Development of Water Harvesting and Treatment Plant in Africa: Nigeria.

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ABSTRACT

The problem of acute water shortage and gully erosion is one that gives stakeholders great concern most especially in Nigeria. To curb these issues, a water harvesting and treatment plant of 2,000 liter capacity was designed, installed, and tested for low income earners in some part of Nigeria. 4'' PVC pipes were used to channel the water from the rooftop to a plastic storage tank. The collected water was subjected to series of filtration process. Sieves were placed in the funnel to prevent medium and large particles from flowing to the storage tank while chlorine was added to the collected water in the storage tank. In all, the project cost less than $335 (N 50,000).

(Keywords: water harvesting, sustainable, safe drinking water, potable water, treatment plant)

INTRODUCTION

Water is an indispensible substance to all life processes. It is widely referred to as the universal solvent. Water is classified based on sanitary quality as portable, contaminated, or polluted (Asubiojo *et.al.*, 1997)**.**

Water can be grouped into atmospheric, surface, and ground water. 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, precipitates back to the earth, and eventually returns to the ocean via streams and rivers, to repeat the cycle again [Benes and Steinnes, 1975].

In the rainforest region of Africa, the volume of rainfall is usually high during the rainy season. This, if not properly channeled and harvested, can cause devastating problems to the inhabitants of the region. Water, a necessary reserve, has been found to be in short supply. The global crisis of water shortage has sent human populations on the lookout for new water resources. Drinking water plays a major role in the intake of a number of nutritional and toxic trace elements in man (Nkono and Asubiojo, 1997). This has made man to result to different ways of getting water to meet his need. One of the free sources explored by man is rain water harvesting [Gould and McPherson, 1999].

What is Rainwater Harvesting?

Rainwater harvesting is the process of collecting and storing water for future productive use. When rain falls, water is collected either directly or from a roof for storage and eventual use. The harvest is necessary in areas having significant rainfall but lacking conventional water supply system. It is used when fresh surface water or ground water is lacking [UNEP, 1983].

Rain water harvesting consists of a collection area, in most cases the roof of buildings. The effective roof area and material used in construction influence the efficiency of collection, water quality, and quantity. Before now, the people of the region have been collecting rainfall water by placing their buckets under the roofing sheet of their home and in the open air (Figure 1).

This acted as the motivation for this project. Design consideration was for a 2,000 litter storage facility. This will serve a house of three different families of three people per family and will supply them for three days.

Figure 1: Traditional Method of Harvesting Water in Nigeria.

OBJECTIVES

This study seeks to:

a. Design an effective system that will harvest a safe drinking water

b. This system will help to avoid wastage of the water while also ensuring that erosion is also avoided in the area. Erosion is a major problem associated with heavy rainfall in the area.

USES

The collected water can then be used for cooking, watering lawns, washing cars, flushing the toilet or other domestic uses (Figure 2).

In this report we present the design consideration of a 2,000 liter capacity water harvesting and treatment plant in the southern part of Nigeria, West Africa.

MATERIALS AND METHODS

Materials: The following materials were used:

a. PVC: 4'' diameter PVC was used as a channel to direct the water from the roof top into the storage tank

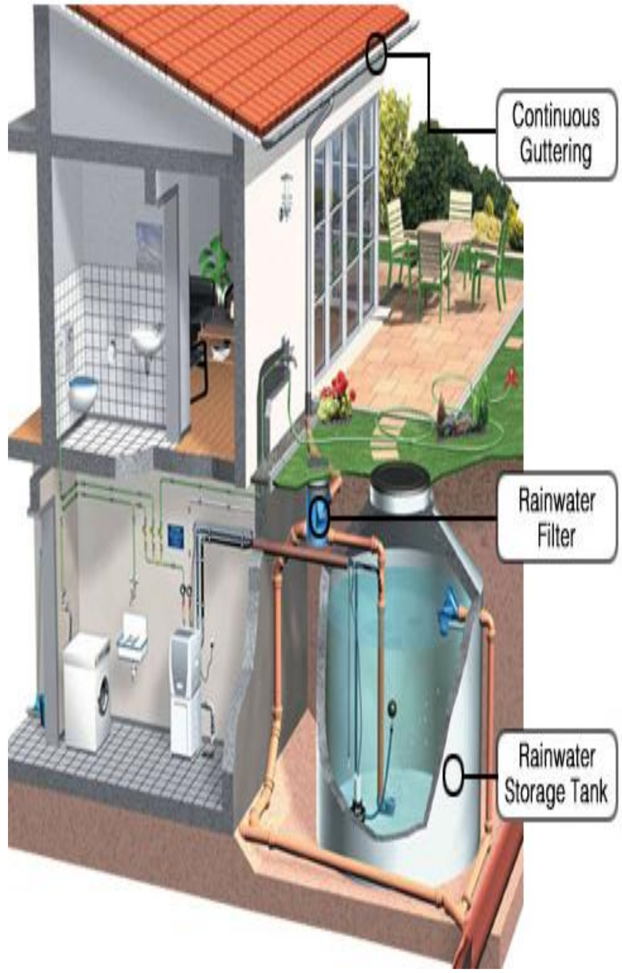

Figure 2: Outline of the Usage of Harvested Rainwater Storage Tank.
Courtesy: http://www.bluegranola.com

b. Collector or funnel: funnel was placed at both ends of the channel and the collected water directed by a 4'' diameter PVC pipe.

c. Gutter: it was made of zinc sheet.

d. Storage tank: Thermoset plastic was used as the.

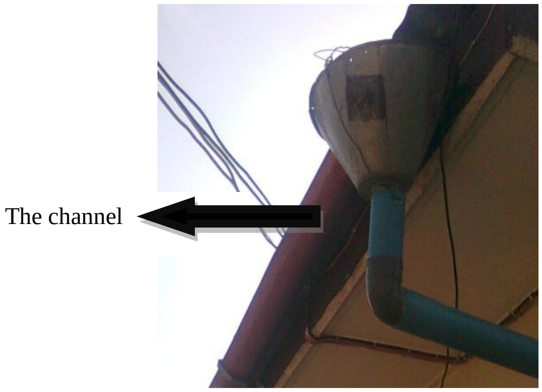

Figure 3a: The Channel, Funnel, and the PVC Pipe.

Figure 3b: The Funnel and the PVC Pipe Conveying the Water to the Storage Tank.

Figure 4: The Funnel and the PVC Pipe Conveying the Water to the Storage Tank Viewed from a Different Angle.

Figure 5: The Channel Leading to the Storage Tank.

Figure 6: The Channel Leading to the Storage Tank.

Figure 7a: The Second Drain for Initial Water Run-Off.

Figure 7b: The First Drain for Initial Water Run-Off.

Methods or Design

A channel was constructed as shown in Figures 3a and 3b to channel the water from the roof top directly into the storage tank as shown in the diagram below.

Storage tank: The storage tank is made of plastic to prevent the effect of corrosion. The volume 'V' of the tank is:

$$V = \left[\frac{\pi D^2}{4}\right] L \qquad \textbf{(1)}$$

Where: D = Diameter of the Tank (mm)
L = Length of tank (mm)
V = Volume required (mm^3)
V = 2000 litres

Channel: The channel was made of PVC pipes.

Collector: The collector was made of zinc sheet.

Gutter: Made of zinc sheet.

Treatment of the Harvested Water: The harvested water was discovered to contain impurity of the following categories:

i. Soot
ii. Zinc droplet or particles
iii. Metals.

Table 1: Maximum Allowable Concentration (mg/l) of Trace Metals in Drinking Water.

Metals	WHO	EPA	Canadian	Direct	New Roof	Aged Roof
Fe	0.30	0.10	0.30	0.09-1.05	1.02 – 3.01	2.36 – 4.50
Pb	0.05	-	-	Nil	0 – 0.01	0 – 0.03
Zn	5.00	5.0 – 15.0	5.00	0.12 – 0.36	2.03 – 3.43	2.39 – 3.96
Cu	1.00	0.05 – 1.50	0.05	0 – 0.13	0.02 – 0.10	0.11 – 0.33

WHO and Canadian standards are culled from water quality assessments, UNESCO/WHO/UNEP, 1992.
EPA standards were from "Environmental Protection Criteria 1972" Washington D.C, 1973

The harvested water was then subjected to a treatment process to remove the impurities. Two basic methods were used viz:

i. **Filter:** A mesh of tiny size was included or placed inside the funnel/collector to act as the first phase of the filtration process. This will prevent particles (like leave, zinc, etc) from flowing to the storage tank.

ii. **Chlorination:** The last phase is the addition of chlorine to the collected water in the storage tank.

Production Cost

Bc - This involved the cost estimation
Mc - material cost
Nmc - non machine job

$P_c = B_c + M_c + Nmc$ **(2)**
P_c = N50, 000 as calculated

RESULTS AND DISCUSSIONS

After construction and installation, the system was tested during the rainy season. It was able to fill the storage tank within a day and it served the occupants of the compound for three days. The purpose of this study which is to design, construct and install a water harvesting and treatment plant has been achieved.

CONCLUSION

In conclusion, a treated water harvesting plant is a useful means of collecting and storing of a clean and safe drinking water at an affordable rate all year round. The study also revealed that it is possible to design, construct and install at a low cost, even to the low income earners, a potable safe drinking water system. The storage tank capacity was 2,000 liters.

RECOMMENDATION

The introduction of this treated water harvesting plant to communities in the rainfall region should be encouraged because it will help to ensure a safe portable drinking water all year round.

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SUGGESTED CITATION

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