Assessment of Water Supply and Its Implications on Household Income in Kabuku Ndani Ward, Handeni District, Tanzania

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Authors' contributions

This work was carried out in collaboration between both authors. Author JAS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author FSS gave comments, managed the literature searches and wrote the final draft of the manuscript. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Aims: To assess the water supply accessibility and its implications on household income in Kabuku Ndani ward, Handeni district, Tanga Region.
Place and Duration of Study: A cross sectional design was conducted between November 2013 and January 2014 in Kabuku.
Methodology: Questionnaire related to water supply and household income was administered to 90 respondents who were randomly selected. Interviews with five key informants' explored issues related to water supply and its influence on household income. The hypothesis used states that household's expenditure on water supply does not significantly affect household income.
Results: Majority of respondents falls between 26-56 years of age. About 42% of respondents did not attend any formal education while 59% had attended formal education. Marital status and occupation showed a significant influence on water supply (P=0.036 and 0.048 respectively). Logistic regression analysis showed that infrastructure, management, occupation, education and

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age were significant (*P=0.05*) predictors of household income. People perceived that there was a direct relationship between water supply and household income. Access to water was a big problem which was thought to be caused by insufficient sources of water, outdated infrastructures, administration problems and climate changes. The available water sources could not meet household requirements. In addition long distances from settlements to water sources led people to spend up to 30 minutes fetching 20 litres of water on foot. The water was of poor quality and it could have led to serious waterborne diseases such as typhoid fever. The costs spent on water were alarmingly high and ranged between TZS 36, 000 and 54, 000 per month per household depending on family size.

Conclusion: The study concludes that the water supply problem in Kabuku ward has influence on the limited available household income. Therefore addressing water shortage problems combined efforts at local and national levels are required.

1. INTRODUCTION

1.1 Background Information

Water is crucial for sustainable development however, limited access to clean and safe water associated with poor water supply, hygiene and sanitation at household level is widening the poverty gap, gender inequalities and the prevalence of water-borne diseases [1]. Water is an essential resource for survival and a catalyst to the world socio-economic development [2]. Water is required for various purposes ranging from domestic uses, industrial production, irrigation, hydropower production, navigation to recreational activities and tourism [3]. Currently, over 768 million people face water scarcity, most of them are in sub-Saharan Africa representing one quarter of the global population that faces water scarcity [4].

Tanzania is among the few countries endowed with both surface and underground water resources to meet most of its present needs [5]. Despite the vast amounts of freshwater available, many Tanzanians both in rural and urban areas are still faced with water shortages due to insufficient capacity of water resources management [2]. Among the regions in Tanzania with diminishing quantities of safe water is Tanga [6]. The region has different types of sources of water supply including Charco dam, springs, rivers, shallow wells and boreholes; shallow wells being the leading water source. Some areas such as Korogwe, Muheza and Handeni are deprived of reliable water supply [7]. Handeni is among the dry districts in Tanzania; it has neither a permanent river nor lake. Water supply is not adequate in the district since only 42% of the rural population is supplied with clean and safe water, while 58% of the urban population gets clean and safe water [8]. The available water is from different sources such as Handeni Truck Main scheme, dams, ponds, shallow wells and boreholes [9].

An empirical observation of existing piped water systems in developing countries reveals that many of these systems are not functioning properly. In response to deficiencies in the piped water supply or availability, households invest in alternative supply sources. A household may choose different sources of water for different uses. The coping strategies adopted by households have important economic implications. Households incur high fixed costs, in the form of investment in alternative supply sources and storage facilities, and recurring costs, in the form of water purchases from vendors, when coping with water supply deficiencies. Moreover, they also incur indirect costs such as diversion of labour away from income-generating activities to coping activities of water supply deficiencies [4].

Both men and women lack access to clean and easily accessible water for domestic use and small production activities. They face increased drudgery due to increased waiting time at water points and increased walking distances and insecurity for the girls while fetching water; unimproved health and nutrition due to unclean water and poor sanitation and other hygiene practices [1]. This plays a role in gender discrimination where women fail to engage in other income generation activities for increased disposable income at the household level as well as participation in other productive activities such as agriculture which would further contribute to the general well-being of the household. Also unimproved health and living conditions directly impact on economic security for the community by making it difficult for men and women to undertake income generation activities, because

of reduced time availability and unimproved health (African Development Fund, 2006). The evidence above gives an overview on the association of water supply and household income due to the fact that water shortage has similar impacts in different regions as with the case of Handeni District.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Handeni District in Kabuku Ndani Ward [Fig. 1] with the population of 15,551 people (7,787 males and 7,764 females [NBS, 2013]. Handeni is one of the 8 districts in Tanga region. The district is located within the latitudes 40 55' and 60 04' S and longitudes 370 47' and 380 46' E. The district has 23 wards including Kabuku Ndani [2]. Kabuku Ndani ward has a total of four administrative villages namely Majani Mapana, Kabuku Mjini, Chogo and Kabuku Ndani. Communities living in Handeni district depend on unreliable sources of freshwater such as the Handeni Truck Main scheme, manmade dams, ponds, shallow wells and boreholes.
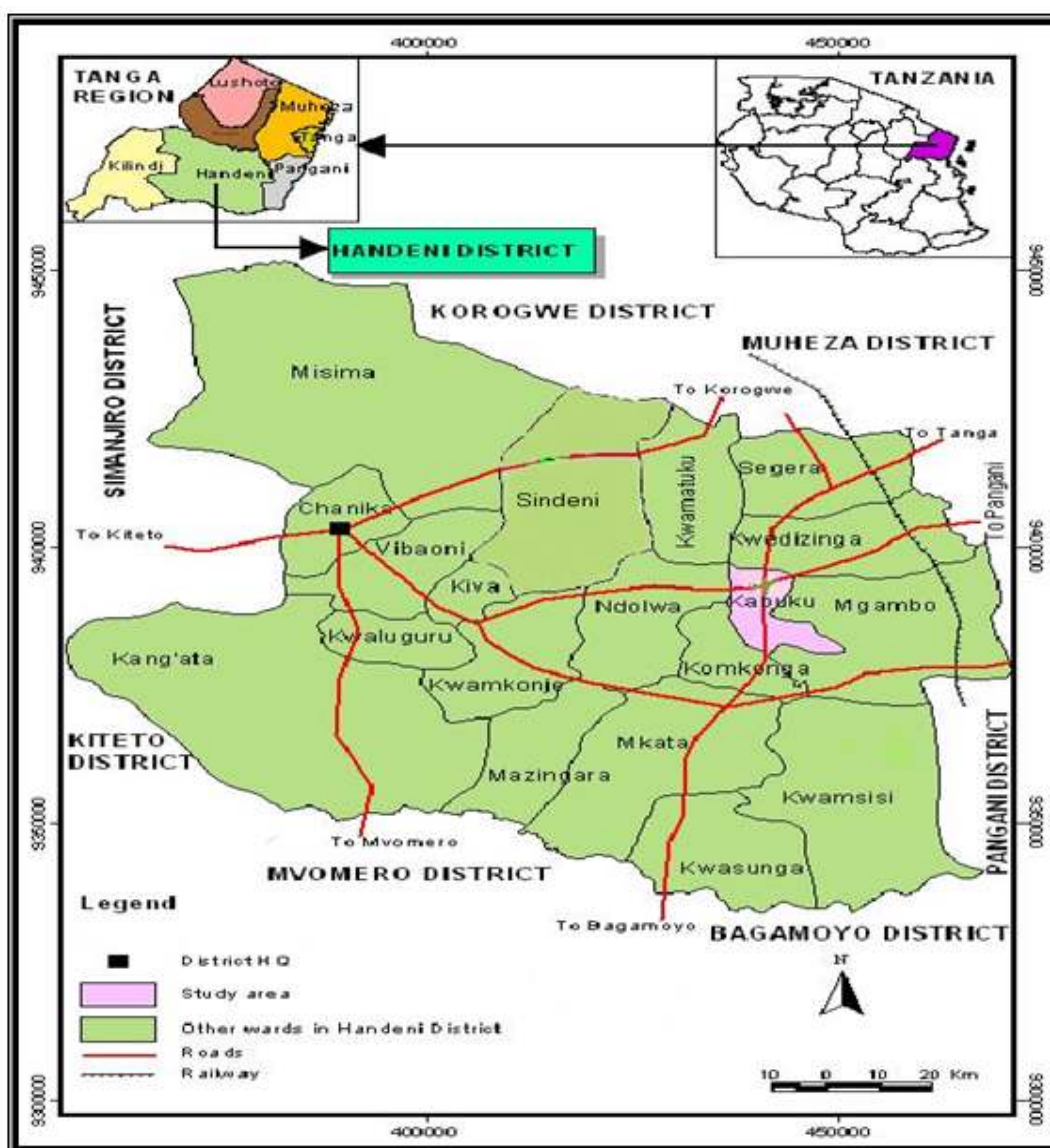

Fig. 1. A map of Handeni District showing location of the study area (Kabuku) shaded in green colour. Shaded in purple colour is Tanga region

2.2 Justification for the Study Area

Handeni has several wards; Kan'gata, Mkata, and Kabuku Ndani to mention few. Kabuku Ndani was chosen from many other wards to be the case study area due to the fact that it experiences critical water shortages. Several authors such as Tanga Region Socio-Economic Profile [10], Handeni District Profile [11], Handeni District Investment Profile [12] and EWURA [13] have documented the problem of water supply in Tanga region, Handeni district and Kabuku Ndani ward is included.

2.3 Research Design

A cross-sectional research design was used whereby data were gathered at one point in time [14]. Cross sectional design was used because it enabled collection of information at one point in time. Both qualitative and quantitative data were collected.

2.4 Sampling Procedures

2.4.1 The study population

The sample was drawn from heads of households or adults in the household from the selected study villages. A household is defined as a person or group of persons, related or unrelated who live together and share a common source of food [15].

2.4.2 Sample size and unit of analysis

According to Bailey [16] regardless of the population size, a sample or sub sample of 30 cases is bare minimum for studies in which statistical data analysis can be done. The unit of analysis of this study is households. The formula used in calculating sample size was; $n = N/ [1+N (e^2)]$ whereby; n represents Sample size, N =Total population, e=10% Sample error [17].

Sample size calculation

Formula; $n = N/ [1+N (e^2)]$
Whereby; n = represents sample size
  N = Total population
  e = 10% Sample error [17]
N = 15,551
e = 10% = 0.1

Then;

$$n = N/ [1+N (e^2)]$$

$$= \frac{15,551}{1+15,551(0.1^2)}$$

$$= \frac{15,551}{1+15,551 \times 0.01}$$

$$= \frac{15,551}{1+155.51}$$

$$= \frac{15,551}{156.51}$$

$$= 99.361$$

Therefore, sample size for this study was supposed to be 99 respondents but 90 respondents were selected due to low and fixed cost.

In addition in-depth interviews were carried out with 5 key informants. Key informants included District Executive Director, District Water Engineer, Ward Councillor, Ward Executive Officer and Village Executive Officer.

2.4.3 Sampling technique

Purposive sampling was used to select the villages for the study. Selection was based on the villages which were mostly affected by water shortages and which could be easily accessed during data collection. In this case Majani Mapana, Chogo and Kabuku Ndani were selected as study villages. Simple random sampling was used in selecting households from different villages. Respondents were selected through the village register books from the village executive officers (VEOs) offices. The process of selecting the study household by simple random sampling involved first to list all the names of household heads in the selected villages and then recorded them on small pieces of papers, folded, shuffled and picked the folded papers at random. The names of the households that were picked through this method were written in a sheet of paper. In each village, an equal number of respondents i.e. 30 respondents were randomly selected for the study. A few people (<5%) who hesitated to participate in the interview on different grounds were replaced by other households who were randomly selected from the list.

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2.5 Data Collection Procedures

2.5.1 Pre-testing and recruitment of research assistant

2.5.1.1 Pretesting of the research tools

Before pre-testing of the questionnaire, the revised version of the questionnaire was translated into 'Kiswahili', the national language understood by majority of Tanzanians for easy communication. Pre-testing of the questionnaire was done in order to assure their clarity and relevance. Questionnaires for pre-testing were administered to 10 respondents drawn from the population with similar characteristics to the respondents. Respondents who were used during pre-testing were not included in the research. Questionnaires were modified accordingly to incorporate lessons drawn from the pre-testing.

2.5.2 Primary data

2.5.2.1 Structured interview

Both quantitative and qualitative data collection methods were used to obtain primary data. The main tool for quantitative data collection was a structured questionnaire containing both closed and open-ended questions. The questionnaires consisted of various aspects related to water supply and household income. These included determining the sources of water available in the research area and their reliability; accessibility to water supply in terms of distance, time and the price; identification of water related activities in the area; gender role in water supply and other factors causing water shortages. The questionnaires were administered by hand delivery to the respondents in their households.

2.5.2.2 Key informants interviews

This involved the use of checklist of questions [Appendix 2] to gather official technical data from five key informants. The key informants include: The District Executive Director, District Water Engineer, Ward councilor, Ward Executive Officer and Village Executive Officer who gave detailed information on water supply in the District. Key informants were selected because they had first-hand knowledge about the community, residents and issues being investigated. Also they were mixed to ensure a variety of perspectives. The information was collected through note books whereby each interview took an average duration of 25 minutes. The interviews were conducted in the office of each respective informant. The key information collected include water sources, amount of water available per person per day, current users of the water sources, sufficiency of the available water for short and long time and water sources quality.

2.5.2.3 Physical field observation

This offered an opportunity for objective assessments of on-site situations of members and further probing of issues that were not covered in the structured questionnaire and checklist. For instance water sources and means of transport were observed as well as the distance from most households to water sources. This also enabled the researcher to estimate the possible time that may be spent per one trip of fetching water from the source on foot.

2.6 Data Processing and Analysis

2.6.1 Quantitative data

Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS). One-Way ANOVA was used to measure the significance differences on water supply across demographic factors for objective two. For objective three, percentages and cross tabulations were used to assess the magnitudes of relationships using Chi-Square Test ($P<0.05$) at 95% confidence intervals. Binary Logistic Regression was used to analyse the maximum likelihood estimates for household income. Moreover, Chi-Square test was used in examining the significance of relationships between respondent's household income and water supply.

Also the standard residual to critical value that corresponds to an alpha of 0.05 was set. For research hypotheses, if the probability of the test statistic is less than or equal to the probability of the alpha error rate, the null hypothesis is rejected and conclude that the data supports the research hypothesis. This signifies that there is a relationship between the variables and if the probability of the test statistic is greater than the probability of the alpha error rate, the null hypothesis is not rejected. Therefore the conclusion is drawn that there is no relationship between the variables.

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2.6.1.1 Regression analysis

An index on variables that influence household income was developed. Binary logistic regression analysis for hypothesis one was used to examine relationship between water supply and household income. It was made using sets of statements which were included in the questionnaire administered to selected respondents. Setting of such statements was necessary because it was not easy to solicit information for such variables by asking one question to a respondent. Answers from those statements were entered into factor analysis to determine the most important among the sets of statements determining each index variable.

2.6.1.2 Specification of the logistic regression model

The logistic regression model was run to establish the relationship between the dependent (household income) and independent variables. The model was presented as follows;

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon$$

$Y = \alpha + \beta_1$ age $+ \beta_2$ sex $+ \beta_3$ occupation $+ \beta_4$ education level $+ \beta_5$ marital status $+ \beta_6$ household size $+ \beta_7$ infrastructure $+ \beta_8$ water sources $+ \beta_9$ management $+ \beta_{10}$ rules, norms and/ or beliefs.

Y = Dependent variable (household income).

Age = Age of respondent in years.

Sex = 1 if member is a male, 0 if otherwise.

Occupation = 1 if crop producer, 0 if otherwise.

Education level = Education attained by household member in ears of schooling.

Marital status = 1 if married, 0 if otherwise.

Household size = Number of household members.

Infrastructure = 1 if functioning, 0 if not functioning.

Water sources = 1 if reliable, 0 if not reliable.

Management = Institutional arrangement for water sources management.

Rules, norms and/or beliefs = Traditional practices pertaining to water supply.

ε = An error term.

α = Constant term

$\beta_{1,} \beta_{2,} \beta_{3\ldots} \beta_{10}$ are coefficients for variables.

2.6.2 Qualitative data

The transcript from focus group discussions and key informant interviews were analyzed using thematic analysis, a flexible qualitative method of analysis used for identifying themes within the collected data [18].

The data were analyzed manually, in which transcripts were read several times to become familiar with the whole data and to get a general overview. Key informants transcripts were also reviewed to identify meaningful concepts. After the data was read from all gathered notes, different themes were established. The aim of content analysis in this study was to reduce the total content of qualitative information into a series of variables. Verbal discussion held with the selected government officials representatives were broken down into meaningfully information using content analysis in order to ascertain values and attitudes of respondents.

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Background characteristics of the respondents

The background characteristics considered in the study included age, sex, marital status, education level, occupation, household size and length of stay in the ward (Table 1). The study assessed whether these parameters had any influence on the household income. Demographic characteristics of the respondents showed that more than three quarters of those interviewed were above 26 years of age. The result consistently shows that the highest proportion of the respondents falls between the ages of 26-56 years. Large number of respondents was males. Assessment on the level of respondents education indicated that about (41.2%) of the respondents did not attend any formal education while (58.8%) attended formal education. Basing on marital status of respondents majority were married (76.7%).

Others were divorced (6.7%), separated (6.7%), widowed (3.3%) and unmarried (6.7%). Moreover, majority were Muslims (66.7%) while minority were Christians (33.3%).

The distribution of respondents among the various occupation groups in the communities studied shows that there are more farmers than any other occupation group. This distribution is not interesting because the result implies that, in rural areas of kabuki ward the non-farm informal sector is not growing. The lengths of stay of the respondent in the ward varied whereby majority stayed in the ward for more than 14 years. The result further shows that more than half of the respondents had between 5 to 8 members in

their households, implying existence of extended family in Kabuku ward.

3.2 Significant Differences on Water Supply Across Demographic Characteristics of Respondents

The significance differences on water supply to household income across demographic factors showed that, with exception of marital status and occupation other demographic factors were not statistically significant (Table 2). Therefore, these factors have no significance influence on household income. Marital status shows a significant influence on water supply (P=0.036)

Table 1. Demographic characteristics of respondents (n=90)

Variable	Category	Number of respondents	Percentage
Age (years)	15 – 25	8	8.9
	26 – 55	58	64.4
	Above 55	24	26.7
Sex	Male	52	57.8
	Female	38	42.2
Marital status	Married	69	76.7
	Divorced	6	6.7
	Separated	6	6.7
	Widowed	3	3.3
	Unmarried	6	6.7
Education level	No formal education	5	5.6
	Adult education	9	10.0
	Madrasa	23	25.6
	Primary education	23	25.6
	Secondary education	11	12.2
	College education	19	21.1
Religion	Muslims	60	66.7
	Christians	30	33.3
Ethnic groups	Zigua	38	42.2
	Sambaa	15	16.7
	Others	37	41.1
Occupations	Crop production	52	57.8
	Employment	31	34.4
	Business	5	5.6
	Pastoralists	1	1.1
	Crop and livestock production	1	1.1
Length of stay in the ward (years)	4 – 14	33	36.7
	15 – 44	31	34.5
	45 – 74	21	23.4
	Above 75	5	5.6
Household size	1-4	9	10.0
	5-8	60	66.7
	9-12	14	15.6
	Above 12	7	7.8

which implies that marriage determines different modes of water availability of a particular household. Occupation of the respondents was also a significant factor to water supply (P= 0.048) which implies that the source of income which determines financial status of a particular household has a significant influence on the mode of accessing water for day-to-day uses.

3.3 Respondents Perception on the Implication of Water Supply on Household Income

This was developed to measure the level of respondent's perception on the relationship between water supply and household income (Table 3). The results show differences in respondent perceptions. The average score shows that (61.1%) strongly agreed, (17.2%) agreed, (3.9%) undecided, (11%) disagreed and (6.8%) strongly disagreed to all statements.

3.4 Water Sources, Uses and Reliability

This section describes water sources, uses and problems which household face in accessing water for domestic use. The major problems facing household in accessing water for domestic uses were mainly time and distance (Table 4).

3.4.1 Sources of water

Large portion of the population in the ward use tap water under the Handeni Trunk Main (HTM) project and bore holes as their main sources of water for drinking, cooking, washing and other household activities. In addition to tap water and bore holes, the community members also had accessed to shallow wells and rain water (Table 4, Plate 1). Rainwater runoff from roofs are collected and stored for drinking and other household activities. However, 74.4% of respondents prefer to rain water as a good source of water because it is cheap to access it and more reliable.

3.4.2 Reliability of water sources

Table 4 indicates reliability of water sources at Kabuku Ndani ward. The findings show that (51.1%) of the respondents argued that water sources are not reliable (Table 4). According to the respondents, the unreliability of water sources is due to the following factors: frequent electricity power supply cut off, leakages in pipes and valves due to ware, rusting and vandalism; aging of pumping units; leakage of storage tanks; improper laying of pipes to some of the places; insufficient communication system and climatic condition. This entails that water is still not sufficiently available to the whole community. It also means that certain group of people has adequate access to water while others do not.

3.4.3 Water storage facilities

Following the unreliability of water sources, large number of the population possesses many water storage facilities at their households (Table 4). The common methods of storing water that respondents currently use in the study area include jerry cans (33.3%) and tanks (32.2%) while others use buckets, clay pots and drums.

Table 2. Significance differences on water supply across demographic factors (n=90)

Respondent variables		Sum of squares	df	Mean square	F	P value
Age	Between groups	29.179	1	29.179	0.085	0.772
	Within groups	29938.102	87	344.116		
Sex	Between groups	0.008	1	0.008	0.034	0.854
	Within groups	21.947	88	0.249		
Marital status	Between groups	6.058	1	6.058	4.516	0.036*
	Within groups	118.042	88	1.341		
Education level	Between groups	0.805	1	0.805	0.373	0.543
	Within groups	189.651	88	2.155		
Occupation	Between groups	18.305	1	18.305	4.006	0.048*
	Within groups	402.095	88	4.569		
Household size	Between groups	0.240	1	0.240	0.441	0.508
	Within groups	83.399	153	0.545		

Statistically significant P <0.05 at 95% level of significant

Table 3. Perception levels on the implication of water supply on household income

Statement	Strongly agree (%)	Agree (%)	Undecided (%)	Disagree (%)	Strongly disagree (%)
There is no relationship between water supply and household income	7.8	12.2	2.2	63.4	14.4
Utilization of water resources maximizes economic growth	66.7	26.7	2.2	2.2	2.2
The current conservation measures are not efficient	58.9	25.6	8.9	3.3	3.3
Poor water supply leads to poor sanitation	66.7	17.8	3.3	7.8	4.4
Long distances to water points delays other economic activities	83.3	10.1	2.2	3.3	1.1
Women and vulnerable groups are highly affected by poor water supply	78.9	11.1	5.6	2.2	2.2
Women and young girls play a great role in searching water	57.8	16.7	3.3	4.4	17.8
Water searching is done by both males and females	68.9	17.8	3.3	1.1	8.9
Average scores	61.1	17.2	3.9	11	6.8

Plate 1. Bore hole (A) and rain water harvest (B) as sources of water in Kabuku Ndani ward

3.4.4 Distance from households to water sources

According to the findings, majority of the respondents (34.4%) reported that the distance from the source of water supply to households is less than 1 kilometre, but greater than 400 metres. In addition another high proportion of the respondents (33.3%) claimed that the distance to main water sources is between 2 and 5 kilometres. This result is not surprising considering the fact that Kabuku Ndani is a linear settlement. The distance between the two ends of the settlement is about 7 kilometres.

3.4.5 Time spent in fetching water

The length of time spent in fetching water varies from season to season, being highest during dry season. The result reveals that the highest proportion of respondents (54.4%) spends more than 30 minutes from their households to the water sources. Only a small proportion of respondents (17.8%) spend less than 30 minutes to reach water sources. Therefore there is a lot of pressure on the few boreholes that are provided in the community.

3.4.6 Means of transport used in fetching water

The means of transport used by individuals in fetching water depends on the distance to the water supply. From the findings, it indicates that the highest proportion of respondents (50.0%) use bicycles in transporting water from the sources (Plate 2 photo B). Another means of transport commonly used by respondents is carrying on the head (28.9%) while the use of motorbikes and other means like vehicles is not common and it is only used by minorities (Plate 2, photo A).

3.4.7 Frequency of fetching water

According to the results it was observed that (25.6%) of the respondents fetch water twice a day while (14.4%) fetch water thrice a day. This means that more than 4 hours are spent per day per person just for fetching water.

3.4.8 Adequacy of water at household level

(83.3%) of the respondents argued that water is not adequate to meet all the needs for the household especially for domestic uses. Conversely, 16.7% of respondents said that water is adequate. The average amount of water used per day is less than 40 litres which is the consumption standard of a person per day. However, majority of respondents (73.0%) use less than 20 litres of water per day. This is caused by several factors such as poverty, obsolete water supply infrastructure and drought.

3.4.9 Household members involved in fetching water

The result shows that individuals responsible for fetching water at household levels include women, men and children. Among the three categories, men (72.2%) are the most responsible group in fetching water for the household, followed by children (16.7%) and women (11.1%).

3.4.10 Quality of water and treatment methods

From the findings it was observed that (90.0%) of the respondents interviewed were unsatisfied with the quality of water in Kabuku Ndani while only 10% were satisfied with the quality of water. Respondents reported not to be satisfied with the quality of water since the water was contaminated with mud and other pollutants. Indeed, up to (49.9%) of the water sources in Kabuku Ndani are saline (hard water) including that from the tap. Moreover, (92.2%) of the respondents treat drinking water by using different methods including boiling, filtering and the use of water guard (Fig. 2). Boiling and filtering were the most common methods used as they are easy and cheap to apply unlike the use of water guard due to its high cost. Boiling method could make saline water to be relatively normal especially if the water hardness was temporary (caused by magnesium or calcium carbonate).

3.4.11 Water related health problems

A number of water-borne disease problems linked to drinking contaminated water were reported by the respondents in Kabuku Ndani ward. This includes diarrhoea, typhoid, helminths, amoeba and cholera. Majority of respondents (48.&%) mention diarrhea to be the most disease affecting their health (Table 5).

3.4.12 Sources of income and household earnings

Community in Kabuku Ndani depends on different sources of income. Table 6 result shows that agriculture (62.2%) is the major source of income to the households. Other sources of income are employment (32.2%) and others (5.6%) business and pastoralism. It was established that the earnings differ in accordance with the type of income source. Employees showed high income status than other sectors with an average of TZS 100 000 – 200 000 per month. The earnings in agriculture sector are in annual terms whereas the employment, business and other sources of income are termed in monthly basis (Table 6).

3.4.13 Estimation of water pricing and affordability

According to Table 7 results, it shows that majority of respondents (93.3%) purchase water while only few (6.7%) reported to get water for free of charge. Moreover, research findings show that majority (84.4%) buy one bucket of water at the price ranging from TZS 100 to 500, 10% buy at the price of TZS 50 and only 2% of the respondents reported to buy water at the price exceeding TZS 500. In average the price of buying one bucket of water is TZS 300. The assumptions made here was that there is constant requirements of water in all the 12 months of the year. The highest proportion of respondents reported to use up to 5 buckets (about 100 litres) of water per day which costs TZS 1, 500 and above (Table 7). This is applied to households with 5 members of the family meaning that every person use one bucket (20 litres) of water per day. In some families with 12 members they need up to 240 litres of water per day which costs TZS 3,600. The least proportion

of interviewed households indicated to require 3.5 to 4 buckets (70 – 80 litres) of water per day which costs TZS 1, 050 – 1,200 (Table 7). Therefore, the first group of these households was expected to spend more than TZS 45 000 per month implying that TZS 540 000 was spent per year as costs of buying water. The second group with 12 members in the family spend TZS 108 000 per month (1 296 000 per year) while the third group with least proportion of households spend TZS 31 500 – 36 000 per month (378 000 to 432 000 per year). However, these water requirements and the associated costs mainly depended on the size of the household.

Apart from this tangible amount of money spent in buying water, there was an issue of time spent in fetching water. Respondents spent 30 minutes in fetching one bucket of water from the sources on foot. Respondents declared that they need at least 5 buckets of water per day. In this case they spent about 150 minutes (2.5 hours) per day in fetching water (Table 7).

Table 4. Water sources and use in Kabuku Ndani ward (n=90)

Category	Frequency	Percentage
Sources of water		
Tap water	39	43.3
Bore holes	31	34.4
Shallow wells	10	11.1
Rain water	5	5.6
Others	5	5.6
Reason for choice of the sources		
Cheap and always available	67	74.4
Distance to other water sources	22	24.4
Water quality issues	1	1.1
Reliability of the sources		
Reliable	46	48.9
Not reliable	44	51.1
Alternative sources of water		
Searching far from households	32	35.6
Buying from private sources	34	37.8
Buying from streets	19	21.1
Using rain water	5	5.6
Storage facilities		
Jerry cans	30	33.3
Drums	7	7.8
Tanks	29	32.2
Buckets	19	21.1
Clay pots	5	5.6

Plate 2. Photos (A and B) show some of the means of transports used in fetching water in the study area

Table 5. Health related water-borne diseases reported by the respondents (n=90)

Disease	Frequency	Percentage
Diarrhoea	37	48.7
Typhoid	36	47.4
Amoeba	2	2.6
Cholera	1	1.3
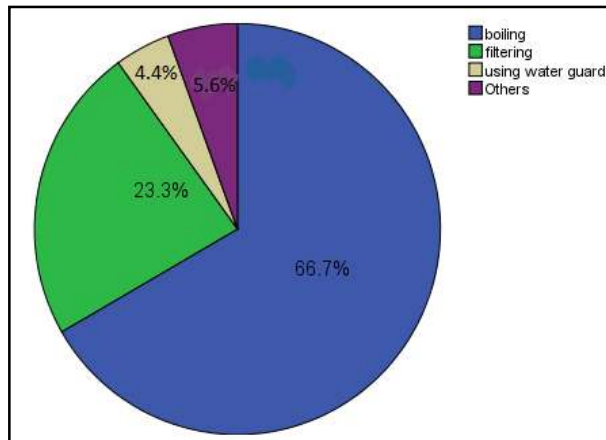
Fig. 2. Water treatment methods in used in Kabuku Ndani ward

Table 6. Income sources and household earnings (n=90)

Source	Earning per year/month (TZS)	Frequency	Percentage
Agriculture	100 000 – 400 000	31	34.4
	500 000 – 1 000 000	13	14.4
	1 100 000 – 5 000 000	7	7.8
	Above 5 000 000	7	7.8
Employment	100 000 – 200 000	8	8.9
	300 000 – 400 000	4	4.4
	500 000 – 720 000	6	6.7
Business	150 000 – 200 000	4	4.4
	250 000 – 300 000	1	1.1
	350 000 – 500 000	5	5.6
Others	50 000 – 100 000	2	2.2
	150 000 – 200 000	2	2.2

The amount of household income spent on water per month in all income categories of respondents in average was greater than the recommended standard of 3% of the total earnings (URT, 2002) (Table 8). In households which entirely depend on agriculture as a source of income in average they spent TZS 20 000 per month i.e. 225% (Table 8). For this case, one household requires a minimum of TZS 1 500 000 per month to spend the recommended (TZS 45 000) three percent on water, something which is mythical in rural areas like Kabuku Ndani.

However, the price of water differs according to place and time. More than half of respondents (53.3%) said that the price of water differs especially during drought seasons. Moreover, 28.9% of respondents believe that the price of water differed due to the nature of the water sources particularly the ownership and 16.7% believed that accessibility was a cause of price differences.

Basing on the high price of water during drought season and insufficient income majority of the households (83.3%) cannot afford to purchase enough water to cater the demand of their domestic use. However, only 16.7% were able to purchase water at high price.

3.5 Economic Activities Involving the Use of Water

The study findings identified different economic activities that were involved in the use of water in Kabuku Ndani ward. These activities included; irrigation farming, bricks making, cafes and water vending. Table 9 result shows that majority of respondents (70%) were not engaged in economic activities involving the use of water, 10% of respondents were engaged in irrigation farming, cafe (8.9%) while few respondents were engaged in bricks making (Table 9).

3.6 Variability of Responses by the Selected Background Variables

Results from Table 10 shows that the age of respondents was not a statistical significant predictor ($p < 0.05$) of the major sources of water, time taken to water source, distance moved to water source, responsibility in fetching water and the amount of money spent on water.

Table 7. Estimated water and time costs per day (n=90)

Quantity of water required by household per day (litres/day)	Average time spent to fetch water (minutes)	Average cost (TZS)	Frequency	Percentage
20 – 40	30 – 60	300 – 600	13	14.4
50 – 60	75 – 90	750 – 900	26	28.9
70 – 80	105 – 120	1 050 – 1 200	12	13.3
> 100	> 150	> 1 500	39	43.3

Note: The average time spent to fetch 1 bucket (20 litres) of water per household is 30 minutes

Table 8. Estimated percentages of household income spent on water per month (n=90)

Occupation	Average household income per month (TZS)	Percentage of household income spent on water per month
Agriculture	20 000	225.0
	60 000	75.0
	250 000	18.0
	> 400 000	11.25
Employment	150 000	30.0
	350 000	12.9
	610 000	7.40
Business	175 000	25.7
	275 000	16.4
	425 000	10.6
Others	75 000	60.0
	175 000	25.7

NB: • TZS 45 000 is an average fixed cost deducted from each household income.
• Households should not spend more than 3% of their income on water (NAWAPO, 2002)

Results from Table 11 shows that gender of respondents was not a positive predictor of the major sources of water, distance moved to water source and responsibility in fetching water (P>0.05). Moreover, gender of respondents have a clear relationship with the time spent on fetching water and the amount of money spent on buying water (p=0.05).

Despite of the fact that all the variables in Table 12 showed positive coefficients but respondent's occupation was not a statistical significant predictor (P>0.05) of the major sources of water, time spent on fetching water, distance to water source, responsibility in fetching water and the amount of money spent on water. This result indicates that there is no clear relationship between respondent's occupation and all variables mentioned in Table 12.

3.7 Regression Model Estimation

Results from logistic regression model showed that age, sex, education, occupation and infrastructure were significant predictors of household income (P<0.01 and P<0.05). Sex, marital status, household size, management, rules, norms and/or beliefs, and water sources showed to have no influence on household income (Table 13).

Table 9. Economic activities involving the use water (n=90)

Economic activity	Frequency	Percentage
Irrigation	9	10.0
Brick making	3	3.3
Café	8	8.9
Water vending	7	7.8
None	63	70.0

Table 10. Variability of responses by age

Variables		Sum of Squares	df	Mean square	F	P value
Major sources of water	Between Groups	71.256	46	1.549	1.135	0.339
	Within Groups	58.700	43	1.365		
Time taken to water source	Between Groups	251.818	46	5.474	0.935	0.589
	Within Groups	245.800	42	5.852		
Distance to water source	Between Groups	43.256	46	0.940	0.922	0.608
	Within Groups	43.867	43	1.020		
Responsibility in fetching water	Between Groups	123.956	46	2.695	0.861	0.691
	Within Groups	134.500	43	3.128		
Amount of money spent on water	Between Groups	3.687	46	0.080	0.475	0.992
	Within Groups	6.750	40	0.169		

Table 11. Variability of responses by sex

Variables		Sum of squares	df	Mean square	F	P value
Major sources of water	Between Groups	0.061	1	0.061	0.041	0.840
	Within Groups	129.895	88	1.476		
Time taken to water source	Between Groups	21.820	1	21.820	3.990	0.049
	Within Groups	475.798	87	5.469		
Distance to water source	Between Groups	1.372	1	1.372	1.408	0.239
	Within Groups	85.750	88	0.974		
Responsibility in fetching water	Between Groups	0.001	1	0.001	0.000	0.985
	Within Groups	258.454	88	2.937		
Amount of money spent on water	Between Groups	0.761	1	0.761	6.686	0.011
	Within Groups	9.676	85	0.114		

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The Chi-Square test (chi-square = 13.144) showed that P = 0.041, that means P is less than the alpha level of significance of 0.05. Therefore, the null hypothesis that household's expenditure on water supply does not significantly affect household income was rejected and hence the alternative hypothesis that household's expenditure on water supply significantly affects household income was accepted (Table 13).

3.8 Effects of Individual Factor on Household Income

3.8.1 Respondents' age, sex and marital status and household income

Table 13 result shows that the coefficient for age factor was positive. Respondents' age category (26-55) showed a statistical significant (P = 0.001) contribution to household income as it represents the working force. Moreover, sex factor was positive but not statistically significant predictor of Kabuku Ndani ward's household income (P > 0.05). This implies that respondents' sex has no clear relationship with household income. In addition, marital status of respondents was not a predictor of household income in the ward (P > 0.05) showing that marital status had no direct relationship with household income.

3.8.2 Education and occupation of respondents and household income

Respondents education and occupation were positive predictors of household income (P = 0.005 and P = 0.021 respectively).These results implies that as one advance in education level, the probability of getting higher income increases. This also implies that people with low level of education are likely to have low income. Occupation is appositive predictor of income since it determines the income of an individual.

Table 12. Variability of responses by occupation

Variables		Sum of squares	df	Mean square	F	P value
Major sources of water	Between Groups	13.136	7	1.877	1.317	0.253
	Within Groups	116.819	82	1.425		
Time taken to water source	Between Groups	64.475	7	9.211	1.722	0.115
	Within Groups	433.143	81	5.347		
Distance to water source	Between Groups	10.292	7	1.470	1.569	0.156
	Within Groups	76.830	82	0.937		
Responsibility in fetching water	Between Groups	13.445	7	1.921	0.643	0.719
	Within Groups	245.010	82	2.988		
Amount of money spent on water	Between Groups	.758	7	0.108	0.883	0.524
	Within Groups	9.679	79	0.123		

Table 13. Analysis of maximum likelihood estimates for household income

Parameter	df	Estimate	Standard error	Chi-square	P value
Water supply infrastructure	4	3.311	0.644	11.454	0.022*
Management	4	1.290	0.366	6.423	0.170
Water sources	4	1.099	1.633	3.544	0.471
Rules, norms and /or beliefs	4	1.099	0.356	5.897	0.207
Age	47	0.405	1.115	83.37	0.001**
Sex	1	0.310	0.212	1.888	0.169
Marital status	4	1.872	0.410	6.963	0.138
Education	5	2.970	0.483	16.572	0.005**
Occupation	7	0.916	0.648	16.461	0.021*
Household size	3	0.268	2.067	7.357	0.061
Statistical test of the model					
Test	df	Chi-square	P value		
Likelihood Ratio	6	13.114	0.041*		
Score	6	13.092	0.042*		
Wald	1	6.101	0.014*		

* P<0.05, ** P<0.01, df = degree of freedom

3.8.3 Water supply infrastructure, water sources and management of water sources and household income

Table 13 result shows that water supply infrastructure had a positive relation to household income (P = 0.022). This result implies that the condition of water supply infrastructure determines sustainability of water supply and thus helps in serving costs and time for other activities. Moreover, the sources of water have a great contribution to the household income in the community although it was not a significant predictor of household income (P > 0.05). In addition, management of water sources was not a significant predictor of household income (P>0.05).

3.8.4 Rules, norms and/or beliefs and household size and household income

According to Table 13 results is shows that respondents rule, norms/beliefs and household size had no significant contribution to household income (P>0.05).

3.9 Factors Affecting Accessibility of Water Supply in Kabuku Ndani

3.9.1 Administration problems

Administration problems were identified as a major challenge hindering access to potable water in the study area. Findings from key informants indicate that when they were responding on what were the reasons for poor water supply in their respective area, majority said *"These cases are contributed by some of the officials who lack integrity in handling projects especially projects that have direct benefits to the community".*

Furthermore, few respondents argued that

> *"Households' were willing to contribute on activities of drilling boreholes in the ward but apart from identification of the site where the activity could take place nothing has been done to date".*

3.9.2 Water sources

The Handeni Trunk Main (HTM) project was the major source of water supply in the study area which was established in 1974 to serve the population in the study area. The project was currently over-loaded due to increase of human population size which does not correspond with the capacity of the water supply.

3.9.3 Obsolete water supply infrastructures

Findings from the key informants' indicated that poor maintenance and outdated water supply infrastructures cause failure in sustainability of water flow from the main intake to the distribution structures. Therefore, people cannot get enough water to meet their daily domestic requirements.

3.9.4 Climate changes

Findings from the key informants' further revealed that Handeni district was among the dry areas in Tanga Region. During dry season community suffer from lack of water, the situation was caused by two phenomena which were environmental degradation and the global warming. Deforestation was among the factors that have led to degraded environment in the district mostly due to lack of people's knowledge on environmental conservation.

3.9.5 Water pricing

Chronic water shortage in the study area has led to increasing water price. Despite of the hardships of life due to poor income but still community members had to pay for water service. Living expenses becomes high as water price increases. During dry season water service is owned by individuals and therefore the water charges peak up to TZS 500 per bucket (20 litres).

4. CONCLUSIONS AND RECOMMENDA-TIONS

4.1 Conclusions

From the findings, it can be concluded that there were no permanent water sources that could have served the community throughout the year despite of the availability of the Handeni Trunk Main project. Most of these sources were found to be located at far distance from the households. In this case men are involved in fetching water for domestic uses while women had to take care of their children and perform other domestic duties.

Domestic water supply has shown to have implications on households' income in Kabuku Ndani ward, Handeni. High expenditure on water

services has kept reducing economy of most families and the community as a whole as most of the respondents in the ward spent more money on water supply than they could have spent on other responsibilities. The distress of searching and collecting water for household's uses widens a room for absolute poverty in the community.

4.2 Recommendations

In order to address the manifold problems, the following should be done;

- The government needs to expand, restructure, and rehabilitate public water supplies infrastructures. This improvement can only be achieved with assistance in terms of technical and financial assistance from aid agencies as most of people in the ward were poor. Moreover, there should be a shared responsibility between aid agencies and communities, which means the community members can contribute in maintenance of infrastructures.
- Protection and fencing of traditional wells by communities can greatly improve water quality and reduce the risk of accidents and waterborne diseases. There is also a need of mobilizing and sensitizing the community to give their technical advice to the management teams and the entire community. Strengthening institutional arrangements will increase the security and safety of schemes for sustainable water supply.
- The government also needs to subsidize the price of water and make access to water affordable for the poor.
- The community Development partners i.e. NGOs, CBOs in collaboration with the Government should on the other hand provide trainings to the community members on the importance of conserving water sources through seminars, meetings and workshops for sustainability of water sources.
- The government should strengthen, recognize, and formalize water management. customary laws.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX 1

Questionnaires

TITLE: ASSESSMENT OF WATER SUPPLY AND ITS IMPLICATIONS ON HOUSEHOLD INCOME IN KABUKU NDANI WARD, HANDENI DISTRICT

SECTION A: INTRODUCTION

The purpose of this questionnaire is to collect your views concerning water supply and its financial implications in Kabuku Ward, Handeni District. The findings of the study will provide basic information on availability and supply of water in the ward. I request your cooperation in filling this questionnaire and I assure you that the information will be treated as confidential and for academic purpose only.

Questionnaire number_____
Date _____
Name of Respondent _____
Name of the village _____
Name of ward_____

SECTION B: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

1a. Name	1b. Household size (1) 1 – 4 (2) 5 – 8 (3) 9 – 12 (4) Above 12	1c. Age (in years)	1d. Sex (1) Male (2) Female	1e. Relation to head of HH (1) Husband (2) Wife (3) Child [95]Other	1f. Marital Status (1) Married (2) Single (3) Separated (4) Divorced (5) Widowed	1g. Education (1) None (2) Adult education (3) Madrasa (4) Primary School (5) Secondary School (6) Certificate (7) Diploma (8) Degree	1h. Religion (1) Muslim (2) Christian (3) No religion (4) Others	1.i Tribe (1) Digo (2) Zigua (3) Sambaa (4) Bondei (5) Other	1j. Main Occupation [1] Crop farming [2] Pastoralist [3] Mixed farming (livestock and crop production) [4] Business [5] Employee [6] Other personal jobs/self employed [7] Student [8] Unemployed
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8
	1 2 3 4		1 2	1 2 3 95	1 2 3 4 5	1 2 3 4 5 6 7	1 2 3 4	1 2 3 4 5	1 2 3 4 5 6 7 8

2. For how long have you been living in Kabuku Ndani ward?………………

SECTION C: SOURCES, AVAILABILITY, RELIABILITY AND ACCESSIBILITY OF WATER FOR HOUSEHOLD'S USE

3. What type of water source do you use/own in your household?

   (i) Shallow well (ii) Borehole (iii) Rain water (iv) River

4. Why did you choose such source(s) of water?

   (i) ………………….. (ii) ………………… (iii) ………………………

5. Are these sources reliable throughout the year?

   (i) Yes......... (ii) No..........

6. If no, what are the alternative sources during water shortage?

   (i) Far distance from household (ii) Buying from private sources
   (iii) Buying in streets (iv) Using rain water

7. Which water storage facilities do you use in your household?

   (i) ………………………………….. (ii) …………………………………
   (iii)………………………………… (iv)…………………………………

8. What is the distance from your household to nearest water source?

   (i) Less than 1km (ii) About 2km (iii) Between 2-5km (iv) Others (Specify)……..

9. How many times do you fetch water in a day?

   (i) Once (ii) Twice (iii) Three times (iv) Other (specify).........................

10. How often do you fetch water for domestic purposes?

   (i) Every day (ii) Twice a week (iii) Once a week (v) Other.........................

11. Which transport means do you use to collect water?

   (i) By foot (ii) Bicycle (iii) Motor bike (iv) Other (specify)…………………

12. How long does it take to access water from the source?

Parameter	Time (min)
Go	
Wait	
Return	

13. How many buckets do you collect per day?

   (i) 2-5 (ii) 5-10 (iii) 10+

14. What is the size of the containers that you carry to fetch water?

   (i) 5 litres (ii) 20 litres (iii) 40 litres (iv) 100 litres (v) 200 litres

15. How many litres of water do you need for your household per day?

   (i) 20-40litres (ii) 50-60litres (iii) 70-80 litres (iv) 100+

16. Is the water adequate to meet all your household needs?

   (i) Yes (ii) No

17. If No, what is the reason(s)?

   (i) Water point is too far (ii) Water point is low yielding
   (iii) Queuing time is too long (iv) Other (specify)................................

18. Who is responsible for fetching water in your household?

   (i) Women (ii) Men (iii) Children (iv) Women and children (v) Other (Specify)……

19. Is the water source you use provide safe and clean water?

   (i) Yes (ii) No

20. If No, what are the problems?

   (i) Salinity (ii) Pollution (iii) Mud (iv) Color (v) Other (specify)…………...........

21. Do you give any treatment to unsafe and dirty water?

   (i) Yes (ii) No

22. If yes, what treatment do you apply?

   (i) Boiling (ii) Filtering (iii) Adding water guard (iv) Other (Specify)……………

23. Have you faced any health problems associated with using unsafe water for different domestic activities?

   (i) Yes (ii) No

24. If yes, what are the problems ever experienced in your household or in the ward?

(i)………………… (ii)……………… (iii)………………… (iv)…………………

SECTION D: LINKAGE BETWEEN WATER SUPPLY AND HOUSEHOLD INCOME

25. What is the major source of income in your household?

   (i) Agriculture (ii) Employment (iii) Commerce/Trade (iv) Petty trade
   (v) Others (specify) …………………………………..

26. How much does your household earn from the source?

Source	Amount per month (TZS)	Who earns this income?
Agriculture (per year)		
Employment		
Commerce/Trade		
Semi-skilled services		
Other income (specify)		
TOTAL		

27. Do you pay for the water?

   (i) Yes (ii) No

28. If yes, how much do you pay per bucket?

   (i) TZS 50 (ii) TZS 100 – 500 (iii) More than 500 (specify)…………

29. Does the price vary per location or time?

30. If yes, why?.............…………

31. What can you say about the price?

   (i) Affordable (ii) Expensive

32. Do you use water for productive purposes/income-generating activities?

(i) Yes (ii) No

33. If yes, what are these activities?

(i) ……………….. (ii) ………………… (iii) ………………………..

34. For these uses, do you use the same sources of water as for domestic uses?

(i) Yes (ii) No

35. If No, what sources of water do you use?

(i)................................. (ii) …………………… (iii) ……………………

36. Do you face any difficulties in getting sufficient amount of water for these productive activities?

(i) Yes (ii) Sometimes (iii) No

37. If yes, what should be done to solve the problem?

(i) …………………….. (ii) ……………………… (iii) …………………………

38. What suggestions do you give to improve water supply so as to enhance household income?

(i) ………………………… (ii)…………………………
(i) ………………………… (iv)…………………………

39. What pro-government measures do you take to ensure that water remain available?

(i) Construction of tanks (ii) Harvesting rain water
(iii) Planting trees (iv) others (specify)……………………….

40. What should be done to maximize economic growth resulting from activities involving utilization of water resources?

(i) ………………………………… (ii) …………………………………
(ii) ………………………………… (iv) …………………………………

APPENDIX 2

Questions for in-depth interviews with key informants

1. What is the current water source?
2. Who are the present users of the water source?
3. What is the quantity of water collected per person per day?
4. How many times can you fetching water per day/per week ?
5. Is the water available at the source enough to meet the needs of all household members during rainy and dry seasons?
6. Are water collections points close enough to where people live?
7. Is the water available at collection points safe?
8. Is the current water supply reliable?
9. Do people have enough water storage facilities?
10. Is there any problem associated with storing water?
11. Are there other alternative water sources nearby?
12. Which means of transport is commonly used to access water from the collection points?
13. How many households are connected with pipe/tap water system?
14. How does the water supplier agencies convey information to customers regarding to water interruptions problems?
15. Is the water source contaminated or at risk of been contaminated?
16. Is water treatment necessary?
17. Are there any traditional beliefs and practices that are related to the collection, storage and use of water?
18. What are the main economic activities that involve use of water carried in the ward?

19. Tick the number from the scale based on whether you strongly agree (SA), agree (A), undecided (UD), disagree (DA) or strongly disagree (SD) with each of the following statement:

S/No	Statements	1	2	3	4	5
		SA	A	UD	SD	DA
1	There is no relationship between water supply and household income					
2	Utilization of water resources maximizes economic growth.					
3	The current pro-government measures are not efficient.					
4	Poor water supply leads to poor sanitation.					
5	Long distances to water points delays other economic activities					
6	Women and vulnerable groups are highly affected by poor water supply.					
7	Women and young girls play a great role in searching water.					
8	Water searching is done by both males and females.					

APPENDIX 3

Checklist for observing access to household water supplies

1. Distance

How far are water collection points from people's residence?

2. Queues (waiting time)

For how long does it take for one to collect water at a point?

3. Transportation

Which means of transport is used in carrying water from collection points?

4. Storage

What storage facilities are used in storing water?

5. Payments

How much money do people pay per bucket of 10 litre/20litre?

6. Ownership

Is the source owned publically or privately?

7. Quality

What is the quality of water available?

8. Gender

Is the activity of water searching done by both men and women?