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Efficiency of Storage Tank system in Preservation of Rainwater at Arusha Technical College, Tanzania

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ABSTRACT

Harvesting rainwater has been adapted in many countries since early times. Water is a major problem at Arusha Technical College (ATC) during summer, thus proper preservation during rainy season could reduce water shortage. This paper aims at evaluating the possibility of rainwater harvesting using storage tanks systems to reduce problem of water shortage and reducing cost of water. Published literatures and information on water preservation from different households was collected in this research. Findings show that the use of storage tanks system in rainwater harvesting increases the efficiency to reserve water in households and thus resulting into using the water storage for many days compared to dependence on urban water supply. It is proposed that the authority should introduce use of storage tanks systems in harvesting and preserving rainwater for use at ATC.

Introduction

Arusha Technical College (ATC) is an institute which is registered and fully accredited by the National Council for Technical Education (NACTE), currently NACTVET. The college offers various training programmes in technician and engineers' education. The programmes offered are Automotive Engineering, Civil Engineering, Applied Sciences and Social Studies, Continuing Education, and Electrical Engineering., Others are Information Communication Technology, Mechanical Engineering and Transportation Engineering.

ATC is blessed with various water resources, from ground water aquifers and Arusha Urban Water Supply and Sewerage Authority (AUWSA). Despite of these sources, ATC still experiences shortage of water due to an increase of its population which is encouraged by increasing student enrolment on different engineering programmes, and an increase of its staff at the campus. Due to rapid urbanization, water supply is either inadequate or in some days completely unavailable. However, available urban water supply sources are weakening due to the rise in population, change of climate, and pollution produced by a globally recognized condition of water shortage, particularly in developing countries (Adugna et al., 2018).

The study provides evidence for an increase of different preservation techniques of rainwater at ATC, it also provides information on increase of demand of water for domestic purposes at ATC.

Rainwater harvesting has thus been important to supplement unavailable urban water supply and ground water. The storage tanks systems are the most typical means of rainwater harvesting and have a long global history, the tank can come in various shapes and materials. Storage tank can be of cement, buck iron and or polythene. Harvesting rainwater can then be used in the workshops, for toilets, washing, cooking of foods for students and workers and irrigation at the *Shamba Darasa* (demonstration plots) of ATC. Unfortunately, rainwater could be polluted by some bacterial and hazardous chemicals during dry season. Roofs used to collect water might be dirty from dust and bird waste, however the water quality unit at ATC uses appropriate methods to reduce the bacteria and other hazardous elements from the harvested rainwater.

Water preserving containers vary into various styles. The storage tanks system can be categorized as small, medium, and large. Small tanks and buckets have also been used to preserve water. Various storage tanks are used to reserve larger amount of water like 10,000 liters and above compared to a bucket of 10 up to 20 liters and other small tanks of 200, 300 and up to 500 liters.

In Arusha, the rainfall starts in the middle of March and continues up to the end of May or June. Rainfall can again start in October, however, currently this pattern varies due to climate change. Rainwater harvesting can become the most effective method of preserving water as proposed by the government, and also has a lot of benefits at the institute, in the government and the environment.

Background Information

Rainwater harvesting (RWH) is not a new technique, rather it has been used throughout the history by various countries. Developing and developed countries have water problems and shortage due to climate change and population increase. They all use various harvesting styles as alternative water preservation techniques. Many countries have advanced from the opportunities afforded by using rainwater harvesting using storage tank system.

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RWH can be the cause for and means of revolution from progress in technology. Tanzania National Water Policy of 2002 under section II sub section 4.2 and 4.6 show the Government under the Ministry of Water promotes the suitable application of rainwater harvesting techniques for their social economic development (URT, 2020). The Policy states that:

> "Where feasible and necessary rainwater harvesting will be employed as a means of increasing the availability of water resources and thatthe role of the ministry is to promote, guide and encourage RWH techniques".

Water resources management Acts number II of 2009 section 12 gives citizen the right to establish individual, company or institute rainwater harvesting systems for domestic purposes within their premises. The formulation of this guideline encourages the attention to promote responsible partners in planning, designing, construction operation and maintenance of rainwater harvesting systems in our place. These parties include individuals, consultants, contractors, government and non-government institutions, and private sectors including all other stakeholders as far as rainwater harvesting is concerned. These harvesting systems using roofs, roads, small dams and canal dams and lived water ponds are all encouraged to be practiced.

Although ATC has water shortage due to earlier explained reasons, the absence of proper rainwater harvesting systems is letting this precious rainwater to go into waste drain. Due to high demand of water, various households are now struggling to have an effective rainwater harvesting system. In this effort residents at ATC and campus are taking up the installation of small, medium and larger tanks to collect water from different water sources, including from grounds and from rainwater harvesting. However the urban water supply which is the main source at ATC can be insufficient because the preserved water can only be enough for a limited time. The households around the college and the campus need much water for use.

Literature Review

Definition of key terms

Rainwater harvesting (RWH) is a technology where surface run off water is effectively collected during yield rain period. Harvesting rainwater can then be used for toilets, washing, cooking of students' meals, staff and for irrigation purposes at the *Shamba darasa* (demonstration plots) at ATC.

In developed countries, such as in the UK, RWH is not new, the common rainfall harvesting technique is the roof. Rainwater is collected from roofs by bitumen surfaces. UK collected rainwater from paved surfaces surrounding buildings. The collected water requires extra treatment. Rainwater collected using roofs became polluted with atmospheric particles, and bird waste droppings polluted roofs during such season where there were no rainfall. Therefore, during rainfall the first flush technique is done before process of harvesting is commenced (Fewkes, 2012).

In East Africa, Kenya for example, study conducted by Aroka in 2010, indicate that after periods of employing soil conservation systems, the two Non-Governmental Organizations (NGOs), Kenya Rainwater Association and German Agro Action were putting the attention on rainwater harvesting and water resource management, in short simple, low-cost techniques that comprise the capture and storing of rainwater. Various types to manage rainwater harvesting systems were implemented throughout Kenya as a tactic to safe water resources in rural areas (Aroka, 2010).

Rainwater harvesting system

Rainwater harvesting system is the collection of rainwater directly from roofs and other built catchments, the collection of sheet runoff from man-made ground or natural surface catchments and rock catchments for domestic, industry, agriculture and environment use (Che-Ani et al., 2009). The systems can be characterized as small, medium and large scale, usually the size of rainwater harvesting was established on the size of catchment place.

Rain falls onto roof and is collected by the guttering, directed down into a storage tank which then feeds into your home where it can be used for any purpose.

The Benefits of Rainwater Harvesting Systems

All rainwater that falls on the roof is basically for free. What matters is, it just takes a method to harvest it using a storage tank system for later use.

Rainwater harvesting should be a great important tool to process for people to know their individual or household water practice. Knowing its importance, people should get them to start preserving water in the areas around their home.

For societies that rely on urban water supply as their great sources of their needs, harvesting and collecting rainwater that falls obviously in the community can reduce the cost from urban water supply (Campisano et al., 2017).

Rainwater harvesting should also help utilities reduce highest demands of water during summer seasons, preserving treated water for more imperative and suitable water uses.

While rainwater can be a perfect primary water source for many uses and situations, it is also a great backup water supply for emergency situations.

The Environmental Benefits of rainwater harvesting

Rainwater harvesting can decrease storm water runoff from the environment. The elimination of runoff can reduce contamination of surface water with pesticides, sediment, metals, and fertilizers.

By reducing storm water runoff, rainwater harvesting can reduce a storm's peak flow volume and velocity in local creeks, streams, and rivers, thereby reducing the potential for streambank erosion.

Rainwater harvesting systems can be employed as simple and effective methods to meet a municipality's storm water management program requirements of individual properties (Aladenola & Adeboye, 2010).

Rainwater is an excellent source of water for plants and landscape irrigation since it has no chemicals such as fluoride and chloramines (chlorine).

The wet system method employs positioning the collection pipes underground in order to connect multiple downspouts from different gutters. The rainwater will then fill the underground piping and the water will rise in the vertical pipes until it spills into the tank. The downspouts and underground collection piping must have water-tight connections. The elevation of the tank inlet must be below the lowest gutter on the house.

The general objective

The objective of this study is to investigate the efficiency of storage tank systemon harvesting and preserving rainwater and to evaluate possibility of rainwater harvesting using storage tanks systems.

Methodology

This paper is based on literature review, observation and questionnaires administered to students and households around the ATC. ATC is blessed with various water resources, ground water aquifers and from urban water supply. Rainwater harvesting system should supplement the

urban water and groundwater to be collected and placed in the storage system to the whole campus. Figure 2. shows an example of rainwater collected during rainy season and at small amount of just 1000 liters say, and is for water quality unit project at ATC.

The general objective

The objectives of this study is to investigate the efficiency of storage tank system on harvesting and preserving rainwater and evaluate possibility of rainwater harvesting using storage tank systems.

Study Area

The researcher collected data for the study at ATC which is an engineering institution surrounding Mianzini alongside Nairobi Road in Arusha city. The researcher selected Arusha city because, is the Northern Tanzania's centre of agriculture, commerce, trade and tourism. Arusha City is also the Headquarter of the East Africa Community and is the central point in Africa between Cape Town and Cairo. It is surrounded by famous mountains such as Mount Kilimanjaro and Mount Meru. In addition, it is the door to the world's great wildlife refuge including Ngorongoro Crater, Serengeti and Tarangire. All these make the location of the College an ideal place for studying.

Observation

The observations involved rainwater harvesting techniques such as catchment using roofs, groundwater and water from Arusha Urban Water Supply and Sewerage Authority (AUWUSA). Harvesting of ground water need to connect with a pump and also it needs another technology to dig down the ground, so this technique cannot be applied to get lots of water.

The observation comes from the evidence that different tanks were installed at different locations on the campus showing that water scarcity is increasing within the institute. Also, it was observed that as soon as urban water is not available from water taps, people will be found carrying buckets on hands and heads looking for water in different areas.

Field Investigation

Several households were visited during May and June 2023 to check on the rainwater harvesting situation and the different ways the households used for preserving water from different sources. Most households observed obtain preserved water from the urban water supply system. Since there is water shortage during dry season, harvesting rainwater was required to cover the water shortage during crisis period. During the rainy season, the storage tank system are to be used to harvest rainwater which is used throughout the dry season, then the procedure is repeated during the next rain season (Che-Ani et al., 2009).

While the quantity of ground water and urban water supply is unlike to satisfy the needs of consumers, the rainwater harvesting using the storage tanks systems can satisfy the needs of the consumers at the ATC campus.

Harvesting System

Following the water shortage, various tanks of different volumes were fitted at the ATC premises to try alleviate the problem. However, not all tanks harvested rainwater, some water is harvested from the ground using water pump and some is from urban water supply which other sources brings expensive costs in their process and few are from the roof which preserve rain water. Since both preservation from different sources are done in small amount were not satisfy the need for the institute.

Results and Discussion

The findings of this study indicate rainwater harvesting may help in preserving and storing rainwater for future use.

Students' views on the flow of water from water taps at the time of this research, indicate that most households 88%, get water flowing from the water tap while 12% said No, that there was no water flowing from water tap. Such findings might be due to the fact that data for the study were collected during rainy season months, May- June 2023, where there is no water scarcity to many water consumers.

The results demonstrated on Figure 4 show that of the interviewed, 10 of them showed that it takes some time to go to find water after water is not available from the tap, 9 of them mentioned that it takes 50 minutes, and 6 of them showed that it takes a few minutes to collect water. These findings imply that when the water tap cuts water from the urban water supply, from ground water, or even from small rainwater storage tank, it consumes lot of time to find water.

Results from figure 5 show that compared to five years back, the water scarcity is increasing; 19 households show water problem is increasing, 5 of them show that water problem remains the same, meaning that there water problem exists but does not increase. The implication of the increase of water scarcity which increases yearly might be because of population increase at the compass.

The results about the cost of the urban water at household shows that, 15 households paid around 35,000/-, 5 paid 30,000/- a month, 3 households paid 12,000/-, the other two households paid 50,000/- and 100,000/- respectively. The implication of these results is that water bill varies according to the household use. The cost of house hold on May 2023 investigated one month's bill it Figure 6 shows that water is expensive.

The results on Figure 7 show that 72% of the households' cost of water increased each year, 8% shows that the cost decreased, and 20% shows that the cost remained the same

Conclusion

The use of storage tanks in rainwater harvesting increases the efficiency to preserve water in households and thus resulting into using the water stored for many days compared to urban water supply.

Reserve storage tank system reserves large amount of rainwater than the bucket. Water preserving at ATC vary into various styles. Storage tanks systems, small tanks and buckets have been used to preserve water. However, the amount of rainwater carried by receiver storage tank were similar to that carried by urban water (AUWUSA) but the same amount of water from urban supply to be filled in the same tank took longer time to fill, and it is expensive in terms of money to be paid on the water bill than if the same tank was filled using rainwater.

Storage tanks systems can store larger amount of water for example, 10,000 liters and above compared to a bucket of 10 -20 liters and other small tanks of 100, 200, 300 and up to 500 liters.This paper also argues that storage tanks is the most efficient way of preserving rainwater and water from urban water supply.

Suggestions for Improvement on Rainwater System at ATC Campus

In order to improve rainwater harvesting and usage, rainwater can be collected using a tank such as that of 500 liters using gutter and then be connected to the large storage preserver tank systems of different volumes to catch

rainwater in three storage tanks of more than ten thousand liters. The harvested rain water can supplement and reduce water shortage for the campus including staff households.

By using collection of rain water from figure two, rain water can be collected using huge tanks with various volumes. The huge tanks might be many two, three. Even more connected for the intention of harvest much more rainwaters instead of just using small tanks of 2000 litres.

It is proposed that the authority should introduce use of storage tanks in harvesting and preserving rainwater for use at ATC.

Also, while waiting for the authority to introduce storage tanks at households, it is recommended that individual households to make use of huge tanks of at least 10,000 liters and more for collecting rainwater and preserve for use during crisis periods instead of using small buckets to solve the water problem, and also to reduce water costs by only depending on urban water supply.

Abbreviations

ATC	Arusha Technical College
AUWSA	Arusha Urban Water Supply and Sewerage Authority
MAM	March, April and May
OND	October November December
NACTE	National Council for Technical Education
NACTVET	National Council for Technical and Vocational Education and Training
RWH	Rainwater Harvesting System

Figure 1. Buckets as one of the means of rainwater preservation at household

Source: Field Work 2023

Preserve water but only in small volumes and for temporary uses.

Figure2. RWH using small tanks at ATC, Project at water quality unit,

Source: Field work, 2023.

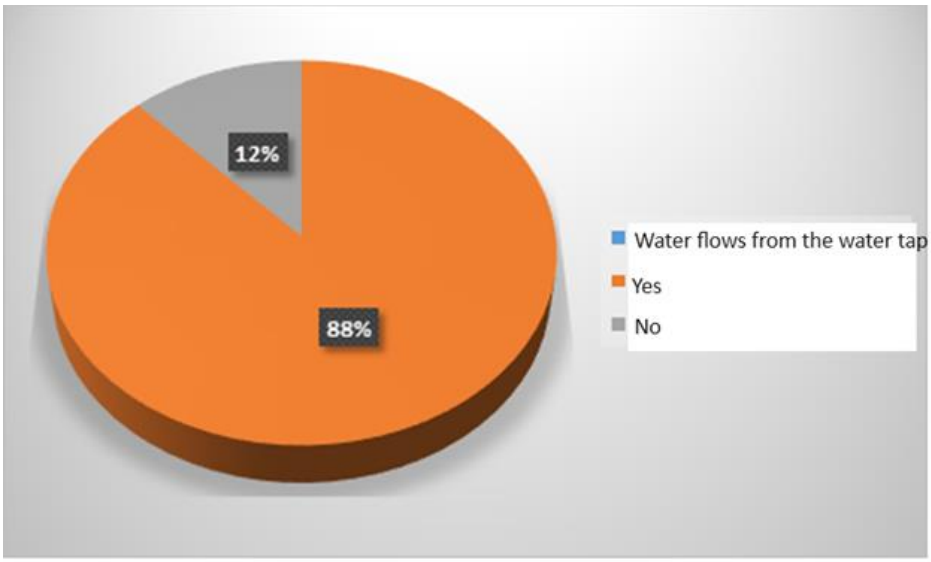

Figure 3. Students' views on water flow from different sources

Source: Field data, 2023

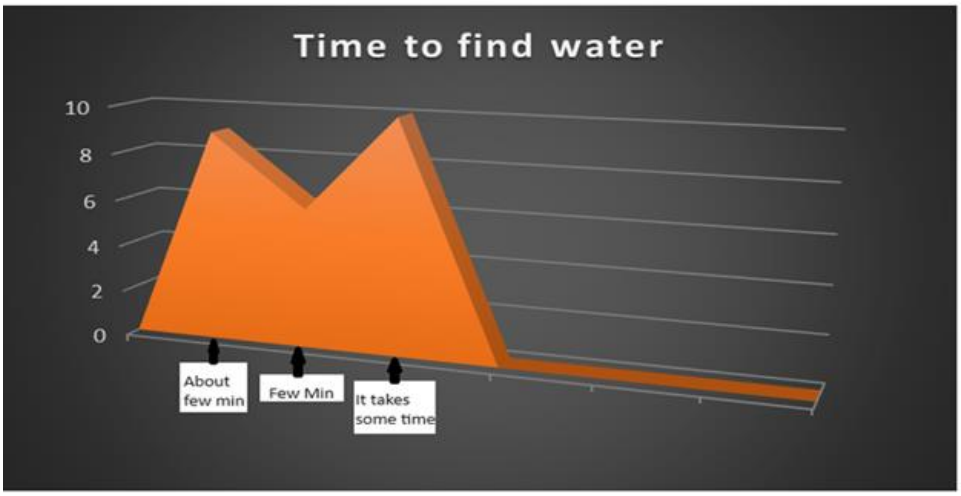

Figure 4. Time it takes to find water after they cut from tape

Source: Field data

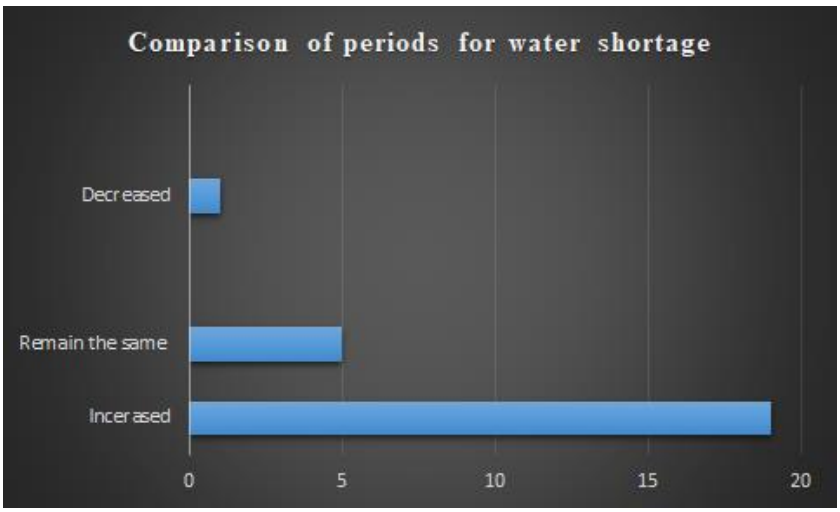

Figure 5.Periods of water shortage

Source: Field data

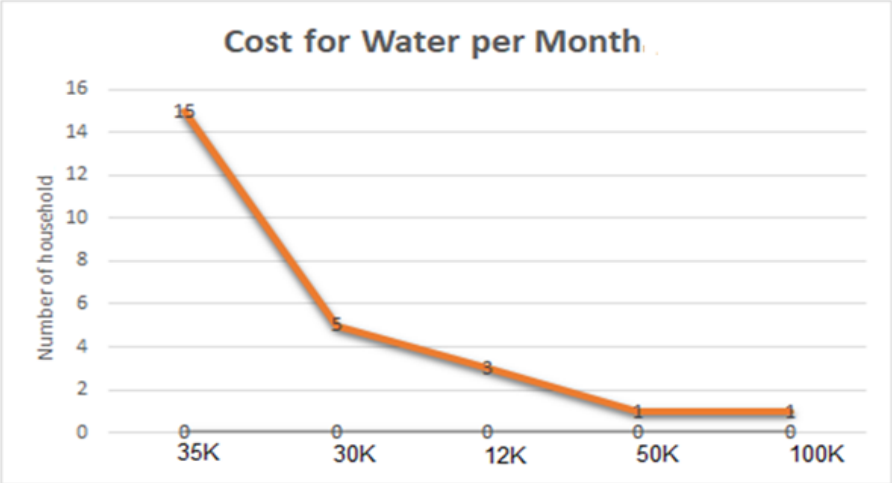

Figure 6. Cost of water on the bill

Source: Month of May 2023

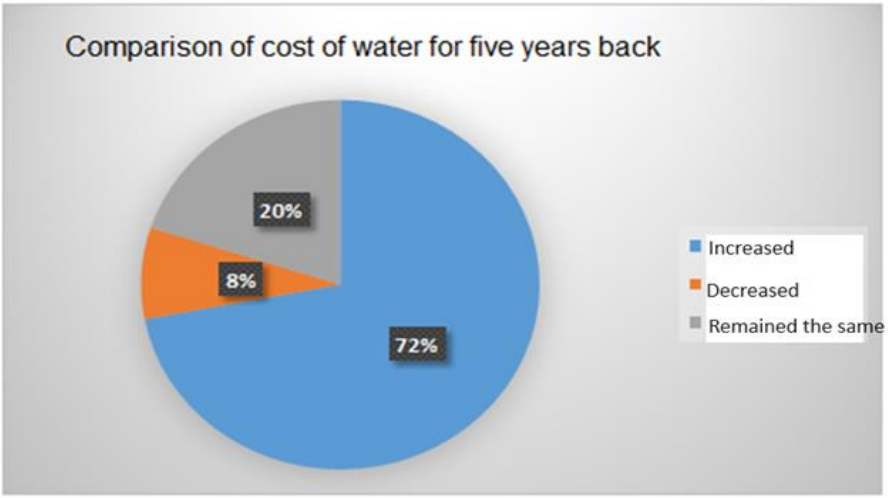

Figure 7. Cost of water

Source: Field data 2023

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