Global Advanced Research Journal of Environmental Science and Toxicology Vol. 1(3) pp. 038-045, June, 2012
Available online http://garj.org/garjest/index.htm

Full Length Research Paper

Evaluating the potential of rainwater harvesting as a supplementary source of water supply in Kanai (Mali) district of Zangon-kataf local government area of Kaduna State, Nigeria

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Accepted 15 June, 2012

Rainwater harvesting is an economical small-scale technology that has the potential to boost safe water supply with least disturbance to the environment, especially in the semi arid regions. In Nigeria, less than half of the population has reasonable access to reliable water supply. This study in Kanai (Mali) district of Zangon-Kataf local government area of Kaduna state Nigeria determined the rate of water consumption and current water sources before estimating the amount of rainwater that can potentially be harvested using 225 copies of well structured questionnaires administered to households. Questions were related to the socio-economic characteristics of household and the sources of water, system or methods of rainwater harvesting, time and the distance spent to source for water, purpose for rain harvesting, strategies used by individuals/households to cope with domestic water scarcity and whether the strategies adopted meet their demand for water supply or not. A survey on 88 households in three villages namely, Runji, Gora Gida, and Sagwaza established that more than half of them rely on sources that are vulnerable to drought, i.e. shallow hand-dug wells and natural water bodies, while only 3% harvest rainwater. Kaduna state where the study area is located have a mean annual rainfall of 1,064 mm. Annual rain water harvesting potential per household was estimated to be 63.35 m^3. The amount could not meet the water demand for the study area although the three villages would have to supplement their rainwater with other sources. There is therefore sufficient rainwater to supplement the need of the rural communities if the existing mechanism and low involvement of the villagers in rainwater harvesting activities could be improved.

Keywords: Rainwater harvesting, Water sources, Public water supply, Households, Water storage

INTRODUCTION

The absence of public water system in the rural areas and the inability of water facilities to function effectively in the towns and cities of Nigeria have made it impossible for most of her population to have access to portable water. According to Orebiyi et al. (2010), fifty two percent (52%) of Nigerians have no access to improved drinking water supply. Water is an indispensible substance to man and all life processes. It is widely referred to as universal solvent. Water is classified based on sanitary quality as portable, contaminated or polluted. Water can be grouped into atmospheric, surface and ground water.

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Atmospheric water includes moisture contained in the cloud and which precipitates as snow and rain. Rain water is a form of precipitation in which liquid water falls to the earth's surface. It forms a major part of the hydrologic cycle in which water from the oceans evaporates, condenses into clouds and precipitates back to the earth and eventually return to the ocean via streams and rivers, to repeat the cycle again. (Ghisi et al., 2006) Water, a necessary reserve, has been found to be in short supply. Each day some 25,000 people are said to die from their every day use of contaminated water. Many millions more suffer from frequent and devastating water borne illnesses. (WHO, 2004) About half of the people that live in developing countries do not have access to safe drinking water and 73% have no sanitation, some of their wastes eventually contaminate their drinking water supply leading to a high level of suffering. The provision of water for domestic and other uses in rural and urban centers is one of the most intractable problems in Nigeria today.

Rainwater harvesting is the gathering or accumulating and storing of rainwater (Encyclopedia Britannica, 2010). Rainwater harvesting has been used to provide drinking water for man and his livestock and for irrigation or to fill aquifers in a process called groundwater recharge. Rainwater collected from the roofs of houses, tents and local institutions, or from specially prepared areas of ground, can make an important contribution to drinking water. Rainwater systems are simple to construct from inexpensive local materials and are usually successful in most areas. Roof rainwater can be of good quality and may not require treatment before consumption. However, some rooftop materials may produce rainwater that is harmful to human health.

Wirojanagud et al, (1989) opined that rooftop catchment of rainwater can provide good quality water, clean enough for drinking, as long as the rooftop is clean, impervious, and made from non toxic materials.

Household rainfall catchment systems are appropriate in areas with an average rainfall greater than 2000mm per annum, and no other accessible water sources. Availability of adequate water supply for drinking, cooking, washing, personal hygiene and other domestic purposes is essential for healthy survival of every community. The provision of potable water is one of the duties of the government to its citizens. Water scarcity is one of the major problems encountered by people of Kanai (Mali) district, just like in other parts of the state and many urban and rural centers in Nigeria.

Kania (Mali) district usually experiences periods of peak water shortage like many other towns and this corresponds to the dry/harmattan season of the year. Rainwater harvesting is an option, which has been adopted in many areas of the world where conventional water supply systems are not available or have failed to meet the needs and expectations of the people (Alam, 2006). Rainwater is free from arsenic contamination and the physical, chemical and bacteriological characteristics of harvested rainwater represent a suitable and acceptable means of potable water. Rainwater harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater, prevention of loses through evaporation and seepage and all other hydrological studies and engineering intervention, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit as a watershed (Agarwal and Narain 1997).

People can construct storage reservoirs so that they can use rainwater during the entire rainy season and about 2-4 months of the dry period, the capacity and the construction materials of the reservoir and its maintenance depend on the socio-economic condition, population, educational background and awareness of the inhabitants of the area.

The study focused on the effectiveness of the rainwater harvesting systems (methods and techniques of rainwater collection) in kanai (Mali) district of Zangon-kataf Local Government Area.

The study problem

The people of Kanai (Mali) district in Zangon-Kataf Local Government Area, like all other areas of the world require water for their daily domestic and commercial activities. Most settlements in the district are several kilometers away from the nearest stream or river, making access very difficult. All previous attempts to sink wells or boreholes in the district have failed because of the extremely low water table in the area. Majority of households in the district therefore rely on rainwater for domestic and other purposes.

Rainfall is however not evenly distributed throughout the year; this necessitates the need for its storage over time to cope with periods of scarcity. Unfortunately, people of different socio-economic strata have different financial capacities to acquire storage facilities to sustain them. Observations show that during the period of scarcity, people of all ages go about with containers in search of water for various purposes. It has also been observed that during the rainy season, rainwater is wasted through run off. This produces surface floods because of lack of storage facilities.

The study problem, therefore, is to examine the effectiveness of the rainwater harvesting systems (methods and techniques of rainwater collection and storage) in Kanai (Mali) district.

Aim and objectives of the study

The aim of the study is to assess the effectiveness of the

Table 1. Sample size selection.

Village	Population	Number of Households	Number of Households Sampled	% of Sampled Households
Runji	1171	112	56	50
Gora Gida	1644	178	89	50
Sagwazah	1433	151	80	50
TOTAL	**4248**	**441**	**225**	

Source: National Population Commission (Zangon-Kataf L.G.A Office)

Table 2. Gender of respondents.

Gender	Frequency	Percentage
Male	195	87
Female	30	13
Total	225	100

Source: Field Survey 2011

rainwater harvesting systems (methods and techniques of rainwater collection and storage) in kanai (Mali) district.

The study objectives, therefore, include the following:

i. To identify the sources of water in the study area.
ii. To determine the purposes for which rainwater is required in the study area
iii. To determine the methods and techniques used in rainwater harvesting in the study area.
iv. To determine the effectiveness of the methods and techniques of rainwater harvesting in the study area.
v. To identify the problems associated with rainwater harvesting.

The study area

Kanai (Mali) district, the study area is one of the districts of Zangon-Kataf Local Government Area found in Atyap Chiefdom and is about 10 km from Zonkwa the administrative headquarters of Zangon-kataf Local Government Area of Kaduna State and is one of the Local Government that makes up Southern Kaduna Senatorial District.

MATERIALS AND METHOD

The method of data collection was through the use of applicable sampling techniques. Since the research population is made up of the households in the study area, since the research population is made up of people who harvest and use rainwater, these are the residents of the study area, the researchers carried out a stratified sampling to delimit the area of study into villages. There are several villages in the study area. The area was stratified based on the villages in the area. .And three (3) villages were chosen because the selected villages have a reasonable population. The selected villages were then delimited using the simple random sampling technique to select various households for the research work. From these villages, the study samples were taken. Information on the number of households in the various villages of the study area was obtained from the National Population Commission (NPC) of Zangon-Kataf Local Government Secretariat.

The breakdown on how the samples were taken from the households in the three selected villages in Kanai (Mali) District is shown in Table 1. The study chose a sampling size of 50% for the households in the study area which is 225 households out of a total of 441 households in the study area. The sample size of 50% was chosen for convenience due to the limited time available to carry out the research. Oral interviews was also conducted with some of the household heads together with their wife/wives and children were engaged in a group discussion on the procedures of rainwater harvesting, uses of the harvested rainwater and the problems they encounter during periods of water scarcity in their various locations. The people responded to the questions. Some officials of the Kaduna State Water Board (KSWB) and the Local Government Officials as well as Ward heads were interviewed. This helped a lot in addressing some of the important issues which were not raised in the questionnaire.

RESULTS AND DISCUSSION

Table 2 shows the gender distribution of the respondents. It shows that a greater proportion of the respondents i.e 87% were males. This is so because most of the questionnaires were given to the heads of the

Table 3. Age of respondents.

Age group	Frequency	Percentage
21-40	62	28
41-60	141	63
Above 60	22	9
Total	225	100

Source: Field Survey 2011

Table 4. Educational status of respondents.

Education status	Frequency	Percentage
Primary	43	19
Secondary	121	54
Tertiary	11	5
Informal Education	50	22
Total	225	100

Source: Field Survey 2011

Table 5. Number of persons per household.

Number of persons	Frequency	Percentage
2-5	22	10
6-8	170	76
9 and above	33	14
Total	225	100

Source: Field Survey 2011

households sampled. Most household heads in the area of study were the males; this made the female respondents to be as low as 13%.

From Table 3 it could be seen that 62 of the respondents fall within the age group of 21 years to 40 years; this represents 28% of the total respondents. About 63% of the respondents are within the age range of 41 years to 60 years while a total of 22 respondents were above 60 years old, thus representing 9% of the total respondents. No respondents were younger than 20years. This is not unexpected since mostly household heads were interviewed.

Table 4 shows the educational status of the respondents. From the table, the number of respondents that had educational level up to secondary school surpasses the others as they claimed 54% of the total respondent. This is followed by those that obtained informal education with a percentage value of 22. Those that attained primary education were 19% of the entire respondents. About 5% of the respondents had tertiary education.

Table 5 reveals that 10% of the sampled households are 2-5persons. About 76% of the households have 6-8persons in them while 14% of the sampled households have more than 9 persons living in them. No household had less than 2 persons in them.

Table 6 shows the occupation of the respondents. About 7% of the respondents indicated that they are civil servants. About 5% of the respondents are traders. About 85% of the respondents are farmers; this group represents the largest proportion of the respondents. Artisans, craftsmen and other occupations make up 1% each.

Sources of household water

Table 7 below shows the main sources of water for domestic use in the study area.

The major sources of water supply for the study area are depicted on Table 8. The results show that 55% of the study population gets their water from hand dug wells. While 44% of the study population gets their water supply from rainwater harvesting. This is consistent with the researchers' observation during the periods of reconnaissance survey and data collection. Most of the households in the study area have different shapes and sizes of facilities for harvesting and storing rainwater

Table 6. Occupation of respondents.

Occupation	Frequency	Percentage
Civil servant	15	7
Trader	12	5
Farmer	192	85
Artisan	3	1
Craftsman	2	1
Others	1	1
Total	225	100

Source: Field Survey 2011

Table 7. Sources of water supply.

Sources	Frequency	Percentage
Rainwater	100	44
Hand Dug Well	123	55
Stream/river	2	1
Total	225	100

Source: Field Survey 2011

Table 8. Distance to water supply source during the dry season.

Distance (km)	Frequency	Percentage
2-5	196	87
More than 5	9	13
Total	225	100

Source: Field Survey 2011

as it is their major source of water supply all year round.

About 1% of the respondents get their water from streams/rivers; this could be attested to the fact that the nearest stream/river to the households in the study area is quite a distance.

Table 8 shows the distance travelled by the respondents to source for water during the dry season. The finding reveals that about 87% of the respondents travel a distance of about 2-5km to source for water during the dry season while a greater proportion(13%) of the respondents travel more than 5km to their respective sources of water supply during the long dry season.

Table 9 shows the average daily water usage per household in the study population. The result indicates that 15% of the respondents use below 100 litres of water in their households per day. This is inconsistent with the UNICEF's stipulated 50 litres of clean water a day per individual which it considered necessary to stay healthy - for drinking, washing, cooking, sanitation and personal hygiene. A greater proportion of the respondents (60%) make use of about 100-200 litres of water in their respective households per day. About 18% of the respondents make use of 201-300 litres of water per day in their households while 4% of the respondents use between 301-400 litres of water per day. Those that use about 401-500 litres of water per day in their households were just 2%.

Table 10 shows the major uses of the harvested rainwater. Twenty percent of the respondents use theirs mostly for cooking, 17% of the respondents use theirs mostly for drinking, and 44% of the respondents use theirs mostly for personal hygiene such as washing of clothes, flushing of toilets and bathing. About 11% of the respondents use theirs mostly for washing of kitchen utensils while 8% of the respondents use theirs mostly for brewing of their local drink popularly known as Burukutu. Four percent of the respondents use theirs mostly for other purposes such as washing of cars and irrigating their gardens.

These findings reveal that the rainwater harvesting in the study area is very effective. This is attributed to the fact that about 44% of the residents employ various means to harvest and store rainwater for their use.

However, the water only serves them for the rainy

Table 9. Average daily water use by the households.

Quantity of water (litres)	Frequency	Percentage
Less than 100	35	15
100-200	136	60
201-300	41	18
301-400	9	4
401-500	4	2
Total	225	100

Source: Field Survey 2011

Table 10. Major uses of the harvested rainwater.

Water use	Frequency	Percentage
Cooking	44	20
Drinking	38	17
Washing utensils	24	11
Personal hygiene	98	44
Brewing	13	6
Others	8	4
Total	225	100

Source: Field Survey 2011

Table 11. Alternative sources of water supply during dry season.

Source	Frequency	Percentage
Hand Dug well	200	89
Streams/Rivers	25	11
Others	0	0
Total	225	100

Source: Field Survey 2011

Table 12. Problems encountered during periods of water shortage.

Problems	Frequency	Percentage
Drying up of wells	112	50
Long distance to water source	32	14
Time wasting	22	10
Water borne diseases	10	4
Poor hygiene/Sanitation	49	22
Total	225	100

Source: Field Survey 2011

season as the wells provide water during the long dry season.

Table 11 shows that 89% of the respondents depend on hand dug wells during the dry season. About 11% of the respondents resort to the stream as an alternative source of water supply during the dry season.

Table 12 shows that 50% of the respondents face the problem of drying up of wells the dry season, particularly in the months of February through April. About 14% of the respondents face the problem of having to travel long distances to the stream. In most cases, the stream is far away from the settlement area. About 10% of the

Table 13. Assessment of Benefit from the Government on water supply.

Response	Frequency	Percentage
No	225	100
Total	225	100

Source: Field Survey 2011

respondents face the problem of time wasting as a result of searching for water during the dry season while 4% of the respondents face the problem of water borne diseases. About 22% the respondents face the problem of poor hygiene/sanitation as a result of water shortage during the dry season.

The respondents were asked if they are benefiting from any government assisted water project in their areas, all the respondents replied that there is no form of government assistance in water supply in the area.

Major findings of the study

Major findings of the study show that majority of households in the study area use harvested rainwater as their major source of water supply while water vendors and streams are other main sources. This simply implies that a large proportion of households in the study area get their water from untreated and sometimes unhealthy sources.

Major storage methods for the harvested rainwater in the study area includes earth pots, basins and buckets, reservoirs, water tanks and water drums. Majority of the respondents store their harvested rainwater in locally made earth pots.

The major technique of rainwater harvesting in Kanai (Mali) district is through the roof top. Rainwater is collected in simple vessels at the edge of the roof.

Findings on the major uses of the shows that about twenty percent of the respondents use the rainwater mostly for cooking, 17% of the respondents use theirs mostly for drinking, and 44% of the respondents use theirs mostly for personal hygiene such as washing of clothes, flushing of toilets and bathing. About 11% of the respondents use theirs mostly for washing of kitchen utensils while 6% of the respondents use theirs mostly for brewing of their local drink popularly known as Kunu and Burukutu. Two percent of the respondents use theirs mostly for other purposes such as washing of cars and irrigating their gardens.

These findings reveal that the rainwater harvesting in the study area is very effective. This is attributed to the fact that about 44% of the residents employ various means to harvest and store rainwater for their use. However, the water only serves them for the rainy season only as majority of the residents do not have adequate finance to construct or purchase larger storage facilities.

Majority of the respondents depend on hand dug wells during the dry season. About 11% of the respondents resort to the stream as an alternative source of water supply during the period of scarcity.

Result of the findings also indicated that 15% of the respondents use below 100 litres of water in their households per day. A greater proportion of the respondents (60%) make use of about 100-200 litres of water in their respective households per day. About 18% of the respondents make use of 201-300 litres of water per day in their households while 4% of the respondents use between 301-400 litres of water per day and about 2% make use of 401-500 litres of water per day in their households.

The results obtained from the study also revealed that major water supply problems faced by the households in the study area includes inadequate supply, long distance to the source of water supply and high cost of purchasing water during the dry season.

The research revealed that there is no form of government assistance in water supply in the area.

CONCLUSION

The people of kanai (Mali) district of Zangon-kataf local government area of Kaduna state are crying for potable water. The major source of water in the study area is from hand dug wells and rainwater harvesting which they enjoy during the rainy season only, as they largely lack bulk storage facilities to last through the dry season. During the dry season they encounter severe scarcity, because only few people could afford to dig reservoirs to store water for use at least for half a year. Majority of the people in the area store their water in small containers such as pots, buckets, Jerry cans and basins for short term usage only.

The lack of adequate storage facilities means that there is a lot of run-off during the rainy season and shortage during the dry season.

The water supply situation in Kanai (Mali) district typifies the scenario in other rural areas of Kaduna state in particular and Nigeria in general. To some extent, the poor water supply situation in Kanai (Mali) district is due to inadequacy of the state government and private sector participation in the provision of the basic facility coupled

with the rapid increase in the population of people in the area. This explains why majority of the people in the study area resort to untreated sources of water supply such as hand dug wells and streams.

RECOMMENDATIONS

The researchers are appealing to Federal Government, State Government, NGOs and individuals who are capable to come to the aid of the people to pull the people out of the water problem.

The following recommendations are hereby offered towards addressing the issue of poor rainwater harvesting systems practice in the study area:

- An earth dam should be constructed by the government to serve the whole Local Government Area.
- Boreholes, a source of water not available in the study area should be sunk as a means of curbing the water scarcity especially during the dry season.
- The local government in working collaboration with the state government should ensure the completion of the Government water projects in the area.
- There is also need for provision of pipe borne water hence the authority concerned should be brought into the picture with the aim of frequent provision of water.
- Since the harvested rainwater is partially contaminated, the local government Health Authority should carry out massive awareness campaigns on ways of purifying water before consumption from the available sources.
- Community participation should be encouraged as it can lead to a successful rural water supply scheme. This could be done in the form of personal involvement in the form of contribution of money for the purchase and installation of additional storage facilities.
- Proper hygiene should be maintained, closed pit latrines should be properly evacuated when filled and reservoirs should not be dug along the same line with s pit latrine. This will avoid seepage that leads to contamination of water sources.

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