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Enhancing Community-Driven Initiative in Rainwater Harvesting in Nigeria

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ABSTRACT

Water stakeholders are becoming increasingly worried about water scarcity as the population growth and climate change are likely to produce a drastic decline in the amount of water available per person in many part of developing world. Enhancing domestic Rainwater harvesting provides an additional source from which to meet local water needs. Rainwater harvesting provides full coverage in the wet season and partial coverage during the dry season as well as providing short – term security against the failure of other sources. Therefore, the paper presents domestic rainwater harvesting technology which reflects in the water policies of many developing countries like Nigeria, where it is now cited as a possible source of household water. Obviously, it is a better option where there had been shortage of drinking water at difficult terrain and other sources are extremely non – reliable. More so, collected data of mid – decade rainfall with corresponding graphs reflect the climate change in Nigeria.

Keywords: *Rainwater, Harvesting, Coverage, enhancing, guttering, roof, dry and rainy seasons.*

1. INTRODUCTION

Rainwater harvesting is a widely used term covering all those techniques whereby rain is intercepted and used “close” to where it first reaches the earth, Hatibu and Mahoo, (2000). As millions of people throughout the world do not have access to clean water for domestic purposes, where many parts of the world conventional pipe water is either absent, unreliable or too expensive according to Hattum and Worm, (2006) and in agreement with Hedcon, (2001), that one of the biggest challenges of this century is to overcome the growing water shortage in the entire world.

An enhancing rainwater harvesting as stated by Maddocks (1975) has thus regained its importance as a valuable alternative or supplementary water resources, along with more conventional water supply technologies. Actually, much or potential water shortage can be relieved if rainwater harvesting is practiced more widely.

Most often, in rainy season, people collect and store rainwater in buckets, tanks, ponds and wells, also this commonly referred to as rainwater harvesting and has been practised for centuries. Rainwater can be used for multiple purpose, ranging from irrigating crops to washing, cooking and drinking.

Moreover, rainwater harvesting is a simple low – cost technique that requires minimum specific expertise or knowledge and offers many benefits. Collected rainwater can supplement other water sources when they become scarce or are of low quality like brackish groundwater or polluted surface water in the rainy season Nicholson (1993).

Olaruntade and Oguntunde (2009) found that rainwater harvesting provides a good alternative and replacement in times of drought or when the water-table drops and wells go dry, also in the most arid or semi – arid areas, the prevailing climate condition makes it of crucial importance to use the limited amount of rainwater as efficiently as possible, as people realise that it cannot be managed. Also collected rainwater is a valuable supplement that would otherwise be lost by surface runoff or evaporation.

In recent time, rainwater harvesting technology has, however, quickly regained popularity as users realise the benefits of a relatively clean, reliable and affordable water source at home. In the six geographical regions of Nigeria, rainwater harvesting has now been introduced as part of an integrated water supply, where the town water supply is unreliable, or where local water sources dry up for a part of the year, while rainwater can also be introduced as the sole water sources for communities or households, Ionides, (1975).

Rainwater harvesting has according to Thomas and Martinson (2007) in their roof water harvesting brought into focus the innovative technology which is flexible and adaptable to a very wide variety of condition, also used in the richest and poorest societies as well as in the wettest and the driest regions.

Consequently, rainwater harvesting from the roof of individual houses and the method of harvesting is the main focus of the research paper. The roof water harvesting is a subset of rainwater harvesting and needs the best performances from the system also needs to be effectively managed by the users, to ensure that water is available in the dry season when water has its highest value, Thomas and Martison, (2007).

Indeed, one purpose of water store is to transfer water from the wet season to dry season. Domestic roof water harvesting system is managed directly by house holders rather than by government water committee or water companies, and a task that house holders soon be perfect, Tarhule and Woo, (1998). Therefore the following are the main characteristic of domestic roof water harvesting:

- It collects only the rain falling in the available roofs.
- It requires a suitable roof type and on – site water shortage (Tank).
- It delivers water direct to the house without need for water carrying.
- It does not require favourable local topography or suitable geology.
- It is household technology, and therefore does not require communal or commercial management.
- It gives chemically clean and usually biologically low – risk water.

In the study conducted by Hatibu and Mahoo (2000), stated that domestic roof water harvesting yields adequate quantities of water throughout the humid tropics, but only low quantities in semi – arid zones. Obviously, domestic roof water harvesting system includes a large and expensive storage tank, the availability of harvested water varies with seasons. In the light of these facts, the aim and objectives of domestic rainwater harvesting are:

- To expand service coverage to give 100% of the population access to safe water and appropriate sanitation.
- To achieve sustainability of service delivery.
- To reduce untold hardship and burden on the rural populace.
- To ensure that a basic adequate level of service of affordable through low – cost service delivery.
- To introduce non implementation of subsidy and tariff framework which is adequate and beneficial to the poor.
- To ensure that water being both a social and economic good is managed in the best way.
- To ensure maximum benefits in term of infrastructure, economic development and good public health.
- To develop and strengthen institutional structure for sustained effective village level, self-operational and maintenance of harvested water.
- To give user of self-initiative confidence.

2. STUDY AREA

Nigeria as the study area is located on the latitude 4° - 14° north of the equator and longitude 3° - 15° east of the Greenwich meridian. She lies at the southern edge of the West African region, covering an area of about 923,243km^3. The climate of Nigeria is more varied than those of any other country in West Africa. This is as a result of her great length from south to the north (1100km) which covers virtually all the climate belt of West Africa, Iloeje, (1981).

Table 1: Zones and their corresponding stations

S/N	Sahel Zone	S/N	Savannah Zone	S/N	Rainforest
1	Sokoto	1	Kainji	1	Ibadan
2	Katsina	2	Kaduna	2	Ikeja
3	Nguru	3	Minna	3	Oshogbo
4	Maiduguri	4	Bida	4	Ondo
5	Potiskum	5	Bauchi	5	Akure
6	Kano	6	Jos	6	Lokoja
7	Gusau	7	Abuja	7	Makurdi
8	Yelwa	8	Jalingo	8	Ogoja
		9	Yola	9	Ikom
		10	Ilorin	10	Calabar
				11	Portharcourt
				12	Warri
				13	Benin
				14	Enugu
				15	Owerri

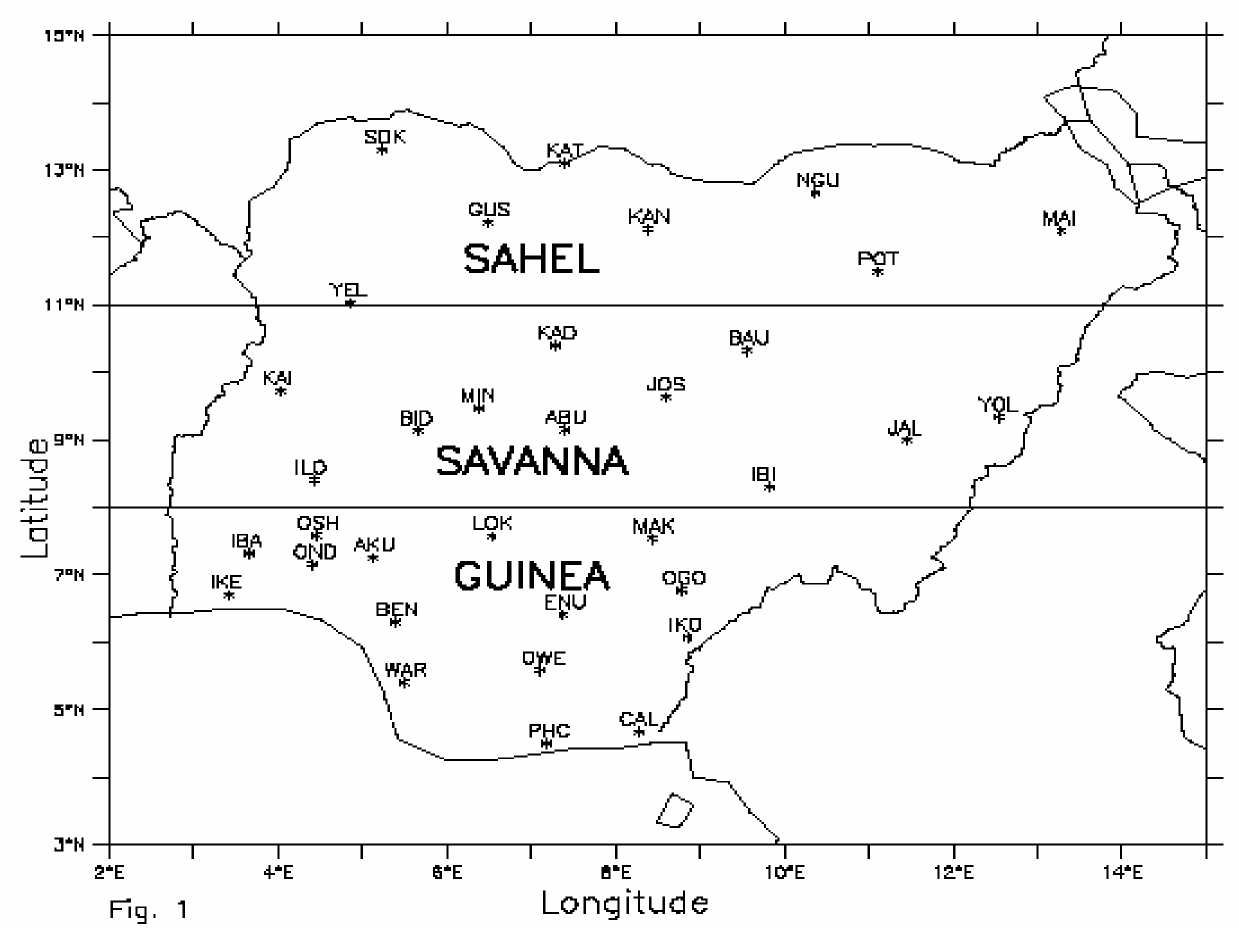

Fig. 1

Map of Nigeria showing the zones and the stations

3. METHODOLOGY

Water harvesting is the collection of run off rainwater for domestic water supply, agriculture and environmental management, water harvesting systems which harvest run off from roofs or ground surface fall under the term rainwater harvesting as stated by Hattum and Worm (2006). The method focuses on rainwater harvesting from roof surface at household or community level for domestic purpose, such drinking, cooking and washing. There are three basic components of domestic roof water harvesting systems, which are catchment, delivery system and storage reservoir, Watt, (1998).

The catchment of water harvesting system the surface that receives rainfall directly and drains the water to the system. The method focuses on roof top rainwater harvesting but surface runoff. Galvanised, corrugated iron sheets, corrugated plastic and tiles make good roof catchment surfaces. Ionides (1967), in his water in dry places noted that delivery system from the roof top catchment usually consists of gutters hanging from the side of the roof sloping towards a down pipe and tank. This delivery system or guttering is used to transport the rainwater from the roof to storage reservoir and for effective operation of rainwater harvesting system, a well – designed and carefully constructed gutter system is crucial because the guttering is often the weakest link in a rain water harvesting system. As much as 90% or more of the rainwater collected on the roof will be drained to the storage tank, if the gutter and down pipe system is property fitted and maintained. Metal and PVC are common material for gutters and with high intensity rains in the topics, rainwater may shoot over the gutter, resulting in rainwater loss and low harvesting production, Thomas and Martinson, (2007).

The water storage tank usually represents the biggest capital investment element of a domestic rainwater harvesting system. It therefore usually requires the most careful design to provide optimal storage capacity and structural strength while keeping the cost as low as possible, UNDP (2001).

The quality of collected rainwater is safe guarded through roof and guttering and cleansing regularly. A wire mesh is placed over the top of the down pipe to present it from becoming cogged with washed off material.

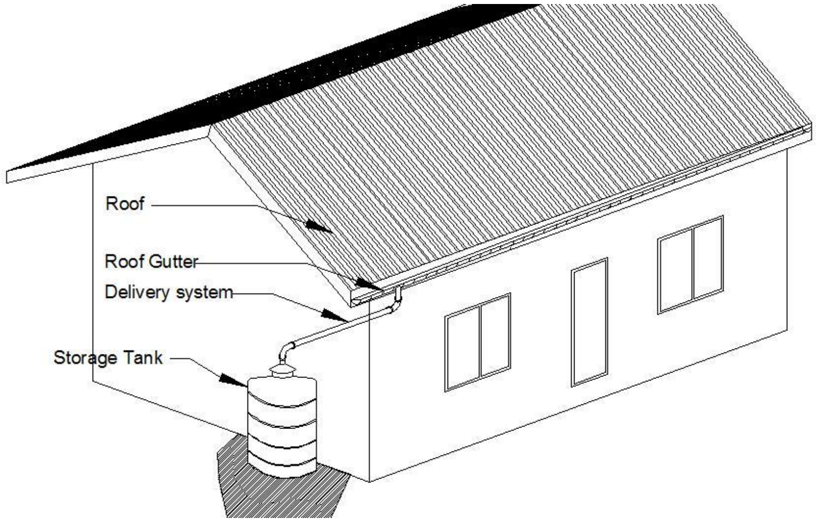

Fig. 1: Rainwater Harvesting system

The date of rainfall collected covers fifteen stations well spread over Nigeria covering the first half of the decades 1980, 1990 and 2000. Analysis carried out on each of the three climatic zones are represented as follows.

Rainforest: Port Harcourt, Enugu, Ibadan, Akure, Ikeja, Calabar, Benin.

Savannah: Abuja, Minna, Bauchi and Yola.

Sahel: Sokoto, Yelwa, Maiduguri and Gusau.

Table 2: Mid – Decadal Rainfall

S/N	Town	1980 – 1984	1990 – 1994	2000 – 2004
1	Abuja	7670.88	8015.20	9444.00
2	Akure	8248.65	8629.20	7833.20
3	Bauchi	6137.58	6360.47	6060.90
4	Benin	13374.44	13767.86	13120.00
5	Calabar	19252.36	15500.22	17629.20
6	Enugu	11720.20	9149.46	10802.60
7	Ibadan	7421.90	7397.00	8116.70
8	Ikeja	8692.40	10388.06	9073.40
9	Maiduguri	4816.24	5124.16	4559.30
10	Minna	7466.70	6987.41	7314.30
11	Portharcourt	12480.70	11998.08	12625.50
12	Sokoto	4070.53	4685.20	4310.20
13	Gusau	5572.30	6463.37	4310.20
14	Yelwa	5213.72	6477.05	5849.00
15	Yola	4818.03	4358.00	5390.40

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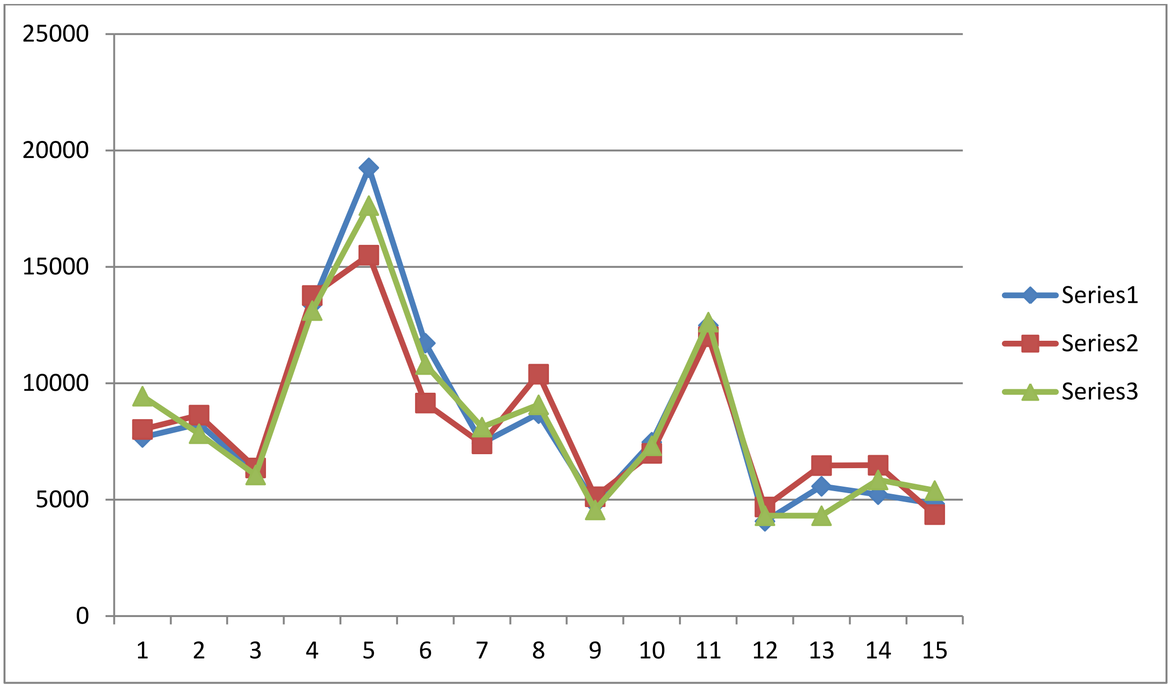

Fig. 1: Three mid-decadal rainfall spatial comparison graphs

Roof catchment and storage of rainwater and the size of roof depends on the size of the house. The quality of rainwater that can be collected through roof catchment, is largely determined by the effective area of the roof and the local annual rainfall.

Example:	Roof Area	=	A
	Annual Rainfall	=	I
	Runoff coefficient	=	η
	Duration	=	d
	Household member	=	N
	Water use (per capita)	=	w

Supply

Required minimum storage for most dry zone (Sahel)–Sokoto.

Average= $\dfrac{(1980-1984)+(1990-1994)+(2000-2004)}{3}$

Average = $\dfrac{4070{,}53+4685.20+4310.20}{3}$ = 4355.33

Then by mid – decade

$\dfrac{4355.33}{3}$ = 871mm

Therefore required storage = A × I × η

(10m × 10m) × 871 × 871 × 0.8 = 69.860 litres/year

Or $\dfrac{69{,}860}{365}$ = 190.9 liter/day

Demand

Water use (per capita) × household member (N) × d

Demand = W × N × d

W = 25 litre per capita

N = 6 normal size of a family

d = 365 days/year

Demand = 25 × 6 × 365 = 54,750 litre/year

Demand for one month = $\dfrac{Demand\ \ for\ \ year}{12Months}$

= $\dfrac{5475}{12}$ = 4562.5 litre/month

Therefore, required minimum storage capacity of a day period of four months (Nov., Dec., Jan. and Feb.) 4 × 4562.5 litre/month = 18,250 litres.

The result above is the rough estimates of the required tank size and it does not take into account variation between different years such as occurrence of drought years. The amount harvested in year can comfortable be sufficient for the user throughout the dry season.

4. OPERATION AND MAINTENANCE

There should be always the consideration of routinely monitoring of maintenance process, cleaning of roof drains filter and the tank as stated below:

Table 2: Routine Maintenance

S/N	Maintenance component	Maintenance Activity	Duration
1	Roof	- Keep cleaning - Flush after first rain	- Frequently - Before rain
2	Drain system	- Cleaning - Checking the function	- Frequently - Prior to rain
3	Filter media	- Cleaning - Checking the function - Replaced media	- Prior to rain - Prior to rain - Once a year
4	Rain water tank	- Cleaning	- Frequently

5. CONCLUSION

Conservation of rainwater has been a common supplementary drinking option in the past decades, and the techniques and methods used for collection were not systematic or properly done. However, in the past, the concepts on application of rainwater harvesting in rural water supply systems have been developed and established as satisfactory domestic water option. Further, this has been accepted by the rural communities in dry zones (Sahel) as a better option to fulfil their drinking water needs where there had been acute water quality problem (such as fluoride, iron) with their water source, UNDP (2001).

Recently, rainwater harvesting was selected as a better option where there had been shortage of drinking water at difficult terrains and other sources are extremely non – reliable. More time taken water carry has effectively been cut down from 2 hours to 20 minutes with which the users have shown their impression and satisfaction. Also, no major complaints were received from the user groups with respect to the quality of rainwater in their tanks either at short interval on insufficiency of the tank capacity (i.e. $5m^3$) to undertake effective collection of rain water within two intermittent showers (i.e. an average of 45 days).

In the regard, it is totally in agreement with NIMET (2004) and Nicholson (1993) who noted that the picture from the table and graphs of recent rainfall pattern and changes over Nigeria, also the result shows more stations in the rainforest recorded less rainfall in the early years of decade 2000 as compared with the early years of decade 1980. Conversely, more stations in the (Sehehs) recorded more rainfall in the early 2000 than in the early 1980.

RECOMMENDATION

The stakeholders are recommended to:

- Promote increasing trend for rainwater harvesting as satisfactory alternative water supply option where there is an absolute need.
- Promote satisfactory change of user's perception of rainwater harvesting for drinking, due to low mineral content or bacteriological pollution on roof.
- Promote an additional tank to enhance the storage capacity by the existing consumers.
- Promote a programme of rainwater harvesting against certain barriers with respect to socio – cultural belief and attitudes.

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