Rain water harvesting: a sustainable alternative for domestic water supply in South–Western Nigeria: in the case study of Ado-Odo/Ota LGA Ogun State

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Abstracts. Nigeria is currently facing various environmental challenges such as water scarcity and water quality; which is one of the largest environmental problems. However, the available supply of renewable water is short of the demand in Nigeria. Researchers have studied many alternative to better solve the emerging water supply problem. This study considers rainwater harvesting as an alternative source of water to ameliorate the possible scarcity. To better understand common practises in the rain water harvesting community and motivation for collecting harvested rainwater a socio-demographic survey was conducted in four communities in Ado-Odo/Ota Local Government Ogun State Nigeria to determine the rate of water consumption and supply from current water sources. A total of 400 questionnaires were administered to various household and the data collected through the survey were analysed using SPSS and selected statistical methods. Rainfall data for Ota was obtained and it was to calculate the cumulative runoff in a year was determined for roof sizes are $\leq 75m^2$.This study demonstrated among other things that rainwater harvesting has the potential of contributing significantly to solving the problems of water shortage suffered not only by the rural-poor communities but also in the urban areas where conventional modes of water supply have failed to provide the desired level of service.
Keywords: Rainwater, supply

1. Introduction

Beside air, water is undoubtedly man's greatest need, one which will ever remain indispensable as long as there is life. Throughout antiquity and even in the modern times, the goal of providing good quality water in quantities sufficient for the sustenance of man and animals. This invariably constitutes one of the greatest challenges of human civilization. Rain water is one of the basic sources of portable water. The process of collecting water for valuable use or water infiltration into the ground increasing groundwater capacity in the aquifer is known as rain water harvesting [1].

Rain water harvesting ends up being a feasible option for local water supply in south-western Nigeria because of the fact that Nigeria is a developing nation and public water supply to the populace obviously gives a ruin sought after. At the point when there is an incredible imbalance between the regular extraction of water and common release over some undefined time frame, the drop of the water table results in lessening the yield. The main option for the present age is to enhance the recharge of water back into the ground or surface water bodies well beyond the congenital procedures. Rain water harvesting and recharge shows very high prospects and also have artificial recharge methods [2-4].

In south western Nigeria, over the years, surface water via: rivers, streams etc. and ground water have been exploited in various forms to meet water needs [5]. Dams and reservoirs have been built to provide water for different societies. In central urban areas, there are piped borne water facilities which supply water to households, while rural dwellers obtain water from streams and rivers within their

environs [6]. However, recent developments in these areas have shown that water scarcity will remain a grave problem, a situation which shows that conventional water supply initiatives do not possess the magic for automatically solving all water problems. Besides the problem of water scarcity, available water bodies within this part of Nigeria are being indiscriminately polluted at an alarming rate due to unhealthy industrial practices.

Rainwater harvesting research has been an overwhelming examination region at the worldwide science. [7] in 1982 audited 170 articles on rainwater harvesting in the vicinity of 1970 and 1980. Likewise, there have been an expansive number of concentrates that have examined rainwater harvesting in all the distinctive parts of the world. Endeavours have been made in Nigeria [8], Brazil, South Africa, and Kenya and some other developing countries. Rainwater harvesting (RWH) is an expanding basic practice everywhere in the world. In Nigeria, populace development, contamination of groundwater caused by poor waste administration and low yield of wells amid the dry season [9] make collected rainwater an appealing option for consumable and non-consumable (e.g. water system, clothing) employments. There is an expansive use of rainwater in numerous parts of the world including, US, Australia, Bangladesh and Korea [9]. People keep on modifying their abodes and devise frameworks to use harvested rainwater because of population increase worries over environmental change and weight on water demand.

There is an issue of absence of supply of pipe-borne water in Nigeria. Thus, numerous homes have wells sited around the house some distance away from their septic tank. The shortage of pipe-borne water has influenced people of the community to discover other water sources; groundwater sources being a reliable source. Wells are a typical groundwater source promptly investigated to meet the society's water necessities or address deficiencies [10]. The difficulties in expanding access to enhanced drinking water is additionally convoluted by disparities in arrangement, which might be topographical (amongst urban and rural settlement); financially (between poor people and all the more monetarily hindered) or identified with the unbalanced spotlight on water in correlation with sanitation. The essential explanation behind this examination is to have a goal at embracing rainwater harvesting as an option for local water supply and by so counteracting water shortage now and in the closest future.

2. Methodology

The study area is Ogun State; is located in the south western region. The study area of this research includes Ilogbo, Balogun, Idiagbon and Olorunda Agonan which are villages located in Ado-Odo/Ota local government in south-western part of Ogun State as shown in Figures 1 & 2. The local government has a population of 526,565 residents (2006, National population Bureau, of statistics). The catchment occupied an area of about 87.8km^2. Below are the characteristics of the villages visited within the local government. The mean annual rainfall for the study area is about 1900mm. Rainfall usually begins in the month of February or March and declines in the months of October to November of each year.

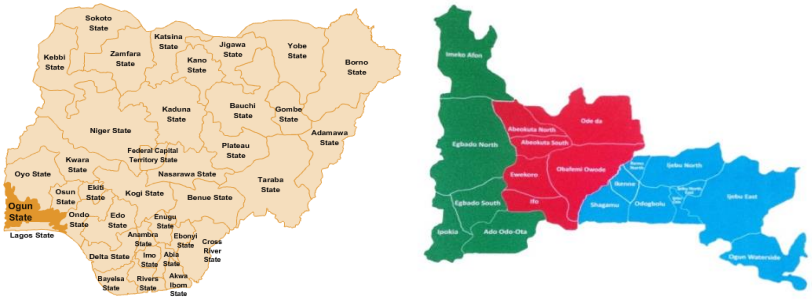

Figure 1. Map of Nigeria and Ogun State Respectively

The study is aimed at detailed description of the socio economic effect of rain water harvesting and common water supply practices. The survey was conducted in villages within Ado-Odo local government with the use of a well-defined questionnaire to obtain information for analysis on the

sources of water in the study area, its usage and how to develop a culture of harvesting rain water in every household.

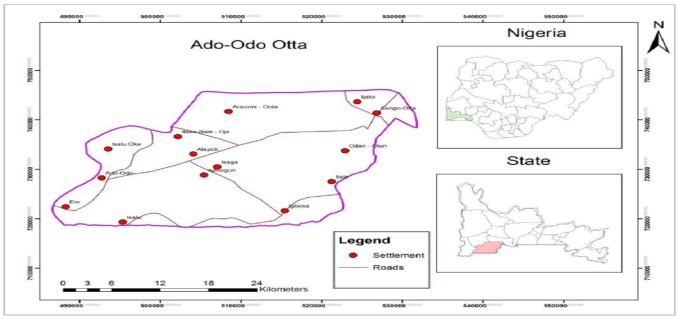

Figure 2. Maps Showing the Study Area, of Ado-Odo/Ota LGA

2.1. Data Collection Method

In data collection, two sets of data were obtained in the study, they include primary and secondary data. Primary data/information on rainwater harvesting as an alternative source of water in the Ogun state region which was acquired by meeting inside and out with the utilization of questionnaires as a guide. This technique unfurled respondent perception and information by speaking and taking down the subtle elements and in circumstances where respondents can actually round out the data, they are permitted to do as such. Restrictions experienced incorporate the necessity of respondents' collaboration and powerlessness to give solid answers. A great deal of time was likewise associated with examination of the information as significant exertion is put into its collation.

Secondary data used which is readily available from other archives. These data were obtained from the following sources: Journals, Articles, Reports, Website pages, Conference Proceedings Newspapers.

2.2. Method of Data Analysis

The data gotten from the questionnaires was analysed with the use of computer applications such as Microsoft excel and Statistical Package for Social Science (SPSS). The data was then neatly entered into tables in order to permit meaningful statistical analysis and proper interpretation. Statistical tools like charts (bar chart and pie chart), graphs, and tables will also be used for the data analysis. Laboratory test will also be carried out on water samples gotten from rooftop rainwater harvesting technique.

3. **Results and Discussion**

The first section will summarise the general findings of the research with respect to water supply/use scenario within the study area of Ado-Odo Ota local government in Ota town, Ogun state as well as the attitude of the generality of people to domestic rainwater harvesting with the help of the questionnaires shared. In the second section, the cumulative harvested water for each month is calculated using data from the types of roof obtained from the questionnaire.

3.1 Characteristics of the Respondents

A total of 400 people were interviewed. 51% of the individuals interviewed are males and 49% are females. The individuals interviewed were within the age group of 17 to 55 and above. Most of the respondents were within the age group of 35-44 which accounts for 27% of the total people interviewed. A very large percentage of the respondents are married and a few were single or divorced. Most of the respondents had one occupation or the other leaving only 4.7% of the respondents unemployed. Most

of the respondent's highest level of education is primary school certificate which explains why most of them selected unskilled labour for their occupation.

Table 1. Locations where the questionnaire were distributed.

Location	Number of questionnaires shared
ILOGBO	50
BALOGUN	50
IDIAGON	50
OLORUNDA	50
LUISADA	50
ISHAGA	50
OGUNTED	50
AKINWUNMI	50

Table 2. Sex distribution of respondents.

Variable N = 400	Frequency (n)	Percentage (%)
Sex		
Male	204	51
Female	196	49

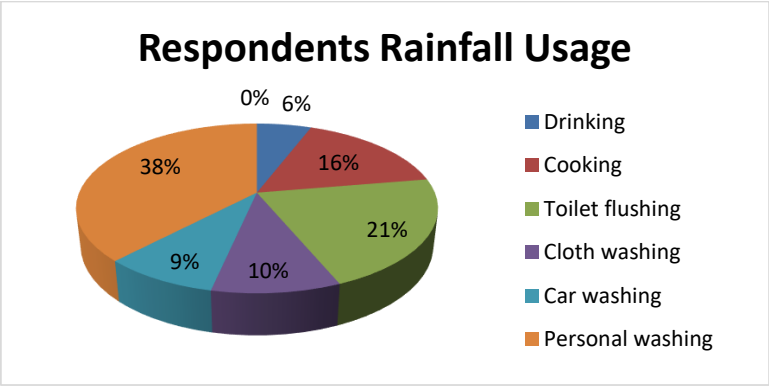

Figure 3. Sex Distribution of Respondent

Table 3. Age distribution.

Variable N = 400 Age (in years)	Frequency (n)	Percentage (%)
0 – 17 years	6	1
18 – 24 years	26	7
25 - 34 years	80	20
35 – 44 years	108	27
45 – 55 years	92	23
55+ years	88	22

3.2. Respondents Roofing Material

From the results obtained, it was noticed that a larger percentage uses corrugated iron sheet for roofing their houses because it is more affordable and economical. This roof is prone to corrosion, so the harvested water needs to be treated with chlorine or other substance if it's to be used for portable use. A result of the research done in the villages visited in Ado-Odo/Ota local government was that the average area roof area is 75 m^2. Now working with volumes in terms of runoff, a 75m^2 roof can harvest 77,657L/yr. This signifies that 212L/day assuming water is gotten constantly.

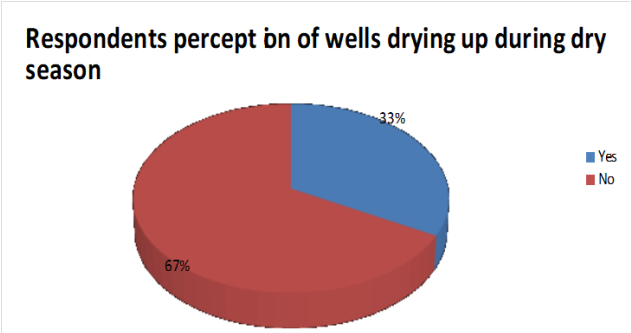

Figure 4. Roofing Material Used by Respondents

3.3. Respondents Rainfall Usage

The fig below shows the usage of rainwater harvested by the respondents (Starting from highest order of usage) personal washing, toilet flushing, cooking, cloth washing, car washing, and general outdoor use respectively. These signifies that majority of the water harvested is used for personal washing and washing of toilets. These two activities consume a lot of water as 55L/day is used for personal washing and 35L/day per day for flushing of toilet.

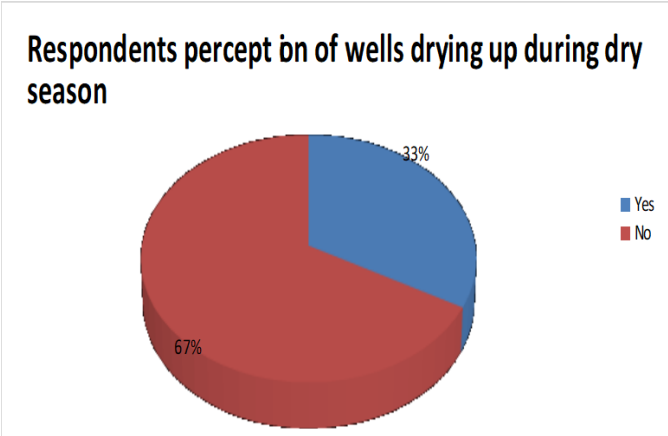

Figure 5. Respondents Rainfall Usage

3.4. Respondent Awareness to Rainwater Harvesting Technologies

The chart below shows if the respondents are aware about rainwater harvesting. A very large percentage of 82% are not aware about this and just 18% was aware of this. The respondents were also asked if they would like to buy or rent rainwater technologies if available. 71% of the respondents were interested in buying or renting rainwater technologies. This shows there is still a huge potential for rainwater harvesting.

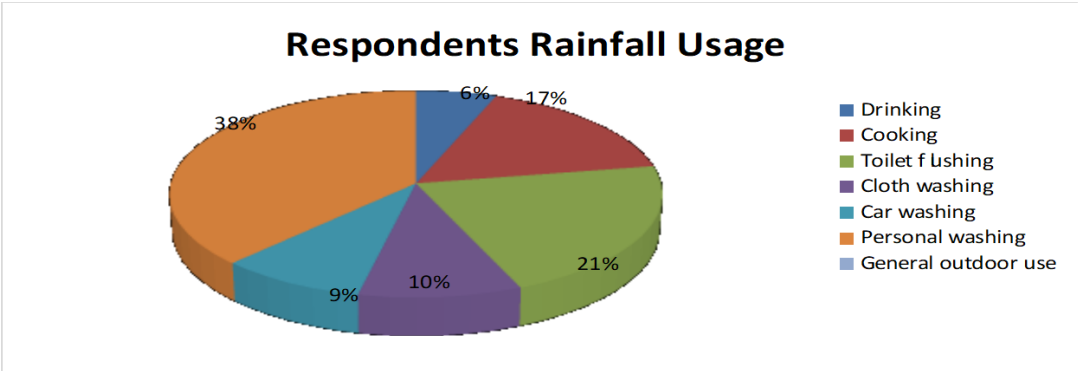

Figure 6. Respondent Awareness to Rainwater Harvesting Technologies

3.5. Major Health Hazard Associated with Drinking Contaminated Water

From fig 7, a large percentage (73%) of the respondents suffer from typhoid disease which is quite alarming. 6% of the respondents also suffer from cholera and just 1% suffer from diarrhoea. This means that 80% of the respondents suffer from one disease or the other from consuming water from their various water sources. The result explains that a new portable water source should be found as an alternative water source for the respondents.

These chart shows the percentage of wells that runs dry during dry season. Since a larger percentage of the respondents selected dug wells as their major source of water supply, that means a larger percentage suffers the drying up of well. When also asked about their level of satisfaction with hand-dug wells in terms of its ability to meet their daily water needs as well as quantity, the respondents expressed a high level of frustration with it because of quality problems taste, colour and hardness were the main problems identified with it. Respondents that selected borehole also claimed that water level reduces during dry season when asked. However, a good number of the respondents were not so enthusiastic about its quality. Many openly registered their displeasure with its taste, colour and saltiness.

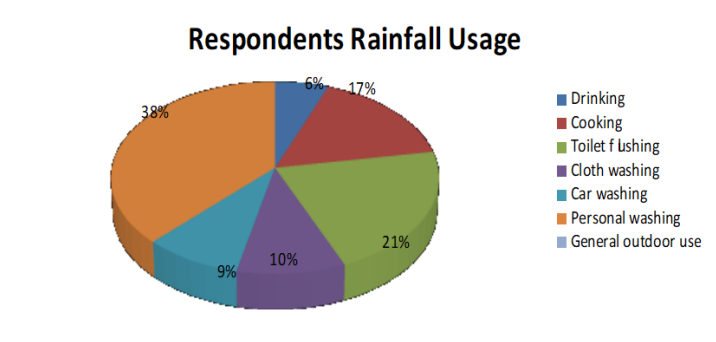

Figure 7. Major Health Hazard Associated with Drinking Contaminated Water.

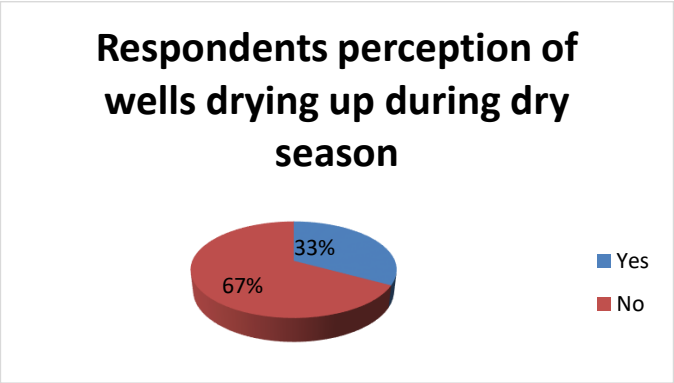

Figure 8. Respondents perception of wells drying up during dry season

3.6. Rainwater harvesting

The following are the typical representations for the rainwater harvesting system. Table 4 and Table 5 are shown below for the coefficient for various roofs and the cumulative harvested water.

Table 4. Typical runoff coefficients for various roofs.

Surface	Type	Coefficient
Roof	Pitch roof tiles	0.75-0.90
	Flat roof with smooth surface	0.5
	Flat roof with gravel layer or thin turf (<150mm)	0.4-0.5

Table 5. Cumulative Harvested Water.

Month	Average rainfall [I] (mm)	Runoff coefficient [C]	Roof area [A] (m^2)	Monthly runoff harvested [C*I*A] (m^3)	Cumulative runoff harvested (m^3)
January	3.1	0.825	75	0.19	0.19
February	34.6	0.825	75	2.14	2.33
March	80	0.825	75	5.0	7.33
April	115.5	0.825	75	7.2	14.53
May	150.5	0.825	75	9.3	23,83
June	190.6	0.825	75	11.8	35.63
July	180.4	0.825	75	11.2	46.83
August	146.2	0.825	75	9.01	55.84
September	192.6	0.825	75	12.0	67.84
October	180.9	0.825	75	11.2	79.04
November	20.4	0.825	75	1.3	80.34
December	8.2	0.825	75	0.5	80.84

From the table, a total of 80.84m^3 of water can be harvested from rooftops assuming a constant withdrawal.

4. Conclusion and Recommendations

This study has demonstrated among other things that rainwater harvesting has the potential of contributing significantly to solving the problems of water shortage suffered not by the rural-poor communities but also in the urban areas where conventional modes of water supply have failed to provide the desired level of service. The developing nations of the third world where inadequate water supply continues to be a recurrent feature stand the chance of benefitting enormously from the often neglected "wisdom" inherent in this initiative. The awareness survey carried out revealed a high degree of ignorance about formal rainwater harvesting on the part of the respondents and by implication the generality of the people. Not many are aware of the process involved. However, when asked about their willingness to adopt such systems, a good number of them sounded rather enthusiastic about the idea which is an indication of the initiative holds huge prospects if only there is proper enlightenment. Rain water harvesting could be practised in south western Nigeria from the results gotten from the case study Ado-Odo Ota due to the sustainable level of rainfall. About 88% of the rooftops are still in a fair state and made of appropriate materials. Results gotten the research in the study area shows that the average roof is within 75m^2 range and will collect 77,657L/yr (42L/person/day) for a household of 5 people. This value is close to the water demand for cooking and drinking. Hence, the storage capacity for storing rain water harvested for multipurpose use must be large enough to store a large quantity of rainfall. Due

to the nature and type roofs used by people, rainwater must be properly treated before it's used for portable use. The research also shows that Ogun state in general has huge potential of rain water harvesting.

Acknowledgement
The Authors acknowledge Covenant University for the conference support payment

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