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SUSTAINABILITY OF WATER AND SANITATION SYSTEMS

Rainwater harvesting in Uganda

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UGANDA HAS BEEN divided into fourteen climatic zones based on a study for a rain gauge network (C. Basalirwa 1992) and the regions are shown on the map in Figure 2. The areas have been grouped together as follows.

Lake Basin and Central Region

This includes areas At, A2, B and D as shown on Figure 2, with representative stations being Kawanda, Jinja, Galiraya and Tororo respectively. The rainfall pattern in this region is strongly bimodal with the two rainfall seasons running between March and May and September to November. The March to May rains are the main season. The highest rainfall in Uganda occurs in this region and is on the Ssese Islands, where rainfall of up to 2000mm is recorded. The rainfall varies between 1100-2000mm.

Western and South Western Region

This includes areas C and M as shown on Figure 2 with representative stations being Mbarara and Kilembe respectively. The area can be described as between semi arid to moist humid except for areas to the North west where rainfall is plentiful and more stable. The rainfall pattern is strongly bimodal and the seasons are March to May and September to November which is the main season in this case. The rainfall varies between 900 - 1600mm.

North West and North Central Region

This includes areas L, K, I and J as shown in Figure 2 with representative stations as Bulindi, Masindi, Gulu and Moyo respectively.

The rainfall pattern here becomes increasingly unimodal and the season runs from April-November. The areas to the North and North East of Lake Albert experience high rainfall variability e.g. Masindi and Mayo. The rainfall varies between 1200-1600mm.

North East Region

This includes areas H. and G. as shown on Figure 2 represented by Kitgum for area H and Kotido for area G. These areas are increasingly semi-arid to arid and as you move to the East the rainfall variability increases. The rainfall here, is mainly unimodal with the season running from April to October. In addition to this there is significant occurrence of flash floods The rainfall varies between 400- 1500mm.

East and Central Region

This includes areas E and F as shown on Figure 2 with Soroti and Opolipot representing the former and Mbale representing the latter. The region is a transitional zone between bimodal and unimodal rainfall seasons, with bimodal in the South and unimodal rainfall to the North. Since they lie in the transition zone, they experience high rainfall variability especially between July and November. Rainfall Varies between 1100 and 1600 mm.

Methodology

The average monthly rainfall for 30 years was obtained from the Meteological Department for each of the representative stations. These monthly rainfalls were multiplied by an assumed roof area of $30m^2$ and a runoff coefficient of 0.8 in order to obtain monthly volumes of runoff in litres. From the monthly volumes, the cumulative monthly volumes were obtained and both were plotted. On the same graph a constant demand line was drawn assuming constant abstraction for whole year. The maximum difference between the demand line and the cumulative rainfall gave the storage capacity of a tank, to store all the rain water derived. A second demand line was plotted assuming a rapid withdrawal in 13 cases after 6 Months 2 cases after 9 months and 3 months respectively.

This rapid withdrawal rate provided a second capacity of tank of a lower capacity. The above technique was adopted from Pacey and Cullis, 1986. These results are tabulated in Table 1 .

Observations

As earlier mentioned fifteen stations were selected representing each of the climatic regions in Uganda. From the representative sample it is clear that for 12 stations out of the 15 have a rainfall of 1000mm or more and the average annual rainfall of the 15 station (without weighing the areas) is 1278 mm, in terms of volumes of runoff a $30m^2$ roof can collect 30672 litres a year.

This means 84 litres a day assuming a constant withdrawal, throughout the year. For a family of six, this means 14 litres per head per day, which is quite a substantial amount of water in the rural areas, provided there is sufficient storage

The first observation drawn is that Uganda is a very well watered country, with substantial amounts of rainfall available each year. The map of isohyets for annual rainfall in Figure 1 shows this even more clearly. The

Second observation is that the greater the annual rainfall the larger the tank size that is required. It was noted that for the same amount of rainfall different tank capacities wore obtained depending on the climatic region; specifically the capacity of tank depended on whether the rainfall was bimodal or unimodal.

A plot was therefore made of tank capacity against rainfall for each of the categories of rain fall; bimodal and unimodal respectively. These are shown in figure 3 and figure 4. As can be seen there is a clear trend in both, cases linear regression was carried out and the equations of the lines arc indicated in each Case.

For the Bimodal case: Q = 6.34i - 2365 where Q is tank capacity in litres, i is rainfall in mm. The coefficient of correlation r = 0.915.

For the Unimodal case: Q = 5.44i + 1150

The symbols are as above with a Coefficient of correlation r = 0.882.

These relationships are applicable for a roof area of 30m. For any other sized roof, the area divided by 30 and the factor is multiplied by the tank capacity obtained from the graph to derive the required capacity.

The third aspect to be considered is the actual practical significance of the values obtained from Table 1. It can be seen that the tank Capacities obtained by the rationing method arc between 3000 litres and 11,000 litres with an average of 7000 litres for rapid depletion rates the tank capacity varies between 1000 and 6000 litres and an average of 4000 litres.

The values obtained by this method are for ensuring that all the rain water available is collected and stored and therefore the capacities are higher for higher rainfall values. In practice this is not necessary and lower capacities of tanks are adequate.

For the individual household the limiting factor will be the cost of constructing such a tank. A survey recently done by RUWASA gives the costs of the various types of tank.

These are tabulated in Table 2.

From Table 2, the cost of a rainwater tank constructed from burnt bricks or concrete blocksISthe cheapest at US$ 0.06 per litre followed by corrugated iron sheets at US$ 0.08 per litre, then pot jars at US$ 0. 10 per litre for the most expensive being PVC tanks at US$ 0.27 per litre. It should however be noted that for lower capacities, corrugated iron tanks arc not available and pot jars extend to lower capacities. Although not shown in the table, capacities of masonry tanks (burnt bricks and blocks) can be much lower. For a tank capacity of 1000 litres a tank from burnt bricks costs US$ 120 and for a family of six this is US$ 20 per head which is far less than for a typical urban scheme at US$ 50 per head. It should be noted that the immediate target group for rainwater harvesting arc those who already have corrugated iron roofs and they comprise 30% of the population. Therefore the cost will not include that of constructing iron roofs.

Conclusions

- There exists a relationship between the amount of rainfall and mode of rainfall in a given climatic are in Uganda to the proposed size of tank based on the uniform rationing method adopted. The relationship is linear and can be applied for estimating the tank size
- The tank size obtained by this method could be adopted for institutions like schools health centres and other public buildings.
- The tank size estimated from this method may be high in terms of costs for individual households and a tank size of one quarter, the size can be adopted for particular areas. The cheapest arc burnt bricks and concrete blocks followed by corrugated iron sheets and pot Jars.
- Uganda is a well watered country with rainfall average of about 1200mm and therefore the potential for rainwater needs to be further examined.
- In order to achieve this support from Government and External Support Agencies Donorsand NGO's will be required to disseminate information arid promote rainwater harvesting as an alternative means of sustainable water supply.

References

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Figure 1. Map of Uganda showing Isohyets

Figure 2. Map of Uganda showing climatological zones

Table 1. Analysis of rainfall

Table 2. Costs of rain water tanks

Figure 3. Tank capacity Vs rainfall (bimodal)

Figure 4. Tank capacity Vs rainfall (unimodal)