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VIABILITY OF RAINWATER HARVESTING IN SUPPLYING DOMESTIC WATER IN RURAL AREAS OF SWAZILAND: A CASE OF MPAKA COMMUNITY

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ABSTRACT

A descriptive study to determine whether or not rooftop rainwater harvesting is a viable supply of domestic water in rural areas of Swaziland was conducted at Mpaka community. Data was collected using face-to-face interviews and guided direct observation. Interviews were administered to heads of households, while the guided observations were made to compliment data solicited through the interviews. Heads of households were selected through a purposive sampling procedure since the interest was on households engaged in rainwater harvesting. The data collected was presented using tables and graphical techniques. The findings indicate that a majority of the households practice rainwater harvesting. However, only few households possess sound rainwater harvesting facilities to store enough water for the whole year. A majority of the households were not in a good financial state to purchase a sound rainwater harvesting system. Nevertheless, having a sound rainwater harvesting technology can be a solution to the water shortage problem in the community in particular and the country in general.

Keywords: Conveyance systems, Rainwater harvesting, Rooftop catchments, Storage device

INTRODUCTION

Background

Rainwater harvesting is any human activity involving collection and storage of rainwater in some natural or artificial container either for immediate use or use before the onset of the next season (Kemp, 1998).

Rainwater harvesting is not a new phenomenon as people from time immemorial have collected water from rooftops and from gullies that are filled by rain immediately after the rain. India and Africa are testimony to that, as these two continents are enlisted among the first regions which had practiced rainwater harvesting by traditional means.

According to Rutherford (2006), rainwater harvesting has only attracted considerable attention in recent years covering a lot of techniques from the collection of rainwater from roofs to the retention of surface and sub-surface in rivers. The main interest has been on methods of collecting and conserving rainwater at an early stage as possible in the hydrological cycle to ensure the best use of rainfall, before it has flown into rivers and groundwater, or has disappeared as evaporation.

Additional benefits from such measures of water control will often include a reduction in both soil erosion and in the damage caused by flooding. This is more relevant to urban centres where most of the ground surface is cemented; therefore, water percolation is minimized. Therefore, after a heavy shower rainwater end up demolishing property. This is usually the case with Swaziland’s capital city, Mbabane.

According to United Nations Environment Programme, (UNEP) (1982) rainwater harvesting technology involves **three** basic stages, namely; catchment areas (rooftops and land surfaces), conveyance systems (plastic or corrugated iron gutters) and collection devices (storage tanks).Water is life, for instance a human body is made of more than 71 % water (Peter, 2000). Yet millions of people throughout the world lack enough of this basic commodity for their hygiene and/or have no good quality water for drinking and preparing food. This is the case because conventional (perennial rivers, groundwater water supply systems are now not adequate to meet the water demands of large and rapidly expanding human populations. To combat the problem of shortage of domestic water, a majority of the developed countries have engaged in rainwater harvesting. This is mainly the case with Sub-Saharan Africa which is heavily suffering from problems of insufficient water supply, because of rainfall scarcity.

The problem of water scarcity is not a declining or steady process, but a worsening one as future projections indicate that in sub-Saharan Africa an estimated 400 million people will live in countries facing severe water scarcity by the year 2010 (Rutherford, 2006). To solve the problem of limited water supply in the region alternative simple and less expensive measures of obtaining water have to be considered by the African countries to supplement convectional methods of water supply, such as rainwater harvesting Therefore, through impacting knowledge the study is likely to promote the practice of rainwater harvesting in the Mpaka community, and the rest of the rural areas in the Southern African region.

Water balance in the hydrological cycle

Pacey and Cullis, (1986) states that river flow together with annual turnover of groundwater account for less than 40 percent of the rain which falls on the land surface. Furthermore, the remaining water is lost through evaporation from the soil, or from pools, marshes and lakes, and by evapo-transpiration from the leaves of growing plants. In some drier regions of the world, water collected from rivers account for as little as 4 percent of precipitation. Despite the low amount of total precipitation which collects in surface and underground water bodies, most of the advanced technologies for extracting and using water are concerned mainly with the exploitation of river systems and underground water by means of wells and boreholes.

The importance of rainwater harvesting

Apparently, if rivers only represent a small proportion of annual precipitation, one method of maximizing the use of precipitation water is to collect rainwater before severe evaporation losses takes place. This is why rainwater harvesting is encouraged in many developed countries. According to Hofkes (1983:27), "Rainwater harvesting has the potential of meeting water needs of rural communities". Singh et al. (1998), argues that the main objective of rainwater harvesting is to provide adequate quantity and quality of water for domestic use, irrigation and livestock.

Hofkes (1983) adds that the methods used for rainwater harvesting play a vital role towards the achievement of the objective of water harvesting. These methods are numerous and vary from region to region and so will the quality of the harvested water. Therefore, determination of ideal sites and suitable methods of water harvesting on large scale present a great challenge to the people of that region, who are often financially challenged (Hofkes, 1983).

According to Vilane and Mwendera, (1998), the collection of rainwater from surfaces such as, roofs has been a common practice in many regions with moist climatic conditions. However, today rainwater harvesting seems to be a viable solution for the problem of water shortage, even for dry climatic conditions. The use of water collected particularly from roofs can actually relieve the burden of collecting water from distant sources during the season when people are busy working on their agricultural land.

Furthermore since surface water is susceptible to contamination especially during the rainy season, rainwater collected from roofs can provide good quality water for domestic uses. Water from rooftops can ensure the availability of adequate and clean water for households in developing countries (Vilane and Mwendera, 1998). The benefits of rainwater harvesting are immense as it offers an ideal solution to problems of having inadequate water resources, raise the ground water levels, mitigate the effects of drought, reduces soil erosion, and also improves the quality of water.

According to the United Nations Environment Programme, (UNEP), (1982) the Indian government has passed a legislation whereby no houses can be built without the provision of a rainwater-harvesting technology.

In India two large soft drink companies are currently contributing to harvesting of rainwater through ground water recharge. “As a result of the technology that enhances proper utilization of rainfall; Indian people have managed to make huge investments in irrigation projects which have boosted the levels of crop production.” (Oweis, et al., 1998:85).

IDRC (1981: 4) points out that, “Water having been turned into a political issue more than 16% of India’s land still remains rain fed and in 200 years India has moved from a water equipped country to a water starved country.” Due to the failure in governance there is a lot of pollution in the current water system, and sanitation has turned out to be a major problem in the villages.

Bock (2005) states that, rainwater harvesting is the most appropriate technology that can complement the current water management systems and governments should provide funding for the success of such initiatives. There is also a need for more awareness creation on the potentials of rainwater harvesting and the integration of the technology within the integrated water resource management programme to help Africa in its endeavor to deal with water issues in a cost effective and sustainable way.

The development of rainwater harvesting in Swaziland

Despite the fact that Swaziland is categorized as a well-watered country traversed by five significant rivers, with mean annual rainfall ranging from 550-625 mm in the Lowveld and 850-1400 mm in the Highveld, water is one of the major constraints to development (Government of Swaziland, 1997b). For instance, a majority of the population residing in rural and peri-urban areas do not have access to safe and clean water (Government of Swaziland, 1997a). However, government strategies that currently exist are not aimed at improving the provision of clean and adequate potable water to rural areas of the country through rainwater collection. Similarly, the government's resource research agenda of water supplies does not include rainwater harvesting, but rather focuses mainly on river basins and groundwater.

Nevertheless, there is inevitable evidence that rainwater is harvested in the rural areas of Swaziland. Rainwater is harvested and stored in various containers, such as metal, plastic and cement tanks, clay pots and used oil drums. Maseko (2002) highlights that; the quality of the harvested rainwater is in line with health standards. However, this study did not reveal problems that rural communities face in implementing rainwater harvesting technology in the community, such as their financial problems.

Therefore, the present study being a case study conducted in a small rural community that is drought prone has come up with socio-economic problems of water supply in the Mpaka community. This has helped to unveil the difficulties that the general rural communities are suffering in the quest of domestic water. This research is likely to motivate the communities to increase the practice of rainwater harvesting. Motivation, in the sense that some of the rural people show less interest or trust in the potential of rainwater harvesting for domestic purposes. This is manifested through their dependence on freefall conveyance which in return leads to less amount of water being collected under a sound rooftop catchment surface area and a reasonable storage vessel.

The objectives of the study were to: (i) identify sources of domestic water at Mpaka community; (ii) determine the different uses of the harvested rainwater in the community; (iii) investigate whether or not the people of Mpaka community do have money to purchase a rainwater harvesting system; and, (iv) explore the types of rainwater harvesting systems (catchments, conveyances, and storage devices) used in the community.

METHODOLOGY

Description of study area

Mpaka community is the study area. It is located in the Lowveld region of Swaziland and has a total surface area of 69.3 km^2. Mpaka community is located on the west of Siteki town about 13 km, respectively. In terms of longitudinal and latitudinal position, Mpaka community extends from $31^0 42'$E to $31^0 48'$E and $26^0 23'$S to $26^0 28'$S (Figure 1).

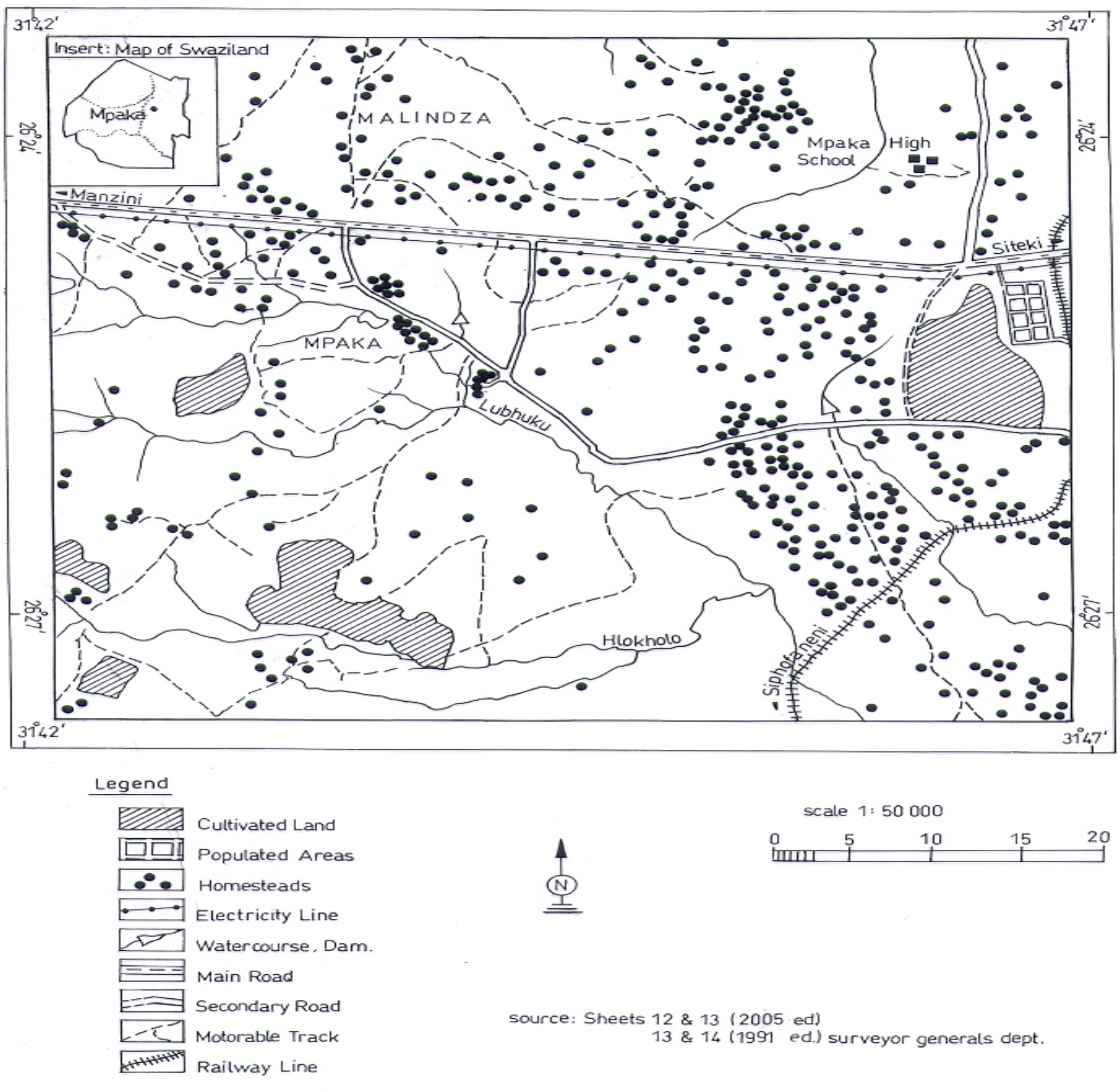

Figure 1. MPAKA COMMUNITY

Since the study area lies in the Lowveld region of Swaziland, it is characterised by a dry sub-tropical climate with variable rainfall ranging between 300mm and 670mm per annum (Government of Swaziland, 2006). However, most of the rain falls during the summer season especially between October and March. There is also a large diurnal temperature range experienced with a maximum temperature reaching 39^0C in January and a minimum temperature of 9^0C in July (Government of Swaziland, 2006).

The area is gentle undulating with some rock outcrops while most of the households are located in the low- lying parts (Government of Swaziland, 2005). Only a few parts of the area are sloppy and that is where valleys and mountains are located. On these slopes soils are less resistant to soil erosion. The main source of water in the area is earth dams, since there are no perennial rivers.

Like almost all the rural communities of Swaziland the people of Mpaka practice mixed subsistence farming. They keep livestock, mainly cattle and goats, and also grow maize, cotton and sugarcane. However, agriculture in the region is failing to provide the community with adequate food crops for the whole year, mainly because of unreliable rainfall. Hence, donor food plays a crucial role in sustaining people in the community. Also as a result of low agricultural productivity local people migrate to urban areas such as the three sugar plantations of the country in search of job opportunities.

In terms of population distribution, Mpaka community have 147 homesteads and 189 households, respectively. This study employed a case study research approach. This approach was adopted so as to undertake an in-depth analysis and explanation of the rainwater harvesting practise.

Data collection techniques

The study used face to face interviews guided by a questionnaire and a guided direct observation to complement information solicited through interviews. The questionnaires were administered to heads of households. Two thirds of the 189 households at Mpaka community were selected through purposive sampling. Therefore, only rainwater harvesting households were included in this study. An inventory was also conducted to ascertain the cost of the rooftop rainwater harvesting, where prices for the technology were obtained from five (5) prominent local hardware stores.

The data for this study are presented in narratives and tables. The responses were coded and inputted for analysis using the Statistical Package for the Social Sciences (SPSS).

FINDINGS AND DISCUSSION

Types of water sources

With regard to water sources 66.7% of the respondents obtained their water from earth dams, while 25.3% obtained water mainly from stand pipes, and only 8% obtaining water solely through rainwater harvesting (Table 1). Although the later group forms a minority, it was enough testimony that rainwater harvesting can provide adequate domestic water when fully propagated.

Table 1: Types of water sources

Source of water	Frequency	Percentage (%)
Dam	84	66.7
Stand pipe	32	25.3
Rainwater harvesting	10	8
Total	126	100

With respect to distance travelled to water sources 46% of the respondents had to travel more than 200 metres (Table 2). Moreover, 35% of the respondents travelled less than 50 metres to water sources (Table 2).

Table 2: Distance travelled to water sources

Distance to water sources in metres (m)	Frequency	Percentage (%)
0-50	44	35
50-100	5	4
100-150	4	3
150-200	15	12
200 and above	58	46
Total	126	100

In terms of adequacy and sustainability of available water sources 92% of the respondents indicated that harvested rainwater do not sustain their families throughout the year due to having small storage facilities. Furthermore, even those with big tanks could not be sustained by harvested rainwater for a long duration due to large family sizes. However, 8% of the respondents indicated that they fully depend on harvested rainwater through out the year, and these had 10 000 litres tanks and smaller family sizes of one to five people.

In addition, there were also problems encountered with stand pipe and dam water. For example, dam water quality was compromised by that people shared it with livestock. As a result, the water was dirty with small bacterial animals and had a bad taste (Table 3). With regard to stand pipe water, the main problem was unreliability since the water was not always available and also the high costs for maintenance (Table 3).

Table 3: Problems associated with dams and stand pipe as water sources

Water source	Problem	Frequency	Percentage (%)
Dam	Bad taste	12	10
	Dirty	32	25.3
	Shared with livestock	44	35
Stand pipe	Unreliable	24	19
	Rain scarcity	6	4.7
	High costs	8	6
Total		126	100

Rainwater harvesting system

The rainwater harvesting system involves catchments, conveyance and storage devices. In terms of catchments, the leading materials used were corrugated iron which was used by 92% of the respondents and tiles used by 8% of the respondents. With respect to conveyance systems, 19% of the respondents relied on freefall whereas other households either used plastic or metal gutters (Table 4).

Table 4: Conveyance systems used at Mpaka community

Conveyance system	Frequency	Percentage (%)
Freefall	24	19
Plastic gutters	50	39.7
Metal gutters	25	41.3
Total	126	100

Regarding storage devices, 10% of the households had storage tanks with a capacity of 5 000 – 10 000 litres. On the other hand, 33% of the households used containers with a capacity of 100 – 300 litres (Table 5).

Table 5: The size of water storage devices for households

Size of storage device	Frequency	Percentage (%)
0-100	18	14
100-300	42	33
300-500	4	3
500-1000	15	12
1 000-5 000	35	28
5 000-10 000	12	10
Total	126	100

In terms of duration of stored rainwater there was a direct relationship between storage size and the period over which the water was used, such that the smaller the size of the storage device the shorter the period over which the water was used. For instance, 60% of the households used their stored rainwater for a period less than one month since their storage facilities had a capacity less than 500 litres (Table 6). On the other hand, 6% of the households used their stored water for a period more than six months since their storage facilities had a capacity of 5 000 – 10 000 litres (Table 6).

Table 6: The duration of stored rainwater

Duration (months)	Frequency	Percentage (%)
0 -1	75	60
1 -3	20	16
3 – 6	23	18
6 and above	8	6
Total	126	100

Regarding treatment of stored rainwater 25.3% of the respondents indicated that they treated the harvested water, while 74.7% did not treat the water due to short duration of water storage. To treat the stored water households used either chlorine or bleach.

The cost of an effective rainwater harvesting system

An effective rainwater harvesting system comprised PVC plastic gutters and PVC plastic storage tanks with a capacity of 5 000 – 10 000 litres. The study carried out an inventory on the cost of PVC plastic gutters and tanks in five local hardware stores. From the findings the average cost of a 5 000 litres tank was E2 114.79, while a 10 000 litres tank was E5 109.00 (Table 7).

Table 7: The cost of rooftop rainwater harvesting systems

Item (tanks/gutters)	Hardware store and price of items in Emalangeni (E)					Average
	Shop No.1	Shop No.2	Shop No.3	Shop No.4	Shop No.5	
5 000 litres PVC tank	2 128.95	2 145.00	2 100.00	2 150.00	2 050.00	2 114.79
10 000 litres PVC tank	4 940.00	4 975.00	4 800.00	6 030.00	4 800.00	5 109.00
6 metres plastic gutter	122.95	134.00	164.00	195.30	-	154.06

* Worth noting is that Shop No. 5 do not sell gutters but only tanks.

With regard to economic power, 68% of the households earned monthly incomes of E0 – 1 500, hence they were unable to save for the implementation of an effective rainwater harvesting system, as almost everything was spent on household needs and school fees (Table 8). Moreover, 9% of the households earned monthly incomes of E1 500 – 3 000 and they were able to save about E 1200 – 1 500 after deduction of monthly expenses, in the form of school fees and household needs (Table 8).

Table 8: Households' monthly income, expenditure and savings

Average monthly income (E)	Average monthly expenditure (E)	Average savings (E)	Frequency	Percentage (%)
0 - 1 500	1 000 – 1 300	200 - 500	86	68
1 500 – 3 000	1 500 – 1 800	500 – 1 200	11	9
3 000 – 4 500	1 800 – 2 400	1 200 – 1 500	18	14
4 500 and above	2 400 – 3 000	1 500 – 2 500	11	9
Total			126	100

The findings further, indicate that 68% of the households had very little savings (E200-500), thus unable to budget for better rainwater harvesting systems such as plastic tanks and gutters. In terms of financial assistance towards purchasing rainwater harvesting systems all the respondents indicated that there was none, either from the government or from Non Governmental Organisations (NGOs). Thus they funded the rainwater harvesting systems on their own.

CONCLUSIONS AND RECOMMENDATATION

In conclusion rainwater harvesting is a viable supply of domestic water in rural areas. This is primarily because it offers immediate hope for thousands of scattered, small rural communities which cannot be easily served by more centralised water supply schemes. For instance, the findings indicate that some households in the study area entirely depend on rainwater harvesting for a supply of domestic water. Moreover, even those who do not entirely depend on rainwater harvesting were mainly constrained by small storage facilities and also large family sizes. Therefore, if households could afford big storage facilities the acute water shortage problem could be averted especially when there is adequate rainfall during the wet season. Thus, considering the viability of rainwater harvesting it is crucial for Swaziland and other developing countries to defy all the odds that stand against proper implementation of the technology.

Hence, this study recommends that future studies consider the practice of rainwater harvesting in an effort to supply micro-scale agricultural water (household gardening). Moreover, further studies also need to focus on the role of rainwater on urban settlements as it can cut the costs of piped water and mitigate city flooding risks.

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