

Water Harvesting, Rural Poverty and Health in Dodoma Region, Tanzania

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Abstract

Water is a unique basic resource found in rivers, lakes, springs and ground water reservoirs. However, it is unevenly distributed over the world; some parts have more access to it while others have little or none at all. Indeed, this anomaly has compelled man to resort to various ways of developing this unique resource either by increasing the quantities available for use at one location or store the excess amounts to be used during the time of deficiency or scarcity. Furthermore, the provision of water supplies in every district is strongly linked to economic, social and health reasons. Through a sample of about nine villages in Dodoma region this study examined the relationship between health and water harvesting in the region. As a whole the study shows that the majority of people in the region use traditional water sources such as sand river holes that have little sanitary protection. There are efforts of installing improved water supplies in every district in the region but very few use it because they are very costly in terms of fuel and spare parts. Nonetheless, there is a strong relationship between good water supply and health of an area. This is because areas with good water supply have low infant mortality. Above all, the future prospects of improving health in Dodoma region depends on the improvement of water harvesting techniques.

Introduction

Water is a unique basic resource found in rivers, lakes, springs, oceans and ground reservoirs. Besides this it is unevenly distributed over the world so that some parts have excess water while others have little or none at all (Armbruster et.al. 1986:12-15). This anomaly has compelled man to resort to various ways of developing this unique resource either to increase the quantities available for use at one-location or store excess amounts to be used during the time of deficiency or scarcity. Some of the few efforts used

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to increase quantities of water include building dams, watershed management, water recycling, desalting or cloud seeding. On the other hand, some of the few efforts used to store excess water include flood control reservoirs for river regulations and embankments. Moreover, man has also looked below the earth's surface for water where precipitation and surface water has been found to be inadequate for the various water requiring activities (Msangi, 1985:1).

Furthermore, the provisioning of water supply to rural areas in developing countries has been given high priority due to economic, social and health reasons. Economically and socially it is expected that the provision of better domestic water supplies would save time and energy that is used for fetching water. In terms of health it will lead to better quality of life in rural areas by reducing the incidence of waterborne and water based diseases (Mjwahuzi, 1978:12; Mbonile, 1995:148-151). Besides this water contributes to better agricultural and livestock production which increases the nutritional status of a population (Tshannerl, et al, 1971:28; Msambichaka et al., 1997:88).

Moreover, the improvement of health is achieved by providing water in a way that solves the prevailing health problems of the population. Hence if the common diseases which trouble the people are classified as water borne it is important to improve the quality of water supply in order to reduce these water borne diseases. In this case struggles should be directed towards improving the delivery of water. On the other hand, if the existing diseases are classified as water-washed the various health problems can be properly tackled by increasing the quality of water. Also if aquatic animals create the health problems or parasites such that it is water based diseases the problem can be eradicated by removing the host animals or parasites. In addition, if insects that depend on water cause the infections the solution would be to remove the favourable habitat for these insects (Mjwahuzi, 1978:12; Falkenmark, 1982: 38-39).

Statement of the Problem and Objectives of the Study

Dodoma is among the semi-arid regions in Tanzania with an average rainfall falling below 500 mm per annum. This low rainfall problem is compounded by a high annual evaporation rate (2,200 mm. pa) that is far above the average rainfall in the region. As a result this high evaporation rate retards open surface water management. Hence the population in the region is forced to ravage for water in dry sandy watercourses, which are highly contaminated because they are used as toilets and livestock routes (Mbonile, 1996:3;

Rwehumbiza et al. 1999:142). Also despite the fact that water is needed for various household activities such as drinking, cooking, washing, bathing, irrigation and so forth semi-arid areas like Dodoma region are facing a lot of problems to supply this critical resource to the population. They are compelled to resort to underground water that is very salty and intermittent sources like rivers during the dry season. The lack of water makes the people put less priority to bathing and washing clothes when compared to cooking and so giving a better chance for diseases like trachoma and others to thrive. Trachoma blinds several people who end up being beggars in towns and hence perpetuating the vicious cycle of poverty (Mbonile, 1996:5; Mosi, 1996:79). Therefore, this study will examine the relationship between water, rural poverty and health in Dodoma region. In addressing this problem a number of research questions will be answered, which include:
What is the relationship between water/ rural poverty and morbidity/ mortality in Dodoma region?

- (1) What are the main limitations of improving water supply in Dodoma region?
- (2) What measures can be taken to reduce morbidity/ mortality in Dodoma region?

Besides this the study will address one major hypothesis that states that there is a strong relationship between water supply and morbidity/ mortality in Dodoma region.

Methodology of the Study

The study began in 1996 as a broader study on rural poverty and environment in Tanzania that was organized by the United Nations Division for Environmental management and Social Development. This study aimed at establishing multi-disciplinary approach in confronting poverty and environmental issues. In order to have a reasonable coverage of the region the study covered all districts in the region. The various wards and villages in the district were selected on the basis whether water harvesting will be useful in domestic use, crop and animal husbandry.

In Dodoma Urban district Mapinduzi, Matumbulu and Vikonje Villages were sampled. In Mpwapwa, Chisenyu and Mbori Matomondo villages were selected while in Kongwa Mageseni and Songambe villages were

selected. In Dodoma Rural district Muungano, Mlowa Bwawani and Mvumi villages were selected and in Kondoa district Kalema, Masawi and Kolo villages were selected (Table 1).

Table 1: Selected Study Villages and Districts in Dodoma Region

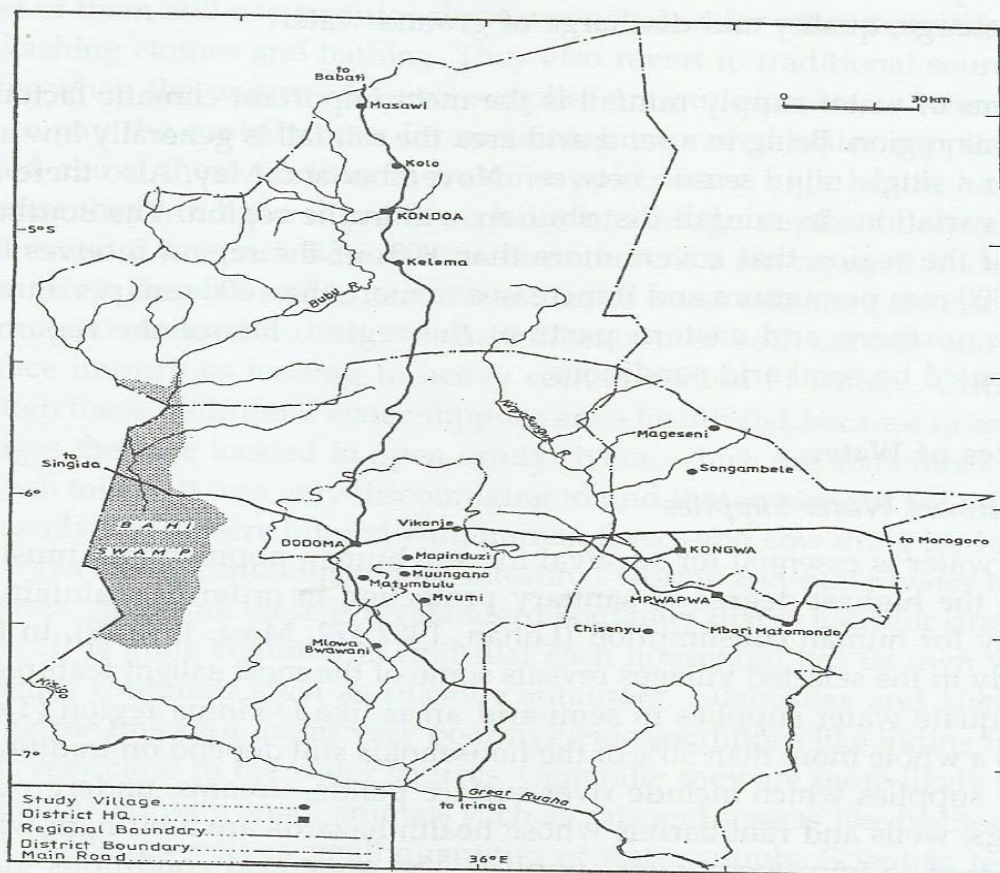
DISTRICT	DOMESTIC	LIVESTOCK	CROP
Dodoma Urban	Pilawema Mapinduzi* Mkoyo Ihumwa	Hombolo Matumbulu*	Vikonje* Ikowa Zuzu Swaya
Dodoma Rural	Mlowa Muungano*	Dabalo, Nonowa Ndumila Mlowa Bwawani* Mchiko	Chikopelo Mvumi* Chipanga
Kondoa	Kalema* Msaada	Kisaki Mwisanga Farkwa Haubi Bicha Masawi*	Bereko Kolo*
Kongwa	-	Dababako Mlaki Mageseni*	Songambele* Chamkoma
Mpwapwa	Chisenyu*	-	Mbori Matomondo* Tukugwe

The Study Area

Dodoma region covers an area of about 41,300 km² and has an altitude that varies from about 500 meters in the Great Ruaha river valley to about 2,000 meters above sea level on the Rubeho Mountains. As a whole the region is composed of undulating peneplain landforms and a few mountain chains such as the Rubeho, Usagara and Ukaguru.

In terms of drainage Dodoma region is situated on a continental watershed (Map 1). The middle and eastern part of the region is drained by the Kinyasungwe River which is a tributary of rivers Mkondoa and Wami respectively which drains into the Indian Ocean. The second major drainage system is that of Buhu River which drains the northern-western part of the region into the Bahi Swamp. This swamp also drains the water from minor streams from the central and southern parts of the region.

The Northeastern part of the region is drained by streams flowing into the Masai steppes, Shuriro and the Tarangire River that drains into Lake Manyara. However, it is important to note that being a semi-arid area most of these rivers are seasonal rivers flowing only during the wet season. The only permanent river in the region is the Great Ruaha River that is a tributary of River Rufiji, which drains into the Indian Ocean (Hatibu & Mahoo, 1997:5).



Map 1: Location of Selected Villages in Dodoma Region

Geologically crystalline metamorphic and plutonic rocks called Pre-Cambrian Basement Complex underlie Dodoma region. The rocks found in this basement complex consist of granites, gneisses, quartzite, schist, diorites, amphibolites etc and they form the so-called Usagaran, Ubendian and Dodoman geological systems in Tanzania. These basement rocks have been subjected to deformation and metamorphism, such as the Rift Valley system that affected the whole of East Africa. The weathered material from these basement rocks is thin and is deposited in depressions to form undifferentiated, unconsolidated and semi-consolidated gray to dark ferric acrisols. Moreover, the morphostructural setting in the region has a big influence on the availability of both surface and ground water. Since the basement rocks are fractured and covered by thin weathered rock mantles it structurally restricts and controls the drainage pattern. The rock structure makes the ground water to be found in restricted small zones and the hard impermeable rocks that are found in most catchment areas control the recharge, quality and discharge of ground water.

In terms of water supply rainfall is the most important climatic factor in Dodoma region. Being in a semi-arid area the rainfall is generally low and falls in a single rainy season between November and May. Also there are great variations in rainfall distribution within the region. The southern part of the region that covers more than 80% of the region receives less than 500 mm per annum and it increases to more than 600 mm per annum in the northern and eastern parts of the region. Hence the region is dominated by semi-arid conditions.

Sources of Water

Traditional Water Supplies

Since water is essential for survival for any human population it must be given the highest degree of sanitary protection in order to maintain its quality for human consumption (Lohan, 1982:472; Mosi, 1996:79). In fact a study in the selected villages reveals some of the most salient features of inadequate water supplies in semi-arid areas like Dodoma region (Table 2). As a whole more than 50% of the households still depend on traditional water supplies which include river surface ponds, streams, underground springs, wells and rain barrels whose health hazards are a bit high when compared to improved water supplies. The same arid conditions make several households collect water in intermittent sandy rivers especially

during the dry season. The potholes and pans that are dug in these sandy rivers are most often shallow. On the other hand during the wet season (November-April) they depend on surface water that ranges from ephemeral to perennial streams. Therefore, in order to have a better access to this scarce resource the people settle with large heads of cattle and other livestock near these major sources of water or areas with water tables very close to the ground so that they can tap the surface water discharge that comes immediately after the rains. The discharge of run-off increases with time because the concentration of both population and livestock very close to the water sources compacts and impoverishes the area of all possible natural resources. The land becomes so barren that it is only livestock like goats that forage a few dry grasses very close to the household. Furthermore, field observations showed that despite the fact that some villages have improved water supplies such as Mvumi village in Dodoma Rural district most of them still use traditional sources of water for other activities such as washing clothes and bathing. They also revert to traditional sources of water when the improved water supplies are out of order or when they fail to pay the contributions for sustaining improved water supplies. As stated above these traditional water supplies have high health hazards because they are hand dug and so have an average depth of between 0.5 meters and 2.0 meters. Besides this since there is a strong need to deepen them when the water table near the source of water falls they are not lined or covered. Indeed this allows the infiltration of both surface and sub-surface impurities leading to heavy contamination of water. Critically enough these traditional water supplies are a health risk because in several villages they are located in open sandy rivers, which are sometimes used as bush toilets. It was very discouraging to find that in some of the villages the sandy rivers were littered with human faeces and cow dung leading to the water being contaminated by intestinal worms and other water borne diseases. Above all there is no standard container that is used for drawing water. It is quite common to find that each household has its own water drawing container such as plastic containers, calabashes and *kimbo* or margarine tins kept under very poor hygienic conditions like hiding in the bush very close to the water sources. Generally they are more likely to be contaminated with small animals such as rats and insects like beetles that need shelter as well as small quantities of water supply. Scientific testing of the quality of water revealed that the water had large quantities of microbes, mud and other impurities.

Table 2: Types and Conditions of Water in the Surveyed Villages

DISTRICT	VILLAGE	POPULATION		EXISTING WATER SOURCES	REMARKS
		Human	Livestock		
Dodoma Urban	Mapinduzi	4,546	6,312	1. Dugwells 2. Shallow well 3. Charco 4. Borehole	1. Mere seepage at the end of dry season. 2. Supply for 3 to 4 months into the dry season 3. Supply the lower part of the village due to insufficient pump.
	Matumbulu	4,675	3,674	1. Water holes in sand banks 2. Matumbulu dam 3. Borehole	1. Dry up during the dry season but replenished by Matumbulu Dam. 2. Largely silted-up, supplies water for livestock. 3. Out of order, supplies one part of the village.
	Vikonje	4,624	4,159	1. Dugwells 2. Shallow wells 3. Charco 4. Borehole	1. Saline water, used for livestock supply. 2. Slightly saline, mere seepage in dry season fitted with a hand pump. 3. Dries out in the dry season. 4. Intermittent supplies, depending on availability of diesel.
Dodoma Rural	Muungano	4,700	40 (zero grazed)	1. Dugwells 2. Borehole 3. Two shallow wells 4. Waterholes in sandbeds	1. Water slightly saline, dry up during the dry season. 2. Supply from Mzura borehole on alternating arrangements. The village contributes fuel. Water is insufficient. 3. One is out of order and dry up in September. 4. Dry up in the dry season. There is major water problem.
	Mvumi	9,852	405 (zero grazed)*	1. Dugwells 2. Two boreholes	1. Used when borehole supply fails. 2. One borehole is out of order. If all boreholes operate the supply is sufficient. Electrical motor driven pumps
	Mlowa Bwani	4,352	6,558	1. Dugwell 2. Dam 3. Borehole	1. Perennial, down streamside of the dam wall. 2. Heavily silted, dries up in October. 3. Intermittent, no regular supply of diesel.

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Kondoa	Kelema	6,287	4,300	1. Waterholes in sandbeds 2. Borehole 3. Infiltration gallery	1. Perennial and presently provide 100% of the water needs for domestic and livestock. 2. Engine for the pump is stolen 3. Demonstration but poorly built. Draws water from the upper part of the sand aquifer.
	Masawi	5,359	2,002	1. Dugwell 2. Three springs	1. Good water quality but dries up during the dry season. 2. Lembo, Kichangani and Kwanala springs. Development of these requires motorized pumping.
	Kolo	3,517	429	1. Dugwells 2. Two shallow wells 3. Water holes in sandbeds 4. Borehole	1. Dry up at the peak of the dry season. 2. Both dry up during the peak of the dry season. One hand pump is out of order. 3. Perennial though mere seepage at the dry season. 4. Borehole out of order, pump rods broken in the hole. If operational the supply is sufficient to meet water needs of the village
Kongwa	Songambebe	8,813	2,227	1. Borehole	1. Water is brackish-hard. Pump capacity low. Critical water shortage.
	Mageseni	1,411	3,082	1. Charcos 2. Gravity Spring 3. Borehole	1. Dry up in the dry season. 2. Intake and pipeline destroyed. 3. Raising main and rods dropped in the hole, the Borehole is abandoned. Critical water problem.
Mpwapwa	Chisenyu	1,461	Not kept in village*	1. Charcos 2. Piped water from Gulwe railway Station	1. Being used by four villages. Dries up in September. 2. Critical water problems.
	Mbori Matomondo	4,312	3,450	1. Three shallows wells 2. Perennial stream	1. Perennial shallow wells but slightly saline. 2. Systems of canals installed for irrigation

*Note: * Villages under the Hifadhi Ardhi Dodoma (HADO) were compelled to zero graze in order to control land degradation.*

It was in villages like Matumbulu where there were small quantities of impurities because the sand rivers are constantly being replenished by water from Matumbulu man-made dam.

History of Water Harvesting in Dodoma Region

As stated above and as observed by Kifua (1996:1) the historical evidence for the use of improved water harvesting methods in Dodoma region is a bit scanty. Some of the old people in the region still remember that roof water catchment systems were used by the Germans probably immediately after their arrival in the late 19th century. This water was harvested to serve big settlements like forts where soldiers and administrators stayed. Indeed, one of these schemes is observed at the Prime Minister's office in Dodoma. Also, similar schemes were built in other semi-arid areas such as the Mkalama Fort in Iramba district (Singida region). Nonetheless, in both areas these systems are out of order because they have been vandalized and completely destroyed. It is further documented by Nilsson (1986) that the first sand dam was built in 1912 near Dodoma town but at present it cannot be clearly located. The other documented water harvesting project is the sub-surface clay dam that was built at Bihawana Roman Catholic Mission in 1967.

However, since the 1970s a number of roof catchments systems have been installed in several places in the region to provide water to health centers, dispensaries, primary schools and mission areas. Also, during the post-independence period a number of earth and concrete dams were built. These include Matumbulu, Mlowa Bwawani, Ikowa, Dabalo, Hombolo, Kisaki, Lambo, Buigiri, Mkalama, New Dam, Nondwa, Chamwela, and Manda. Also a few deep wells have been constructed to pump deep underground water for villages such as Chalinze (Kifua, 1996:4)

Improved Water Supplies

The history of water supply development in Dodoma region began during the colonial period when several water holes were developed both for human and livestock consumption (Tanganyika, 1949). This struggle for improving the water quality and supply in the region continued during the post independence period when large man-made dams were constructed which include Hombolo, Matumbulu, Ikowa and Mlowa Bwawani (Mujwahuzi, 1978:1). In addition, in several places windmills imported from Australia and other developed countries were installed for pumping

deep underground water. Indeed, an in-depth study of water supply in the study area revealed that nearly 90% of the surveyed villages had improved water at present or in the past. Also the people admitted that they are forced to hunt for improved water supplies even if it meant walking long distances from the household because hygienically it is safe and it is of good quality. Besides this, unlike the traditional water supplies, improved water supplies do not dry during the dry season. Moreover, they considered that improved water supplies reduce the amount of time used by women to hunt for water, especially between June- December.

Nonetheless, the study revealed problems related with the utilization of improved sources of water. First, the majority of the villages had the opinion that improved water was not always of good quality due to the presence of suspended solids and bad taste. This unpleasant taste of water was the result of having large quantities of chemicals, such as chlorides and fluorine that endanger human and livestock health. Secondly, all improved water supplies require pumping machines that are maintained at very exorbitant prices. Sometimes when these machines break down the villagers are compelled to stay for a long period without any reliable water supply. Also there are external forces that retard the development of improved water supplies. As a whole most water pumping machines use diesel engines that are also used in milling machines and hence there were reports of pumping machines being stolen in villages like Mlowa Bwawani (Dodoma Rural) and Mapinduzi (Dodoma Urban). In the case of hand pumps they are being misused by children and other notorious people simply because there are no strict by-laws which prohibit children from drawing water without being accompanied by their parents. Thirdly, it was also very common to find long queues of women during the peak of water drawing especially early in the morning and late in the afternoons that suggest that water was inadequate. Fourth, the other major problem for improving water supplies in Dodoma region include the lack of water troughs which makes the livestock continue to use the traditional water supplies or compete with people for the same water supply. As a result the whole process of bringing livestock close to improved sources of water makes the areas near these sources of water to be heavily eroded and dirty. This problem is very critical during the wet season when the area becomes so muddy and almost impassable. Sometimes the dirty water may ooze into water supplies. Besides this, flies which breed in this dirty water mixed with cow dung impose another threat to the health of the people. Almost

the same threat occurs during the dry season when strong winds bring large quantities of dust very close to these major sources of water. Sometimes the dust is poured in wells and other open sources of water and if not scooped from the sources of water at regular intervals they may fill the wells.

The fifth problem of improving water supplies in Dodoma region is related to the use of open deep wells and open dams (*malambo*). Generally the use of deep sources of water is impeded by salty or hard water. The presence of hard water in villages such as Songa mbele in Kongwa district and Bori Matomondo in Mpwapwa district compels the people to use powdered soap used for washing clothes such as OMO and Dynamo and others which do not contain any oil to soften the body. Also medical tests have shown that sometimes the hard water contains dangerous elements such as aluminium and fluorine. Nonetheless, the people are compelled to use it because the dangerous cut-off of 0.02 milligrams points in Tanzania is a bit higher than in international standards of 0.02 milligrams.

The sixth problem of improving water supply in Dodoma region is that for quite a long period there was an overdependence on foreign aid. There are several non-governmental organizations that are involved in water development in Dodoma region. These include Water Aid (from Britain), water and Health (BSF-Belgium), United Nations Development Organization (UNDP) and numerous local community based organizations (CBOS). Nonetheless, for any sustainable development of water supply village governments must be forced to set up by-laws that reinforce some cost sharing in maintaining the improved water supplies. In fact in several of the villages we visited the villagers were supposed to pay about ten shillings per bucket, which is accumulated to form the water fund (*mfuko wa maji*). Actually from this fund they were supposed to purchase diesel for running the water pumps and buy spare parts for the engines. However, further investigations with the villagers revealed that lack of adequate and reliable sources of water makes households spend more money on buying water rather than paying money to buy the diesel. This is largely because the cost of water increases with the distance of the source of water from the household. For example in Chisenyu village in Mpwapwa district the villagers were quite prepared to pay Tshs 50/= for a bucket of water brought by carts or donkeys from Gulwe railway station.

This problem becomes more critical during the dry season when some households are forced to sell their livestock so that they can get money for buying water. Nonetheless, as stated above, for those who cannot afford to get the water normally resort to traditional water supplies that endanger their health. In one-way or another this unforeseen change from improved to traditional water supplies dilutes the various improvements achieved in reducing morbidity and mortality in the region.

Household Water Supply and Health

As observed by Mujwahuzi (1978:15) and Kjellen (2000:146) there is a strong relationship between water supply and health of the population. Water influences the household health in various ways. For example, the differences in access to water influences the housing conditions that in turn influence the health of the population of the household. As observed in several sub-Saharan Africa the inadequate water supply in Dodoma region is a big limitation to the construction of good houses (Maiga, 1995:46). Indeed, a good house can be defined as the one with good physical fabrics, and access to amenities such as water, sewerage and electricity. It also takes into account the number of people per dwelling and the number of rooms per household (Kulaba, 1981: 13; Maiga, 1995: 47).

Table 3: Proportion of Households with Modern Housing by Village

District	Village	Total Number of Households	Households with modern Houses	Percent
Dodoma Urban	Mapinduzi	909	361	39.7
	Matumbulu	1,016	408	40.2
	Vikonje	1,005	312	31.0
Dodoma Rural	Muungano	1,022	402	39.3
	Mlowa Bwawani	953	403	42.2
	Mvumi	2,142	1,312	61.3
Kondoa	Kelema	1,257	700	55.7
	Masawi	1,072	578	53.9
	Kolo	703	332	47.2
Kongwa	Songa Mbele	785	527	67.1
	Mageseni	243	89	36.7
Mpwapwa	Chisenyu	252	105	41.5
	Mbori Matomondo	862	504	58.5
TOTAL		12076	5,975	49.5

Come out with a standard definition of a modern house. However, this study defines a modern house as the one that is roofed with corrugated iron sheets and the floor is made of cement or both the roof and floor are made of other improved materials such as tiles. By using simple definition it was realized that due to poverty most rural households in Dodoma region have traditional houses called Matembe. These traditional houses are made of simple poles plastered by mud and due to semi-arid conditions they are also roofed with mud. It is only in developed villages like Vikonje, Mlowa Bwawani, Mvumi Songambe and Mbori Matomondo where more than 50% of the households have modern houses (Table 3). In general these houses are too small, crowded and they have small windows or holes that encourage the spread of airborne diseases such as meningitis and fever spread by bed bugs. Besides this, the compounds of these houses are dirty because they are very close to livestock enclosures (*boma*). The livestock enclosures make the household surroundings to be wet and muddy making them ideal places for the breeding of houseflies and the spread of trachoma. In addition, the piles of manure in the livestock enclosures pollute the atmosphere. These poor environmental conditions make the contamination of domestic water and milk inevitable. Another major problem of these traditional houses is that they cannot be used for water harvesting which is essential in semi-arid areas like Dodoma. However, the only major advantage of these traditional houses is that they are cool during the hot season because they are plastered by mud. Also there is a strong relationship between household water supply and sanitation in the study area. As in all third world countries the main drawers of water for sanitation and other hygiene are the women. The women collect water throughout the day by using calabashes, buckets, tins and plastics drums (*madumu*). More often in traditional water supplies they scoop up water by using calabashes that are wide open and the whole process applies very little hygiene. This is because any drawer of water submerges the calabash or any other container without cleaning it before dipping into water.

Generally, after the water has been drawn, water for drinking is supposed to be stored in special containers (earth pots) that are kept in a cool place. However, due to poverty, most households (75%) use the same containers for collecting water to store water for drinking and there is no distinction between water for drinking and that for other uses. Also the study revealed that only about 21% of the households boil water for drinking. In fact most villagers admitted that they boil water when there is an epidemic like cholera. There were several reasons that were advanced by the villagers for not boiling the water for drinking. First, they believe that boiling water

changes the taste of water. Secondly, boiling water is not the culture of the Gogo or Rangi who are the main tribes in Dodoma region. Thirdly, in areas with scarcity of water like Dodoma boiling water reduces the amount of water and also requires firewood that is another scarce resource in several rural semi-arid areas in Tanzania. Fourthly, since the main custodians of household water in rural areas are women they are heavily overloaded with other activities such as farming, cooking and caring for children and so have little time for boiling water. Also it was on very rare occasions when these containers containing water were covered except for gourds that have an advantage of having a narrow neck. Furthermore, the chance of contamination with waterborne diseases increases because very few households use cups with handles to draw water from the containers. Finally, the majority of the households reported that very few members of the households wash their hands after going to the toilets. Nonetheless, most members of the household admitted that they wash food such as sweet potatoes before cooking and that they wash their hands before eating. However, in some households the washing of hands before eating does not minimize the contamination of food because most of the people wash their hands in the same container making the water very dirty when the last person finishes washing his/her hands.

In terms of body hygiene there were few households with bathrooms that indicate that most people bathe near the sources of water. It was also observed that during severe scarcity of water most people might end up washing their faces and hands only. It also appears that most husbands bathe water which is drawn by their spouses and it is only when there is a severe scarcity of water that men draw water by using bicycles, donkeys or two containers balanced on the shoulder by using a long pole known as *mizegazega*. Men also draw water for selling and this habit is gradually spreading from urban areas into rural areas. Nonetheless, the issue of having a thorough hygienic bath is a critical problem among children and poor households because they lack even an ordinary soap. More associated with bathing about 90% of the households wash their clothes at the source of water. However, the washing of clothes more often depends on the amount of water available at the source of water, the workload, the amount of clothes owned and whether the household has soap or not. Moreover, unlike in urban areas, rural households pour the used water anywhere in the compound or near the source of water.

Table 4: Households' Utilization of Toilets by Village

District	Village	Households	Inspected Households with Toilets	Percent of H/Hs with Toilets
Dodoma Urban	Mapinduzi	909	735	80.8
	Matumbulu	1,016	899	88.5
	Vikonje	1,005	826	82.2
Dodoma Rural	Muungano	1,022	816	79.8
	Mlowa Bwawani	953	783	82.2
	Mvumi	2,142	1,939	90.5
Kondoa	Kelema	1,257	1,146	91.2
	Masawi	1,072	850	79.3
	Kolo	703	567	80.6
Kongwa	Songambebe	1,763	1,699	96.4
	Mageseni	243	191	78.8
Mpwapwa	Chisenyu	252	192	76.3
	Mbori	862	769	89.2
TOTAL		13,199	11,412	86.5

In terms of sanitation the practice of indiscriminate defecation near the village and in the fields is almost disappearing for the majority of the households have pit latrines. Indeed, some of the villages such as Mvumi have a well-established habit of using latrines. The few households that were found to have no latrines stated that the latrines had collapsed or they were using the latrines of the neighbours. Nevertheless, most latrines inspected were structurally very simple and in most cases were of very poor quality and below standard. Also most often these toilets lacked the side lining and the floors were of poles reinforced by mud. Moreover, few houses have roofs, doors and covers for pit holes. The depth of most pit latrines was less than 3 meters that makes them good habitats for breeding houseflies and mosquitoes during the wet season. Also no deliberate efforts are made by households to clean the toilets, especially in public toilets found in village offices, dispensaries, local bars and weekly markets (*minada or magulio*).

When those who had no latrines were asked why they did not have latrines they produced several technical problems. First, due to lack of or poor foundations it is very common for the latrine floors to collapse. Also sometimes the floor collapses because termites eat the supporting poles and the soft soil conditions, especially during the wet season, undermine the pit walls. Secondly, the poles used for the construction of latrines are

too small. This is because heavy deforestation very close to the villages has made the big poles to be found very far from the homesteads. Thirdly, the presence of urine around the pit holes makes the livestock that are grazed free range to gnaw the floor and destroy the short walls and roofs of latrines. Finally, the life span of most traditional latrines used by the household is about 3-5 years. As a whole the presence of pit latrines in most households with uncontrolled depth, lack of lids and doors is a health risk to the villagers because they allow the infiltration of microorganisms or other vectors like houseflies to contaminate the major sources of water.

Morbidity and Mortality

Morbidity is the state of illness and disability in a population and its statistics are based on the causes of death drawn from death certificates and other institutional records. On the other hand, mortality refers to the process whereby death occurs in a population (Wilson, 1985:151; Mohan, 1992). Hence Tanzania being a developing country faces several major health problems related to infectious and parasitic diseases that persistently have been the major causes of morbidity and mortality (URT, 1991:3). Indeed, these conditions are reflected in Dodoma region where some of the conditions are magnified because of the semi-arid conditions. In fact when the people in the surveyed villages were asked to name the main diseases which were found in their own villages it is quite clear that due to semi-arid conditions all villages had almost similar diseases (see Table 5). However, an in-depth study of the distribution of diseases by village shows that there is a strong relationship between water supply and the occurrence of certain diseases. First, it appears that waterborne transmission diseases such as diarrhoea are common in villages where there is high proportion of the households that use traditional water supplies or where the improved water supplies are more often out of order such as in Mapinduzi, Vikonje, Mlowa Bwawani, etc.

Moreover, the water scarcity or water-washed transmission diseases such as trachoma are found in nearly all villages because of the semi-arid conditions in the region. The dry conditions leading to scarcity of water makes the people rarely wash their faces, which encourages the spread of the disease by houseflies. Also, as stated earlier the other underlying factor for the widespread distribution of trachoma in the region is the location of cattle enclosures near the households. Normally these turn out to be the main source of houseflies, especially during the wet seasons.

Table 5: Six Major Diseases in the Survey Villages

DISTRICT	VILLAGE	DISEASES BY ORDER OF IMPORTANCE
Dodoma Urban	Mapinduzi	Trachoma, malaria, diarrhoea, intestinal worms, upper respiratory track infections, HIV/AIDS
	Matumbulu	Malaria, upper respiratory track infections, trachoma, HIV/AIDS, intestinal worms, accidents
	Vikonje	Malaria, diarrhoea, TB/RF, skin diseases, trachoma, HIV/AIDS
Dodoma Rural	Muongano	Trachoma, malaria, HIV/AIDS, skin diseases, STDs, blood pressure
	Mlowa Bwawani	Malaria, bilharzia, upper respiratory track infection, diarrhoea, intestinal worms, diabetes
	Mvumi	Trachoma, Malaria, bilharzia, diarrhoea, upper respiratory track infections, HIV/AIDS
Kondoa	Kelema	Malaria, pneumonia, diarrhoea, coughs, trachoma, HIV/AIDS
	Masawi	Malaria, diarrhoea, measles, coughs, pneumonia, upper respiratory track infections
	Kolo	Malaria, HIV/AIDS, Upper respiratory track infections, diarrhoea, trachoma, skin diseases
Kongwa	Songa Mbele	Malaria, diarrhoea, trachoma, intestinal worms, upper respiratory track infections, HIV/AIDS
	Mageseni	Malaria, whooping cough, diarrhoea, trachoma, upper respiratory
Mpwapwa	Chisenyu	Malaria, upper respiratory track infections, trachoma, HIV/AIDS, diarrhoea, skin diseases
	Mbori Matomondo	Malaria, bilharzia, diarrhoea, upper respiratory track infections, trachoma, HIV/AIDS

Table 6: Infant Mortality by Village Improved Water Supply

District	Village	Households	Households Boiling Drinking Water (%)	Infant Mortality rate (Iqo)
Dodoma Urban	Mapinduzi	909	33.3	87.1
	Matumbulu	1,016	44.5	78.2
	Vikonje	1,005	32.8	80.3
Dodoma Rural	Muongano	1,022	37.7	99.8
	Mlowa Bwawani	953	18.5	102.3
	Mvumi	2,142	56.8	70.9
Kondoa	Kelema	1,257	33.3	94.7
	Masawi	1,072	29.4	100.0
	Kolo	703	30.2	80.9
Kongwa	Songa Mbele	1,763	51.5	75.3
	Mageseni	243	22.8	101.5
Mpwapwa	Chisenyu	252	39.6	87.8
	Mbori Matomondo	862	58.8	76.7
TOTAL		13,199	32.6	85.7

In addition, there are water related insect vector transmission such as malaria and bilharzias that are largely found in areas with plenty of water such as Matumbulu and Mlowa Bwawani. Above all despite the semi-arid conditions malaria appears to be a leading disease in the region due to severe land degradation waterlogged pools. In order to have a clear view on the relationship between water supply and morbidity in the surveyed areas it was essential to calculate one mortality indicator. The mortality indicator selected was the infant mortality rate that has been documented to be very sensitive to the environmental and health conditions of a particular area (Mosley & Chen, 1984:32).

The data from dispensaries and village offices visited clearly indicated the peak of malaria transmission being between January and April each year. The excreta-related diseases such as intestinal worms are more associated with villages with poor sanitary conditions. Other diseases like the upper respiratory track infections are associated with strong winds that carry plenty of dust during the dry season, especially between July and October. Furthermore, HIV/AIDS and other STDs were mentioned by villagers and dispensary reports in villages especially that were exposed to the outside world such as Mvumi (Dodoma Rural district) and Songambele (Kongwa District) and those which were close to major roads such as Kolo and Muungano.

To derive the infant mortality rates Trussell variant of the Brass method (UN 1983) was applied to a proportion of children dead per woman in each group. Generally the results show that there is strong relationships between the levels of infant mortality and the type of water supply in the village (Table 6). The other factors which had similar impact as water supply on infant mortality was nutrition, income, sanitary conditions and accessibility to medical services. Nutrition was a very important variable in determining infant mortality because in villages like Matumbulu where the presence of the dam made the cultivation of vegetables throughout the year easy the infant mortality rate was low. Also the presence of a large number of baobab trees in the village lactating mothers enriched the ordinary porridge by the flour extracted from the baobab fruits. Also, in villages where there were dispensaries or maternal and child health centers the lactating mothers were advised on the ingredients for feeding children and proper methods of child spacing.

Future Prospects

In the early 1970s the government of Tanzania set a target that by 1990 (now by 2002) the population of the country would have access to a reliable, clean and safe water at a distance of about 400 meters. This compelled the government to establish several motorized groundwater sources in semi-arid regions of the country. At the beginning these sources of water functioned very well because the government incurred all the costs. Nonetheless, since the late 1980s when the rural communities were requested to operate and maintain these improved water sources most of these sources of water have fallen into disrepair and have been abandoned. This is partly due to poverty, whereby the rural communities are unable to pay for the operation and maintenance of these sources of water. Hence it appears that the future of these higher costs water service will depend on the eradication or alleviation of poverty by the community. Moreover, for communities that are unable to afford a higher service level water supply should be provided with low operation and maintenance water sources, and these sources should be sustainable by the rural community (Kifua, 1996:2). Indeed one of these options which will improve the water supply and the health of the people in Dodoma region is rain water harvesting.

The history of water harvesting in Dodoma region began in the early part of the 20th century when the Germans harvested water to supply their forts in Dodoma town. Also early missionaries built roof catchment systems in church compounds. Moreover, records show that the earliest sand dam was built in 1912 near Dodoma and a sub-surface clay dam was built in 1967 at Bihawana Mission, about 16 kms southwest of Dodoma town. Also, since the 1970s a number of roof catchment systems have been built in a few places in the region to provide water in health centers, dispensaries and primary schools (Nilsson, 1986, Kifua, 1996:2).

In order to have any meaningful improvement of water supply and health in Dodoma region there is need to improve the water harvesting through the traditional water harvesting methods which include water holes in sand river beds, hand-dug wells and ponds in natural depressions. Besides these traditional ways there is a need to introduce new methods of water harvesting.

Direct Rainwater Harvesting

The main technique of this method is roof catchment. In this method the rainwater that falls on the roof of sheet metals, tiles and long grass is collected through the gutters to a storage tank that is located on the surface or underground. As a whole the size of the tank depends on the amount of rainfall in the area, roof surface, water demand and the construction cost. They also differ in design and construction materials. Above all the potential of roof water harvesting in rural Dodoma region requires two stages. The first stage is to encourage the people to construct modern houses instead of the traditional houses. At present it is only possible to utilize public buildings such as schools, health centers or godowns and community centers that are available in several of the villages where the study area was conducted. Also this technique has been applied successfully in villages like Mkonze, Buigiri and Handali in the same region.

Run-off Water Harvesting

This technique involves the short-term and long-term storage of run-off water. The structures associated with these techniques include contour banks, micro-catchments, semi-circular hoops, trapezoidal bunds and interception ditches. These methods have been introduced in the region by Hifadhi Ardhi Dodoma (HADO) and DOVAP primarily to control land degradation in Kondoa and Dodoma districts. Since this method is also used for irrigation of crops, trees as well as livestock it has a high potential of improving the water supplies and health in semi-arid areas like Dodoma region.

Flood Water Harvesting

These techniques involve the construction of level flooded terraces and diversion to off contour bunding. The storage of water is either short term or long term as it is the case with irrigation schemes established at Bahi and Chipanga in the Bahi depression. As a result a total area of about 905 hectares are planted with rice, which is one of the staple foods in Tanzania. The long-term storage of floodwater involves the construction of large dams such as Matumbulu, Mlowa Bwawani, Ikowa, Dabalo, Hombolo, Kisaki, Lambo, Buigiri, Mkalama, Nondwa, Chamwela and Manda. These dams are used for watering the livestock, flood control, fish farming, irrigation and for domestic use. Nonetheless, these dams have a major problem of heavy sedimentation and evaporation. However, the only negative impact is that these are favourable breeding grounds for mosquitoes that spread malaria and snails that spread bilharzia.

Sub-surface Flow Water Harvesting

These techniques include sub-surface and storage dams and infiltration galleries. In general the sub-surface dams are vertical barriers constructed across the river bottom in the sand and down to the clay bedrock. Normally these barriers intercept the sub-surface flow of water within the sand. Then the water is collected and stored within the sand reservoirs created behind the barriers. The barriers may be built of clay, stone-masonry, concrete blocks and other materials and the water can be tapped by using gravity, hand pumps or solar pumps. These sand dams provide water for domestic, livestock or irrigation. For example the Bihawana sub-surface dam supplies about 49,000 m³ of water in the rainy season and about 31,250 m³ at the end of the dry season. More recently constructed sand dams include the Mkonze, Iyumbu, Mkoyo, and Matumbulu that were constructed by UNDP.

Despite the fact that various efforts to improve water supply in Dodoma region have been made, a large proportion of households still use traditional water supplies that biologically increase the chances of getting water borne diseases. Several attempts have been made to improve the water supply in Dodoma region through the introduction of boreholes and permanent dams like Matumbulu, most of which are saline and have a high concentration of other minerals such as aluminium that endanger the health of the people. These water supplies are also very expensive to install due to the fact most of them are installed in basins that have very deep aquifers. Therefore, it is recommended that a through research should be conducted to find cheap and environmentally friendly ways of harvesting water at household level. This process has already started in institutions like schools and hospitals which have better constructed houses.

The endemic poverty of the people in Dodoma region has led to the construction of poor houses traditionally known as Matembe in Ugogo area. Since these houses are constructed out of poles and mud they are not ideal for water harvesting. Besides this the hygiene for drawing and storing water is still very poor and very few households boil the water for drinking. This is because boiling water needs other scarce resources such as firewood and kerosine. Poor toilets that are largely constructed of temporary materials also endanger the health of the people.

As in all developing countries the morbidity in all the districts is very high and the people suffer from infectious diseases like malaria. Malaria and other water borne diseases like bilharzia are more associated with the presence of open water supplies such as dams and run-off, especially during the wet seasons. Therefore, it is advisable that any improvement in water supply in the region should be accompanied by improvement in the drainage system and water delivery points.

In order to have any meaningful improvement of water supply and health in Dodoma region there is a need to improve the water harvesting techniques through the traditional water harvesting methods that include water holes in sandy river valleys, hand dug wells and ponds in natural resources. Also there is a need of introducing new methods of water harvesting such as direct water harvesting methods and sub-surface flow water harvesting.

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