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COMPARATIVE ANALYSIS OF THE QUALITY OF RAINWATER HARVESTED FROM RURAL AND URBAN COMMUNITIES IN UGHELLI NORTH LOCAL GOVERNMENT AREA, DELTA STATE, NIGERIA

Origho Thaddeus
Department of Geography
College of Education, Warri, Delta State, Nigeria
E-mail: thaddeusorigho@gmail.com

ABSTRACT

The study compares the quality of harvested rainwater from urban and rural areas of Ughelli North Local Government Area of Domestic purposes in order to safeguard human health. It is an empirical study of harvested rainwater from the zinc catchment roof in the area. Laboratory analysis of water samples collected were analysed for physic-chemical characteristics in line with WHO (2010) drinking quality standard. The results showed that variation exists in the harvested rainwater from the rural and urban areas. However, most of the parameters examined showed satisfactory concentration; hence the rainwater can be harvested and used for domestic purposes with little purification to eliminate the excess pH, lead, zinc and iron found in it. The study recommends that harvested rainwater should be allowed to settle down for some minutes before use to eliminate pathogenic bacteria and impurities.
Keywords: Comparative analysis, water quality, rural, urban, harvested

INTRODUCTION

Water is a unique resource whose quality and quantity vary over space and time. It is one of the most precious commodities needed by man. Without it, life cannot survive and economic development will be retarded by its absence. Water is the life-blood of the eco-system. It forms the largest part of the most living things. An average man's body is two-third water and would weigh only 13kg when completely dehydrated. Despite its important and abundance, water is one of the most poorly managed resources on earth. We waste it, pollute it and charge too little for its existence (TyllerMiller, 1994). Getting potable water is a problem to millions of people on the earth's surface. It has been estimated by the World Health Organization (2000) that in urban areas, a total of at least 75 percent or 390 million people had reasonable access to safe water. In the light of this, man has continued to search for better ways of obtaining potable water for his survival. The aim is to make water available to everyone.

SOURCES OF WATER

Surface Water

Surface water includes water found in ponds, streams, rivers and lakes. It is the commonest source of water for most rural dwellers in developing countries of the world. It has the advantage of easy accessibility and is permanent through the year. Unfortunately, it is the most easily and frequently polluted resource by human and animal wastes, refuse and chemicals from industrial and agricultural activities.

Underground Water

This is the water we tap into when sink a borehole or a well. As rainwater soaks through the ground and travels underground, it is filtered by the soil. Groundwater is usually clean, plentiful and permanent. In order to make groundwater available for human use, a well or borehole is dug. Today, it is a popular source of water supply for urban and rural dwellers in Nigeria. One major disadvantage of deep wells and boreholes is that, the water may contain a lot of salts and other minerals.

Concept of Rainwater Harvesting

Rainwater is that water that has evaporated from the earth surface through evapotranspiration to the atmosphere and has condensed and fallen back to the earth's surface as rain. It is a process that occurs in the hydrological cycle. As rain falls, some of the rainwater infiltrates into the ground while some runs off into streams, rivers and seas. Through the process of evapotranspiration, some of the water evaporates into the air to form cloud, which condense and falls back to the earth as rainfall. Thus, the concept of rainwater harvesting refers to the collection of this rainwater and its uses. As the rain falls, the roof of the building intercepts the rainwater and it is collected through the gutter by the inhabitants of the area for consumption. Rainwater harvest has been practiced in Iran, Iraq, Kuwait and Jordan in the Mediterranean region (Jakarayan, 1988). Today, in many developing countries of Africa where housing standard has improved and impermeable roofs are constructed, rainwater harvesting is becoming increasingly important, In Zimbabwe, between 80 to 85 percent of all measurable rainfall is collected and stored for use (Morgan, 1990).

In Nigeria, rainwater harvesting has been practiced in parts of Lagos, Jos and other rural communities. Whereas in Delta State, rainwater harvesting has been practiced in the rural communities of Oshimili north and Udu local government areas (Ezenwa, 2004 and Edekele, 2004). Also, Efe (2006), studied rainwater harvesting in some rural communities in Delta State because of the advantages derives from this source of water supply. Rainwater harvesting is advantageous as it is free and located close to the end user. It thus eliminates the need for complex and costly distribution network. Rainwater provides a water source when groundwater is unacceptable and not available and it can augment limited groundwater supplies. Rainwater harvesting is a non-point source pollution and also reduces consumers utility bills, hence its acceptability and by majority of urban and rural dwellers in developing countries of the world and Nigeria in particular.

Statement of the Problem

Our lives depend very much on good supply of water, hence we cannot take water quality for granted. The quality of water harvested from different catchment roofs in the urban and rural areas of Nigeria has been a major concern to researchers. This is based on the fact that most of the harvested rainwater is consumed just as it is collected without further purification especially in the rural areas. Thus, incidences or water-borne disease have been reported in these rural commodities, may be as a consequent of the consumption of this rainwater which may be attributed to the method of collection and materials used

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as against other sources of water supply in the area. Also, in the urban areas, people harvest rainwater as alternative source of water supply because of the erratic nature of pipe- borne water supplied by government. This also has contributed negatively in terms of healthy living of the people. Thus, cases of water-borne diseases such as typhoid, diarrhea and dysentery are widespread in the area. It is on this basis that the need to assess the quality of rainwater in rural and urban areas of Ughelli North Local Government Area of Delta State arose. There is therefore the need to compare the quality of the harvested rainwater in the rural and urban areas as meeting the standard required for human consumption in order to safeguard human health.

AIM AND OBJECTIVES OF THE STUDY

This study is aimed at comparing the quality of rainwater harvested in the rural and urban areas of Ughelli North Local Government Area of Delta State. The specific objectives are:

1. Ascertain the level of variation between the quality of rainwater harvested in the rural and urban areas of Ughelli North Local Government Area
2. Compare the quality of rainwater harvested in the rural and urban areas of Ughelli North Local Government Area.
3. Suggest ways of improving the quality of rainwater harvested in the area

Research Hypothesis

Ho: There is no significant difference between the quality of rainwater harvested in the rural and urban areas of Ughelli North Local Government Area of Delta State.

Area of Study

The area of study is Ughelli North Local Government Area of Delta State with headquarters at Ughelli. Ughelli is located between latitude 5° 28′ N and 5° 32′ N of the Equator and also between longitude 5° 38′ E and 6° 03 of the Greenwich meridian. Agbarha-Otor, Oviri-Ogor, Oteri and Eruemukohwarien, for rural communities and Ughelli as an urban communities are the study areas in this work. These communities depend on rainwater as a source of water supply in the area.

METHODOLOGY

The data for this study were derived from rainwater samples collected at the time of rainfall in the months of June, July and August from the gutter of the zinc catchment roofs in the area. The zinc catchment roof is the predominant roofing sheet used in the urban and rural areas of the local government, hence is choice. The samples were collected with sterilized cans of 2 litres each meant for that purpose. The samples were collected ten minutes after the commencement of the rain. The water samples were collected at the same time in all the locations with the assistance of field assistants trained for that purpose. In all, a total of sixteen samples were collected and kept in a cooler at a temperature of 4°C before being taken to the laboratory for analysis.

DATA ANALYSIS AND DISCUSSION OF RESULTS

The results from the physic-chemical analysis are shown in tables 1, 2 and 3

From the above table 1, 1 the pH values of rainwater harvested were generally lower than the WHO (2010) permissible standard for drinking water quality. A mean pH value of 5.90 was recorded in the area as against 6.5 - 8.5 WHO (2010) threshold value. This shows that the rainwater harvested in the area is mildly acidic in nature. The temperature values of rainwater harvested were generally satisfactory. This is evident from the 29.69°C mean temperatures values recorded in the area. In terms of turbidity, mean value of 0.05 NTU was recorded. This value is generally low and falls within the WHO (2010) acceptable threshold value of 5.00NTU. The acidity values of rainwater harvested were generally lower than the WHO (2010) acceptable threshold. This is evident from the 19.50 mg/1 mean acidity value recorded in the urban area of Ughelli. However, these value are lower than those recorded by Efe and Mogborukor (2008) in a similar study in the Niger Delta of Nigeria

Furthermore, the alkalinity values of the harvest rainwater are generally lower and fall within the WHO (2010) acceptable threshold for drinking water quality. A mean value of 30.76mg/1 was recorded in the area. The dissolved oxygen values of the harvested rainwater were generally higher that the WHO (2010) acceptable limit. A mean value of 7.44mg/1 was recorded in the area. This value is higher than 5.00mg/1 WHO (2010) threshold value. Also in the urban areas of Ughelli, denoted by Zones A — D, the mean values of total dissolved solids were generally low and within the WHO (2010) acceptable threshold. A mean of 0.04mg/1 was recorded. Also, the total suspended solids were generally within the WHO (2010) acceptable values. A mean value of 0.06mg/1 was recorded as against 5.00mg/1 WHO (2010) threshold value (see table 1). Also in the area, the sulphate values of rainwater were generally lower than the WHO (2010) acceptable threshold. This is evidenced from the 16.30mg/1 mean values recorded, which is lower and within the 200mg/1 WHO (2010) acceptable threshold for drinking water quality. Vanadium values of <0.001 mg/1 were recorded in the urban areas of Ughelli. This value falls within the 0.001mg/1 WHO (2010), acceptable threshold. The implication of this is that no vanadium contamination was found in the harvested rainwater samples. Also, nickel values in the analyzed water samples were generally less than 0.001mg/i. This recorded value is less than 0.001mg/i WHO (2010) acceptable threshold. This implies that no nickel contamination was found in the harvested rainwater in the area.

The mean lead values in the harvested rainwater from the zones in the urban areas of Ughelli were generally higher than the WHO (2010) acceptable threshold of 0.O1mg/1 for drinking water standard. A mean value of 0.018mg/1 was recorded in the area. This high value of lead recorded in the area was attributed to pollution from automobiles fumes and also from gas flaring sites located in the area. This assertion is in line with Efe (2006). In a similar study which confirmed high lead concentration in rainwater in the Niger Delta. Also, Iron mean values in the harvested rainwater were generally higher than the WHO (2010) acceptable limit for drinking water quality. A mean value of 0.593mg/1 was recorded as against 0.03mg/i was recorded. This value falls within the Who (2010) acceptable limit

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for drinking water quality. From table 2, the pH values range from 5.72 to 6.54 in the different rural communities with a mean value of 6.04, which is within the WHO (2010) acceptable limit for drinking water quality. The temperature value in the rural communities studied are as shown in table 2 vary from 29.5°OC to 30.05°C with a mean value of 29.87°C, which is within the WHO (2010) acceptable threshold. In the harvested rainwater, turbidity values range between 0.O2NTU to 0.O6NTU with a mean value of 0.O5NTU. This mean value falls within the WHO (2010) acceptable limit for drinking water quality. Also in the rural communities studied, alkalinity values range from 26.45mg/1 to 34.09mg/1. A mean value of 29.61mg/1 was recorded. This mean value falls within the WHO (2010) acceptable threshold for drinking water quality.

Table 1: **Mean physic-chemical characteristics of harvested rainwater within the urban area** of Ughelli

Parameters	Zone A	Zone B	Zone C	Zone D	Mean Value	WHO 2010 Standard	Remarks
pH	6.10	5.86	5.72	5.90	5.90	6.5-8.5	Safe
Temperature °C	29.53	29.73	29.90	29.69	29.69	29.80	Safe
Turbidity (NTU)	0.06	0.06	0.05	0.03	0.05	5.00	Safe
Acidity (mg/1)	18.45	21.33	16.73	21.50	19.50	NA	Safe
Alkalinity (mg/1)	31.75	28.50	33.99	28.78	30.76	Min 30	Safe
DO (mg/1)	7.39	7.93	7.43	7.00	7.44	5.00	Safe
BOD (mg/l)	1.18	1.03	1.06	0.99	1.07	NA	Safe
TDS (mg/l)	0.02	0.01	0.01	0.04	0.02	500	Safe
TSS (mg/l)	0.05	0.02	0.01	0.05	0.06	5.00	Safe
Sulphate (mg/l)	17.48	13.28	18.08	16.34	16.30	200.00	Safe
Vanadium (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	Safe
Total hardness	6.62	6.30	6.65	6.72	6.57	NA	Safe
Nickel (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	Safe
Lead (mg/l)	0.054	0.017	<0.001	<0.001	0.018	0.01	Not Safe
Iron (mg/l)	0.806	0.638	0.398	0.530	0.593	0.30	Not Safe
Zinc (mg/l)	0.632	0.615	0.421	0.310	0.495	3.00	Safe

Parameters	Agbarha-Otor	Oviri-Ogor	Oteri	Eruemuko hwarien	Mean Value	Who 2010	Remarks
pH	5.82	6.54	6.07	5.72	6.04	6.5 – 8.5	Safe
Temperature °C	29.98	29.50	30.05	29.95	29.87	29.80	Safe
Turbidity (mg/1)	0.02	0.06	0.06	0.06	0.05	5.00	Safe
Acidity (mg/1)	23.40	20.14	21.25	18.50	20.82	NA	Safe
Alkalinity (mg/1)	26.45	34.09	28.70	29.19	29.61	Min 30	Safe
DO (mg/1)	7.27	7.35	6.65	7.63	7.63	5.00	Safe
BOD (mg/1)	1.13	0.89	0.93	0.92	0.97	NA	Safe
TDS (mg/1)	0.01	0.01	0.01	0.01	0.01	NA	Safe
TSS (mg/1)	0.02	0.03	0.01	0.02	0.02	5.00	Safe
Sulphate (mg/1)	15.88	6.65	7.08	6.71	9.08	200	Safe
Vanadium (mg/1)	0.001	0.001	0.001	0.001	0.00	0.001	Safe
Total hardness	5.78	7.96	6.69	6.70	6.78	NA	Safe
Nickel (mg/1)	0.001	0.001	0.001	0.001	0.001	0.001	Safe
Lead (mg/1)	0.001	0.003	0.27	0.001	0.015	0.01	Not Safe
Iron (mg/1)	0.749	0.452	0.546	0.547	0.574	0.03	Not Safe
Zinc (mg/1)	0.557	0.561	0.514	0.508	0.536	3.00	Safe

Source: Fieldwork, 2010.

Dissolved oxygen ranges from 6.65mg/1 to 7.63 in the different communities. A mean value of 7.23mg/1 was recorded in the area. This implies the absence of dissolved micro-organisms in the water. The water is therefore safe for domestic purposes. Biochemical oxygen demand (BOD) concentration in the water samples range from 0.89mg/1 in the different communities. A mean value of 0.97mg/1 was recorded. This value falls within the WHO (2010) acceptable limit for drinking water standard. Total dissolved solids and total suspended solids ranges from 0.01 to 0.03mg/1 and 0.01mg/1 to 0.01mg/1 to 0.03mg/1 respectively. Mean values of 0.01mg/1 and 0.02mg/1 were recorded for total dissolved and total suspended solids respectively. These recorded mean values are within the WHO (2010) acceptable limit for drinking water quality.

Table 3: Comparison between the physic-chemical characteristics of harvested rainwater in the urban and rural areas of Ughelli North Local Government Area

Parameters	Urban	Rural	WHO std	Remarks
pH	6.90	6.04	6.5 – 8.5	Safe
Temperature °C	29.69	29.87	29.80	Safe
Turbidity (NTU)	0.05	0.05	5.00	Safe
Acidity (mg/1)	19.50	20.82	NA	Safe
Alkalinity (mg/1)	30.76	29.61	Min 30	Safe
DO (mg/1)	7.44	7.23	5.00	Safe
BOD (mg/1)	1.07	0.97	NA	Safe
TDS (mg/1)	0.02	0.01	0.03	Safe
TSS (mg/1)	0.06	0.02	5.00	Safe
Sulphate (mg/1)	16.30	9.08	200	Safe
Total hardness	6.57	6.78	NA	Safe
Vanadium (mg/1)	<0.001	0.001	0.001	Safe
Nickel (mg/1)	<0.001	0.001	0.001	Safe
Lead (mg/1)	0.018	0.015	0.01	Not Safe
Iron (mg/1)	0.593	0.574	0.03	Not Safe
Zinc (mg/1)	0.495	0.536	43.00	Safe

Source: Fieldwork, 2010

Parameters	N	Correlation	t – Value	df	sig	Remarks
pH	16	-0.388	-0.913	15	0.376.	No Sig difference
Temperature °C	16	0.327	-1.616	15	0.217	No Sig difference
Turbidity (NTU)	16	0.215	-0.426	15	0.676	No Sig difference
Acidity (mg/1)	16	-0.370	-0.739	15	0.471	No Sig difference
Alkalinity (mg/1)	16	0.295	0.480	15	0.638	Sig difference exist
DO (mg/1)	16	0.170	0.709	15	0.489	Sig difference exist
BOD (mg/1)	16	0.289	2.090	15	0.054	Sig difference exist
TDS (mg/1)	16	0.115	1.660	15	0.118	Sig difference exist
TSS (mg/1)	16	0.411	2.214	15	0.024	Sig difference exist
Sulphate (mg/1)	16	0.235	3.368	15	0.003	Sig difference exist
Total hardness	16	0.229	0.534	15	0.601	No Sig difference
Vi (mg/1)	16	0.00	0.00	15	0.00	No Sig difference
Ni (mg/1)	16	0.00	0.00	15	0.00	No Sig difference
Pb (mg/1)	16	-0.123	0.196	15	0.847	No Sig difference
Fe(mg/1)	16	0.588	0.735	15	0.474	Sig difference exist
Zn (mg/1)	16	0.456	-0.715	15	0.486	No Sig difference

Source: Fieldwork, 2010.

Sulphate value ranges from 6.65mg/1 to 15.88mg/1 with a mean of 6.78mg/1. This value falls within the WHO (2010) acceptable for drinking water quality. Also, in the rural

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areas of Ughelli, vanadium values range from <0.001mg/l to <0.001mg/l, with a mean value of <0.001mg/1. This value falls within the WHO (2010) threshold for drinking water quality. It implies therefore that the rainwater in the studied rural areas is safe from vanadium concentration. Nickel equally varies from <0.001mg/1 to <0.001mg/1 in the rural communities. A mean value of <0.001mg/1, which is within the WHO (2010) acceptable limit for drinking water quality. Lead concentration ranges from <0.001 to 0.027 in the rural communities, with a mean value of 0.15mg/1. This recorded mean value is above the WHO (2010) permissible standard for drinking water quality. This implies that the water is not safe for human consumption. Iron concentration in the area varies from 0.452mg/1. A mean value 0.574mg/i was recorded. This value falls above the WHO (2010) permissible standard for drinking water quality. This implies that the water in terms of iron concentration is not fit for human consumption. Zinc concentration in the studied rural communities range from 0.5Omg/; to 0.561 mg/i with a mean concentration value of 0.536mg/1. This value falls within the WHO (2010) acceptable limit for drinking water quality. From table 3, the quality of rainwater harvested in the urban and rural areas of Ughelli North Local Government Area varies in some of the parameters examined. It was observed that variation exists in such parameters as sulphate, alkalinity, dissolved oxygen, biochemical oxygen demand, total dissolved solids, total suspended solids and iron. Whereas in such parameters as turbidity. pH, temperature, acidity, vanadium, lead and zinc, there were no significant variations in their mean values. However, all the parameters examined except lead and iron in the urban and rural areas are within the WHO (2010) permissible standard fro drinking water quality.

Test of hypothesis

The posited hypothesis which states that there is no significant differences between the quality of rainwater harvested in the rural and urban areas of Ughelli was tested using the paired t-test statistical technique. The result is as shown in table 4. It can be deduced from table 4, that there were no significant differences in pH, temperature, turbidity, acidity, vanadium, nickel, lead and zinc, whereas significant differences exist in alkalinity, DO, BOD, TDS TSS, sulphate and iron in the parameters examined.

Findings

The study revealed that most of the parameters examined in the urban and rural areas of Ughelli North Local Government Area in the harvested rainwater showed satisfactory concentrations when compared to the WHO (2010) maximum acceptable limit for drinking water quality. Thus, rainwater in the area can be harvested, stored and utilized for domestic purposes.

RECOMMENDATIONS

In view of the laboratory results of the analyzed water samples from the harvested rainwater in the area, the following recommendations are suggested:

- The harvested rainwater in the area should be allowed to stand for some time to allow the suspended impurities to settle down before being used for domestic purposes.

- The harvested rainwater should be purified further through the addition of some quality of aluminum sulphate to enable suspended impurities to settle down before use
- Rainwater harvesting should be properly carried out by rinsing collection materials such as buckets from the ground, so that sand particles and other impurities do not splash into the buckets. Also, harvesting of rainwater should be done at least 10 to 15 minutes after the rain has started to enable impurities from the catchment roofs to be washed down.
- Harvested rainwater for domestic consumption should be boiled before use to kill all pathogenic bacteria (Efe, 2006 and Tripatty and Panda, 2001).

CONCLUSION

Rainwater harvesting in the urban and rural areas of Ughelli North Local Government Area is an alternative source of water supply for the people. In the study. The examined physic-chemical parameters of harvested rainwater showed satisfactory concentration for domestic purposes. However, harvested rainwater in the area needs to be purified further to eliminate excess concentration of pH, Lead, zinc and iron contents in order to safeguard human health.

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