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# Rainwater harvesting in Nigeria

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ABSTRACT

In 1986 Oyebande (7) estimated that only 46% of the Nigerian population had access to piped water supply. This leaves much to be desired and long term solutions are called for to improve the situation. In the interim, possible short term options should be examined for their viability. This study has clearly demonstrated the potential role of rainwater harvesting in this regard. An average annual harvestable rainfall of 718 litres per square meter of catchment is available. An individual's annual water requirements could be met from a 13 square meter catchment and a 4-cubic meter storage tank.

## INTRODUCTION

Though probably the oldest form of water supply, it is only recently that the potential of rainwater harvesting as a viable water supply option is being recognised. Major seminars and conferences have been held on the subject and the literature is rapidly growing (1,2,3). The advantages of rainwater harvesting include its relatively high quality, cheapness of construction and operation and ease of maintenance. Rainwater harvesting is particularly suited to meeting the domestic water needs in rural areas where several widely dispersed communities are involved; and conventional water supply options are often financially nonfeasible or outrightly uneconomic. The increasing importance of rainwater was recently underscored when the Nigerian President specifically referred to its possible inclusion in the national water policy during the 1987 budget speech. This paper is the author's humble contribution to whatever strategy is being formulated to meet the President's optimism as regards rainwater harvesting as a water supply option in Nigeria. In a recent paper (4) the role of rainwater harvesting in Northern Nigeria was discussed. In this paper, a similar excercise for southern Nigeria is presented.

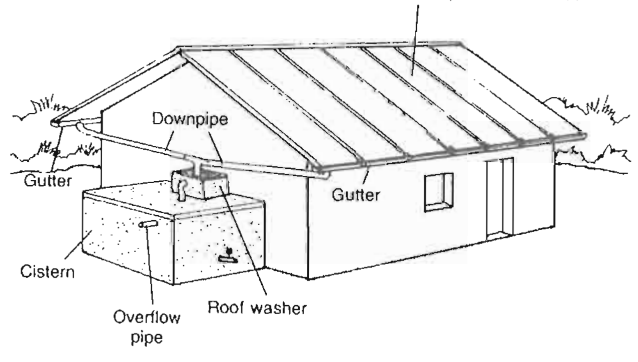



Fig 1 Components of a rainwater harvesting system

## DESIGN REQUIREMENTS

The three components of a rainwater harvesting system are the catchment, the gutter/downpipe arrangement and the storage tank (Figure 1). The house roof is usually the catchment for domestic rainwater harvesting; and being an integral part of the house, this is really not a cost item to the scheme. The roof size is fixed and other items really have to be designed to suit the available roof. The general data requirements are:

(a) household population,
(b) roof characteristics e.g. plan area and runoff coefficient,
(c) climatic characteristics, especially annual rainfall, rainless days, rainfall intensity and evaporation.

A suitable foul water diversion mechanism will also have to be included. A discussion of the performance of a variety of foul flush diversion mechanisms (with diagrams) can be found in Michaelides & Young ( 5).

## HARVESTABLE RAINWATER

The calculations presented refer to roofs of suitable materials such as galvanised sheets, concrete and asbestos sheets. Thatched roofs have a high detention storage which subsequently evaporates; and are not suitable as catchments. The use of asbestos roofs may be objectionable on health grounds. It is possible that roof shape affects the amount of rainwater caught but such effects are considered minimal and are not considered here. Assuming a runoff coefficient of 1.00, the maximum harvestable rainwater (MHR) is simply calculated by

$$MHR = R \times A \text{ litres}$$

where
R = mean annual rainfall depth, mm
A = roof area in plan, square meter.

To calculate the probable consumption, allowances must be made for evaporation and other losses from storage. This assumes that adequate precautions have been taken to minimise losses from the catchment , gutter and downpipe. Nail holes and leakages should be properly sealed. Inadequate design and/or incorrect installation of the gutter/downpipe may result in considerable losses. A procedure for the hydraulic design of gutter and downpipe can be found in Cotton (2).

From measurements at Moor Plantation, Ibadan, (6) the annual evaporation losses are of the order of 1716 mm and 1041 mm respectively for Class 'A' pan and Piche evaporimeters (Table 1).

Table 1 Monthly evaporation and rainfall at Moor Plantation, Ibadan (mm)

| Month | Class A Pan | Piche | Rainfall |
|---|---|---|---|
| January | 152.4 | 123.6 | 0.00 |
| February | 173.7 | 141.3 | 2.29 |
| March | 190.0 | 150.0 | 82.30 |
| April | 169.9 | 85.9 | 144.53 |
| May | 166.7 | 81.5 | 115.06 |
| June | 122.9 | 59.4 | 196.34 |
| July | 108.5 | 61.5 | 159.26 |
| August | 89.9 | 52.0 | 271.59 |
| September | 116.9 | 46.5 | 175.25 |
| October | 142.0 | 58.3 | 132.33 |
| November | 146.6 | 93.1 | 0.25 |
| December | 136.1 | 88.0 | 1.52 |
| Total | 1715.6 | 1041.1 | 1280.72 |

Class 'A' pan evaporation values refer to open bodies of water. Piche measurements made in a Stevenson screen provide a better estimate of evaporation from an enclosed storage tank. Unlike Class 'A' pan measurements, Piche values are less affected by wind and length of sunshine period and tend to be uniform over large areas (Table 2). It is thus possible to use spot measurements of Piche evaporation to represent large areas. For this study the value at Ibadan was used - it was considered better to under-estimate available consumption by using the highest evaporation measurement rather than over-estimate it at certain locations as the use of an average evaporation value probably would.

Table 2 Annual rainfall and Piche evaporation (mm) at selected stations

| Station | Rainfall | Evaporation |
|---|---|---|
| Ile-Ife | 1699 | 893 |
| Ijebu-Ode | 1744 | 893 |
| Ibadan | 1281 | 1041 |

If an additional 10% is allowed for other losses, the harvestable rainfall available for consumption in different parts of southern Nigeria are as presented in Table 3. The locations of the stations are shown in Figure 2.

From Table 3, an average of 718 litres per annum is available for consumption per square meter of roof. From the author's personal experience (I have lived in the a part of the study area all my life), a daily supply of 25 litres of water per person is usually sufficient to meet basic personal needs as shown in Table 4.

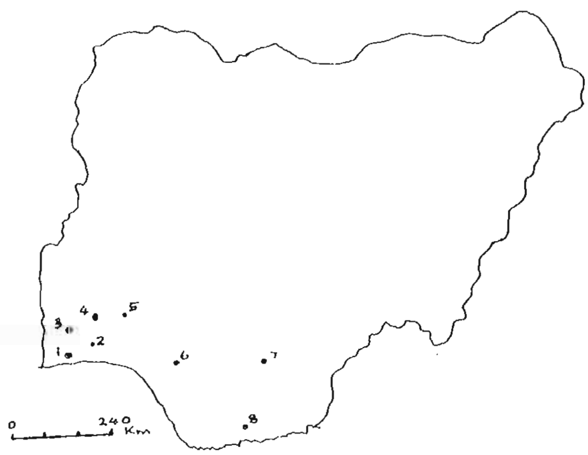
Thus for a year's water requirements to be met entirely from harvested rainwater, the required catchment area is calculated as

catchment size = (25 x 365)/718 = 12.7 sq m/person

Table 3 Annual harvestable rainwater (AHR) available for consumption per square meter of roof

| Station | AHR = (MAR - PE) x 0.9 litres |
|---|---|
| Enugu | 632 |
| Port Harcourt | 1151 |
| Benin City | 925 |
| Ibadan | 161 |
| Lagos | 720 |
| Mean | 718 |

MAR = mean annual rainfall
PE = Piche evaporation




1 Lagos 2 Ijebu-Ode
3 Abeokuta 4 Ibadan
5 Ile-Ife 6 Benin-City
7 Enugu 8 Port-Harcourt

Fig 2 Location of meteorological stations

Table 4 Estimated basic water needs in the study area (Non-piped supply), litres

| Water use | Estimated daily requirement |
|---|---|
| Drinking | 2.0 |
| Bathing | 10.0 |
| Laundary | 5.5 |
| Cooking/ Washing up | 5.0 |
| Wastage | 2.5 |
| Total | 25.0 |

## STORAGE TANK

Though the rainfall is abundant, its distribution throughout the year is very uneven (see Table 1). There are distinct wet and dry seasons lasting from early March to early November and early November to late February respectively. The length of the dry season varies from place to place and up to 50% of the water year could be rainless in some regions (Table 5). The average length of rainless period is 134 days.

Table 5 Average number of rainless days (1941-1985)

| Station | Rainless days | Mean annual rainfall, mm |
|---|---|---|
| Enugu | 120 | 1744 |
| Port Harcourt | 167 | 2320 |
| Benin City | 150 | 2069 |
| Ibadan | 110 | 1281 |
| Lagos | 121 | 1842 |
| Mean | 134 | |

There is thus the need to regulate consumption during the wet season in order to leave something for the rainless days. Some form of storage is called for and a variety of designs (3) are available depending on the amount of water to be stored. Based on earlier calculations, a storage size of 3.5 cubic meters would be required per person to last an average dry season. A design value of 4 cubic meters is recommended to allow for fluctuations in the length of the dry season.

## CONCLUSION

At the moment the water supply situation in most parts of southern Nigeria leaves much to be desired. Because of inadequate funding, piped water supply has not been able to meet the needs of a rapidly increasing population and only 46% is currently served nationwide (7). This situation calls for urgent action by the respective authorities to find a lasting solution to the crisis. While such long term solutions are being planned and/or implemented, possible short term solutions should also be examined for their viability.

This study has clearly demonstrated the potential role of rainwater harvesting in this regard. An average annual harvestable rainfall of 718 litres per square meter of catchment is available. An individual's annual water requirements could be met from a 13 square meter catchment and a 4-cubic meter storage tank. Perhaps the use of rainwater could be restricted to only drinking and cooking during the dry season while other needs are met conjunctively from other sources (most houses already have a hand-dug well). This way the size of the storage tank could be substantially reduced.

## REFERENCES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