exhibits most of the developmental attributes of some urban centres in Nigeria which include the use of rivers, streams, shallow wells, boreholes and rainwater as sources of water supply. Generally in Ughelli, though these sources of water supply abound, the fact remains that more patronage is on water supply from shallow wells (Ushurhe, 2007). However, the quality of the water from these shallow wells is not totally potable for domestic use. According to epidemiological reports obtained from the Cehtral Hospital, Ughelli in 2006 and analyzed showed that polluted water was responsible for cases of typhoid, diarrhea and dysentery in the area (Ushurhe, 2007). The need to assess the quality of rainwater harvested in the area, as most of the inhabitants depend on it as source of water supply during the rainy season for domestic consumption calls for urgent attention.

RAINWATER AND RAINWATER HARVESTING

The most interesting aspect of rainwater harvesting is learning about the methods of capture, slot-age and use of this natural resource at the point it occurs. This natural energy excludes at least a portion of water use from the water distribution infrastructure, the centralized treatment facility, storage structure pumps, mains and laterals, Rainwater harvesting also excludes land based systems with man made landscape feature to channel and concentrate rainwater in either storage basin or planted areas (Nissen-Peterson, 1992 and Gould, 1992).

The components of rooftops rainwater harvesting arrangement include roof catchments area**,** roof gutters, down pipes anti first flush pipes, filter unit, storage tanks with provision for drawing water and spillover (Gould, 1992). In assessing the health risk of drinking rainwater, the path taken by the raindrop through watershed into a reservoir, through public drinking water treatment and distribution system to the end user is taken into consideration. Being a universal solvent, water absorbs contaminants and minerals as it travels to (lie reservoir. While residence in the reservoir, the water can come in contact with all kinds of foreign materials. Oil, animal waste, chemical and pharmaceutical wastes, organic compounds, industrial outflows and trash (Williams, 1997). 11 is the job of the water treatment plant to remove harmful containments and to kill pathogens.

Along with the independence of rainwater harvesting systems come the inherent responsibility of operation and maintenance. For all systems, this responsibility includes purging the first flush system, regularly cleaning the roof, washers and tanks, maintaining pumps and filtering water. For potable systems responsibility include all of the above and the owner must replace cartridge filters and maintain disinfection equipment schedule, arrange to have water tested and monitor tank levels. Rainwater used for drinking should be tested often for pathogens (Lye, 2002).

Rainwater harvesting has been used by the Ladybird Johnson Wildflower research centre in Austin, Texas; the Advance Micro Devices semi-conductor fabrication plant in Austin, Texas, Roynold. Metals in lngleside, Texas; and Coral Islands (Texas Water Development Board, 2002).

In Nigeria and Delta State in particular, rainwater harvesting has been investigated and studied for its use by the works of Ezeriwa (2004) and Edekele (2004) in the rural communities of Oshimili North Local Government Area and Udu Local Government Area respectively. In all, rainwater harvesting is a means of fetching water for domestic consumption in the area.

STATEMENT OF THE PROBLEM

Several researches on water point to the fact that there have been increased studies on the quality of water from the surface (streams, lakes, ponds and rivers) and sub-surface (boreholes and shallow wells) sources to the neglect of rainwater quality (Egborge, 1991; Akporido, 2000; Ikomi and Emuh, 2000; Ovramah and Hymore, 2001 & Efe, 2003).

The reason for this neglect according to Efe (2003) is that most of the inhabitants especially in the rural areas consider rainwater as the most potable source of water; provided it is properly collected and that it needs no further purification before consumption.

In Ughelli, the patronage on shallow well water is more when compared to other sources of water supply. The quality of this water for domestic consumption is still questionable. In an epidemiological report obtained from the Central Hospital, Ughelli in 2006 and analyzed showed that polluted water is responsible for cases of typhoid, diarrhea and dysentery in the area (Ushurhe, 2007). This is based on the fact that zonal distribution and effects of these diseases showed that areas with low quality wells correlate with the high incidence of the diseases. The need to source for alternative means of water supply through rainwater harvesting forms the main thrust of this research in order to scale to its barest minimum incidence of water borne diseases. Hitherto, rainwater harvesting could form alternative means of water supply in the area.

However, the variation in the quality of water harvested from different catchment roofs formed the centre piece of this research in order to protect the health of the people. The researcher also sought to find answers to questions such as the following that guided this study.

- Is the water from rain good for human consumption?
- Is there any difference in the quality of rainwater harvested from the different catchment roofs?
- How can we attain the potability of rainwater harvesting in the area?

AIM, OBJECTIVES AND **HYPOTHESIS**

This study is aimed at assessing the quality of water harvested from different catchment roofs in Ughelli. The specific objectives are:

- assess the quality of rainwater harvested in the urban area of Ughelli.
- ascertain the level of variation in the quality of rainwater harvested from the different catchment roofs in Ughelli.
- suggest ways of improving the quality of rainwater harvested in the area.

A null hypothesis was formulated and tested for the study as follows:

Ho: There is no significant difference in rainwater harvested under different catchment roofs in Ughelli.

STUDY AREA

Ughelli is located between latitudes 5°28'N and 5°32'N of the Equator and also between longitudes 5°58'E and 6°03'E of the Greenwich Meridian. Ughelli is the headquarters of Ughelli North Local Government Area of Delta State. Ughelli is bounded in the North by Eruemukohwarien, in the West by Oteri/Ovwor, in the East by Agbarha- Otor and in the South by Oviri-Ogor.

METHODOLOGV

This study is an empirical research. It involves data collection and laboratory analysis of rainwater collected from different catchment roofs in the area.

Sources of Data collection

The data for this study were derived from water samples collected from rainwater from four different zones (Uloho Avenue, Upper Afiesere, GRA and Sergeant quarters) in the area. The rainwater samples were collected from four different catchment roofs of aluminum roofing sheets, asbestos, corrugated iron sheets and from the open space. The rainwater samples were collected in the month of June, July and August 2008 at the time of rainfall from the mouth of the gutter and open surface by the researcher using sterilized cans. A sample of rainwater was collected at four sources (aluminum roofing sheet, corrugated iron roofing sheet, asbestos roofing sheet and open space (as control) in each of the zones in Ughelli. The open space rainwater samples were collected at a height of 0,5nieters to prevent sand particles from splashing into the water. The rainwater samples were collected at a time lapse of 10 minutes ram the commencement of rainfall. This interval has been used by Esenwa (2004) and Efe (2006) and they achieved significant results.

In all, a total of 16 samples were collected, These 16 rainwater samples were collected with the help of 16 field assistants trained in such act, which enabled the researcher to collect the rainwater samples at the same lime interval. After collection, the water samples were kept in the refrigerator at 0.4°C for preservation. They were taken to the laboratory for analyses with a cooler containing some ice blocks.

The materials and equipment used for the analyses and assessments were based on the analytical equipment recommended and validated by the World Health Organisation (WHO), United State Public Health Services (USPI-1S), American Society for Testing and Materials and the Federal Ministry of Environment for testing water quality.

DISCUSSIONS AND FINDINGS

Rainwater Quality in the Urban areas of Ughelli

To assess the quality of rainwater harvested in the urban areas of Ughelli, the researcher subdivided Ughelli into four zones based on house clusters, existing zones and traditional boundaries of the area. The zones are Overbridge, Uloho Avenue, Upper Atiesere and Sergeant quarters.

In each of the zones, rainwater from different catchment roofs were collected for analysis. The catchment roofs are asbestos, corrugated iron sheet, aluminum and open space as control.

Table 1: MEAN PHYSICO-CHEMICAL CHARACTERISTICS OF RAINWATER WITHIN THE URBAN AREA OF UGHELLI.

Parameter	**Overbridge**	**Uloho Avenue**	**Upper Afiesere**	**Sergeant quarters**	**Mean**	**WHO**	**Remark**
P11	0.1	*586*	*5.72*	*5.90*	*5.90*	*6.5-8.5*	Safe
Temp. °C	29.53	29.73	2L90	**29.69**	**26.69**	29.8	Safe
'Purbiditv (NTU)	**0.06**	**0.06**	0.05	0.03	0.05	5.00	Safe
Acidity (mg/I)	18.45	21.33 *28.50*	16.72	21.50	19.5	N/A Mm 30	Safe
Alkalinity mg/I)	*31.75*		**33.99**	**28.78**	**30.76**		Safe
DO (mg/I)	7.39	7.93	**7.43**	**7.00**	**7.44**	**5.00**	Safe
BOO (mg/I)	1.1 H	1.03	1.06	0.99	1.07	N/A	Safe
TDS (mg/I)	0.02	0.01	0.01	0.04	0.04	0.03	Safe
Tss (m_	0.05	0.02	0.01	0.05	0.06	5.00	Safe
Sulphate (mg/I)	17.48	13.28	18.08	16.34	16.30	200.0	Safe
Total Hardness	6.62	6.30	6.65	6.72	*6.57*	N/A	Safe
n(mgJ1)	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	Safe
Ni(mg/l)	<0.001	<0.00 I	<0.001	<0.001	<0.001	0.001	Safe
Pb(mg/l)	0.054	0.017	<0.001	<0.001	0.018	0.01	Not safe
Fe(mg/l)	0.806	0.638	0.398	0.530	*0.593*	0.03	Not safe
Zn(rng/l)	0.632	0.615 —	0.421	0.3 10	*0.495*	3.00	Not Safe

Source: Fieldwork, 2008

From the above table 1, the pH values of rainwater harvested were generally lower than the WHO standard. The mean value of 5.90 is lower than 6.5-8.0 WI-TO threshold, : However, the lowest p1-I value of 5.72 was recorded in rainwater samples harvested from Upper Afiesere, while the highest pH value of 6. 1 was recorded at Overbridge. The low pH value at Upper Atiesere could be attributed to high rate of industrial atmospheric pollution from rubber processing industries and fumes of automobiles. This shows that the . rainwater harvested from the built up areas are mildly acidic in nature. This corroborates the works of Efe and Moghorukor (2008) in the industrial refinery area of Warn, which recorded a low pH value.

The temperature values of rainwater harvested were generally satisfactory from the different catchment roofs in the urban area (see table 1). The mean value of 26.9°C was recorded iii the zones. However, the lowest temperature value of *29.5°C* was recorded in - rainwater samples harvested from Overbridge, while the highest temperature value of 29.9°C was recorded at Upper Afiesere area. The recorded values are in conformity with WHO standard.

The turbidity values of rainwater harvested were generally low and fell within the WHO acceptable threshold of drinking water standard. The mean value of 0.05 is lower than 5.00 WHO threshold. However, the lower turbidity value of **0.03** was recorded in Sergeant quarter, while the highest turbidity value of 0.06 was recorded in Overbridgc and Uloho Avenuc areas respectively. The high turbidity value recorded at Overbridge and Uloho Avenue could be attributed *to* slight pollution effect from automobiles.

The acidity value of rainwater harvested were generally lower than the WHO acceptable threshold (see table 1). A mean value of 19.5 which is lower than acidity value of 16.72 was recorded at Upper Afiesere from rainwater samples harvested; while the highest acidity value o12 133 was recorded at Uloho Avenue. This could be attributed to pollution effect from fumes of automobiles. These values are lower than those recorded in similar areas in the Niger Delta by Efe and Mogborukor (2008) in communities in the oil- producing region of Nigeria.

The alkalinity values of rainwater harvested are generally lower than the WHO acceptable threshold. This is evidence from the 30.76 mean values recorded. However, the lowest alkalinity value of 28.50 was recorded in rainwater samples harvested at Uloho Avenue, while the highest alkalinity value of3l.75 was recorded at Overbridge.

Dissolved oxygen values of rainwater harvested were generally higher than the WHO acceptable threshold. A mean value of 7.44 was recorded. The recorded value was higher than 5.00mg/I WHO threshold. However, a low value of 7.00mg/I was recorded in rainwater samples harvested from Sergeant Quarters; while the highest dissolved oxygen value of 7.93mg/I was recorded at Uloho Avenue area.

The total dissolved solids of rainwater harvested were generally lower than the WHO acceptable threshold. A mean value of 0.04mg/I was recorded in the zones, This value is lower than the WHO threshold value of 500mg/I, The lowest total dissolved value of 0.01mg/I was recorded in rainwater harvested at Uloho Avenue and Upper Afiesere areas, while the highest total dissolved solids value of 0.04 was recorded at Sergeant Quarter.

Total suspended solids value of rainwater harvested were generally lower than the WHO acceptable threshold. This is evidence from the 0.06mg/I means value of’ total suspended solids as compared to 5.00mg/I WHO threshold. The lowest total suspended value of 0.01mg/I was recorded in rainwater harvested at Upper Afiesere, while the highest total suspended solids value of' 0.05mg/I was recorded in rainwater harvested at Overbridge and Sergeant Quarters respectively (see table 1).

Sulphate values of rainwater harvested were generally lower than the WHO acceptable threshold. This is evidence from 16.30mg/I mean value recorded in the zones as compared to 200mg/I WHO acceptable threshold. The lowest sulphate value of 13.28mg/I was recorded in rainwater samples harvested at UIpho Avenue, while the highest sulphate value of 18.08mg/i was recorded at Upper Afiesere area.

Total hardness value of rainwater harvested were generally lower than the WHO acceptable threshold. A mean value of 6.57mg/I was recorded as against 200mg/i WHO acceptable limit. However, a lower value of 16.30mg/I was recorded from the rainwater harvested at Ijioho Avenue, while the highest value of 6.72mg/I can be attributed to fumes from automobiles.

The vanadium value of the rainwater harvested *and* analyzed had a mean value of <0.001mg/I when compared to 0.001mg/I, WHO acceptable limit. This is an indication that there was no vanadium contamination in the harvested rainwater samples.

Nickel values of rainwater harvested were generally lower than that of the WHO acceptable threshold. A mean value of <0.001mg/I was recorded as against 0001mg/I WHO acceptable limit. However, the lowest and highest values of the rainwater samples *205* were the same: This implies that there was no indication of Nickel contamination in the rainwater samples harvested in the area.

From table 1, the lead value of the rainwater harvested is higher than that of the WHO acceptable, threshold. This is evidenced in the mean value of 0.018mg/I recorded in the sampled rainwater harvested in the zones as compared to 0.01mg/i WHO acceptable threshold. However, a low value of <0.001mg/i was recorded in rainwater samples harvested at Upper Afiesere and Sergeant Quarters, while a high lead value of 0.054mg/I was recorded at Overbridge. This can be attributed to pollution from automobiles fume arid gas flaring sites. This goes to confirm the views of Efe (2006) of high lead contamination of rainwater in the Niger Delta.

In terms of iron concentration in the rainwater harvested, the values were generally higher when compared to the WHO acceptable limit. This is evidenced from the 0.593mg/I mean values recorded in the rainwater samples analysed. This value is higher than the WHO value of 0.03mg/I.

Zinc values of rainwater harvested were generally lower than the WHO acceptable limit. A mean value of 0.495mg/i was recorded as against 3.00mg/i WHO acceptable limit. However, the lowest zinc value of 0.3 10mg/I was recorded in water samples from Sergeant Quarters while highest zinc value of 0,632mg/i was recorded at Overbridge. This could be attributed to fumes of automobiles due to heavy vehicular traffic in the area.

Test of Hypothesis

A null hypothesis which states that there is no significant difference in rainwater harvested under different catchment roofs in Ughelli was tested using analysis of variance (ANOVA) in line with tables 2 and 3 to explain the level of variation in the quality of rainwater harvested from the urban areas of Ughelli.

Table 2: Mean Physico-Chemical Characteristics Of Rainwater Harvested From Different Catchment Roofs Within The Urban Area Of Ughelli

Parameter PH	**Open pace**	**Asbestos**	**Zinc**	**Aluminum**	**Mean Value**	**WHO Limit**	**Remarks**
PH	6.66	5.77	6.64	5.77	6.23	*6.5-8.5*	Safe
Temp. ^{o}C	29.43	30.00	29.50	29.78	29.8	29.8	Safe
Acidity (m4)	18.48	19.42	20.58	19.53	19.50 -	N/A -Min	Safe
Alkalinity mg/I	31.30	31.34	29.73	30.73	30.78	30	Safe
DO (mg/I)	7.08	7.79	6.82	8.05	7.44	5.00	Safe
BOD çmgll)	1.07	1,09	1.06	1.04	1.07	N/A	Safe
TDSrng	0.02	0.03	0.03	0.01	0.02	0.03	
TSS (mg/i)	0.02	0.06	0.10	0.06	16.04	*5.00*	Safe
Sulphate (mg/I)	15.57	16.48	16.14	15.98	6.67	200.0	Safe
Total Hardness	6.39	6.71	6.43	6.76	0.001	N/A	Safe
Vn(mg/l) -	<0.001	<0.001	<0.001	<0.001,	<0.001	0.001	Safe -
Ni(mgJl)	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	Not safe
Pb(mg/l)	0.001	0.054	<0.001	0.017	0.018	0.01	
Fe(mg/I)	0.547	0.653	0.641	0.603	0,611	0.03	Safe
Zn(mg/i)	0.444	*0.568*	0.554	0.461	0.507	3.00	Safe
Turbidity (NTU)	0.03	0.05	0.06	0.06	0.05	5.00	Safe

Source: Fieldwork, 2008.

Table 3: Summary of ANOVA result explaining the level of variation in the quality of water harvested from Open Space, Aluminum, Asbestos and Zinc Roofifl2 sheets.

Model	Sum of squares	Differences	Mean square	F	Critical	Remarks
Regression	13503.564	3	4501.188	876.778	2.60	Sig. diff. exists
Residual	636.589	124	5.134			

Total	14140.152	127				

Source: Fieldwork, 2008

From the above table 3, the calculated F-value is 876.778 at 0.05 level of significance, while the critical value is 2.60. Since the critical F-value is less than the calculated F-value, then the null hypothesis which states that there is no significant difference in the rainwater harvested under the different catchment roofs in Ughelli is rejected. Hence, the alternative hypothesis (Hi) is accepted, which implies that there is significant difference in the quality of rainwater harvested under different catchment roofs in Ughelli.

FINDINGS

Based on the aim and objective of the study and the hypothesis posited; the research has been able to answer the posited questions that all the parameters examined showed satisfactory concentration in virtually all the parameters examined. This implies that rainwater in the area can be harvested, stored and utilized for domestic purposes. However, there is need for some treatment to attain potability. It was also observed from the rainwater harvested that there is a significant difference in the quality of rainwater under the different catchment roofs in Ughelli. Open catchment with a mean of 7.32 and Zinc catchment with a mean of 7.39 are regarded as the best catchment roofs for obtaining rainwater for drinking.

RECOMMENDATIONS

In line with the laboratory results of the rainwater analysed and the hypothesis tested, the researcher recommends:

- The removal of suspended impurities from rainwater through the addition of a required amount of aluminium sulphate to enable the impurities settle down at the bottom of the bucket.

- The water should be disinfected through sterilization in order to kill the bacteria in ii (Tripatty and Panda, 2001; Akinsola, 1993).

- Rainwater should be exposed to sunlight and ultraviolet rays to kill various types of bacteria in the water without giving an undesirable taste or odour to the water.

CONCLUSION

The study revealed that most physico-chemical characteristics of rainwater harvested from open, asbestos, zinc and aluminium catchments in the urban area of Ughelli showed satisfactory concentration, as such the rainwater should be harvested from these sources for domestic uses. However, there should be little purification in terms of pH, lead, zinc and iron content.

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