Small Scale Rainwater Harvesting for Combating Water Deprivation at Orphan Care Centres in Peri-Urban Areas of Lilongwe, Malawi

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Abbreviations

ATPS	African Technology Policy Studies Network
CBO	Community Based Organisations
CPAR	Canadian Physicians for Aid and Relief
LEAD	Leadership on Environment and Development
MASAF	Malawi Social Action Fund
NGO	Non-governmental Organisations
RELMA	Regional Land Management Unit
SEARNET	Southern and Eastern Africa Rainwater Harvesting Network
SIDA	Swedish International Development Cooperation Agency
UNDP	United Nations Development Programme

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Chapter One

Project Preparation and Design

1.1 Introduction

In urban areas of Malawi, like elsewhere in Africa, uncoordinated rapid urbanization has resulted in profuse informal settlements. These are marginal areas of urban development that are often not provided with adequate water and sanitation amenities. This is the case with high density areas of Lilongwe, the capital city of Malawi where most of the low income labour force resides. Each day, water is provided at kiosks that are filled from tanks drawn by tractors. This makes the supply of water erratic, inadequate, and unsafe for people in these high density areas. Of critical concern is the realisation that there are vulnerable groups in the peri-urban areas that comprise the disabled, female-headed households and the orphaned; the latter, principally arising out of the HIV/AIDS pandemic. Over and above their pursuit of daily sustenance, they have to contend with purchasing water, whose availability is erratic and if available, either comes at the wrong time or they have to physically struggle to access it.

Poverty is increasingly recognized as a problem that needs to be brought to the centre stage of mainstream policy and intervention. Kopen (2000) argued that water deprivation is part and parcel of poverty, which is defined as living below the standards that society judges as minimally required for human well-being. Water deprivation jeopardizes health, income, and freedom from drudgery. Carrying buckets, drinking unsafe water, and lacking access to water are increasingly seen as important aspects of integrated water management. To understand and combat this state of water deprivation, the key comprises two forms of processes. First, they are related to the nature of water, which is that water only becomes suitable for human use, if one has the physical means to abstract, store, or divert and convey it to homes, fields, and enterprises. Second, it depends on whether water sources exist to tap from. In relation to either processes, poor people are often disproportionately affected. They are the least to be provided directly or indirectly with physical infrastructure for obtaining water while their means to tap water are weaker.

Conventional water supply systems may not entirely be adequate in solving water needs of the majority. In Sub-Saharan Africa, an estimated 400 million people will live in countries facing severe water scarcity by the year 2010. Further, although Africa accounts for 13% of the world’s population, it has only 11% of the world’s fresh water supply. Because of low ages of irrigated land (5%) and hydro power (3%), water is often used ineffectively.

The Malawi Government estimates that 65% of the population has access to potable water (Mloza-Banda, 2003). However, due to poor maintenance of supply systems only 40% of the population is actually served with potable water. On the other hand, Malawi has ample water resources with an annual average precipitation of 1037 mm of which 196 mm or about 19% is runoff. This translates into 18 billion cubic metres per annum as surface runoff. As of the year 2000, the estimated domestic demand was 95 million cubic metres or about 0.5% of total surface runoff. Thus, realizing that surface and ground sources of water like lakes, rivers and ponds face the challenges of intermittency, extraction and delivery problems, overexploitation, and pollution, there is a growing need to harvest and conserve rainwater where it falls.

Despite its potential and the existing infrastructure, rainwater harvesting has not received adequate attention from policy makers, planners and water project engineers or managers. They consider rainwater harvesting as competing with rather than supplementary to the conventional ground and surface water source. Wanyonyi (2004) argued that rainwater harvesting has been shown not only to improve the immediate water situation but also leads to a whole range of software benefits to the individuals and water and sanitation providers that include the following:

- Improved health and hygiene facilities;
- Increased food and water security at household and community levels;
- Provision of an appropriate water source at the point of use at low cost;
- Independent back up water supply system supply for emergencies;
- Development of employment opportunity and experience sharing skills.

Thus, rainwater harvesting represents a pragmatic developmental plan for augmenting water resources to avert water deprivation for sustenance of livelihoods in these impoverished urban zones. And it is for this reason that the investigators seek support to provide stewardship and a model in rooftop rainwater harvesting which represents an untapped strategic potential in peri-urban communities often not well served with municipal facilities.

Elsewhere in Uganda, in an effort to solve the water problem, women groups in Rakai District were trained in water jar and ferrocement tank construction (Kiggundu, 2003). The technology greatly improved the quality of life in the area by providing safe water for domestic use. Women and children were saved from the burden of fetching water. Other highlighted benefits included: reduction in water borne diseases and infections; regular and timely school attendance by children, which resulted into improved grades; time saved from water fetching from distant sources allocated to performing other development activities; adequate, clean and safe water; income from selling water (used for buying books); and, harmony due to potable water sharing.

There still remain a number of areas requiring further expounding if rooftop rainwater harvesting should be an established practice and parallel water supply system in peri-urban areas. Studies in Uganda have questioned the economic viability, adequacy of roof area, and skills among professionals and technicians and artisans (Uganda Rainwater Association, 2004). Even then, there appears a lack of methodical analysis both in terms of impact of training for technology transfer, required institutional support, and social cost of the technology.

1.2 Project Rationale

The project aims to create a new culture of harnessing water resources amongst disadvantaged peri-urban beneficiaries by facilitating attitude change, and providing knowledge and skills necessary to release the development and investment potential they have and the potential for rainwater harvesting to improve livelihoods. The importance of rooftop rainwater harvesting in the context of the peri-urban environment can simply be visualized as a poverty reduction strategy through improved water supply and sanitation. Water deprivation is integral to poverty. This is particularly so for orphaned and female-headed households whose access to income to purchase water or even access to water at kiosks remains a hindrance. Many households resort to sourcing water from springs and streams in low lying areas (dambos) or intermittent streams.

It is envisaged that the already existing corrugated iron roofs in the peri-urban residential areas allow construction of rainwater harvesting structures at low costs, requiring only installation of gutters and storage tanks. The project will provide a model that creates multiplier effects by working through community-based organisations and artisans, equipping them with vision and skills to implement and scale-up rainwater harvesting. Indeed, it is considered that rainwater harvesting is an effective entry point for other areas of self-help community development.

1.3 Project Objectives

1.3.1 Overall objective

The overall goal of the project is to model best practices for roof catchment rainwater harvesting systems to augment water resources at six orphan care centres in peri-urban communities in Lilongwe City, Central Malawi.

1.3.2 Specific objectives

1. To construct promising small scale roof catchment rainwater harvesting systems for augmenting water resources at orphan care centres.
2. To strengthen the capacity of community level technical staff and NGOs, and peri-urban communities to design and implement roof rainwater harvesting systems.
3. To evaluate factors affecting the performance and adoption of the implemented rainwater harvesting systems.

Chapter Two

Assessment of Access and Consumption of Water for Integrating Rainwater Harvesting Systems for Domestic Water Supply

2.1 Introduction

The findings of the Malawi Social Indicators Survey of 1998 (Malawi Government 2002) reveal that only one third (37%) of the Malawian population have access to safe drinking water that is located within a distance of less than one-half kilometre. This figure increases to 48% when the distance is increased to one kilometre. Only 2.1% and 16.4% of the Malawian population have access to piped water in dwelling houses and a public tap, respectively. The most common type of water facility used in Malawi is an unprotected well or spring while the most popular safe source of water is a borehole. It has been observed that in peri-urban and rural areas, families tend to rely on traditional water sources which often get polluted in the rainy season due to erosion. A reasonable alternative is the use of cisterns to catch rainwater from roof catchments. The total daily water requirement per person is 30 litres out of which the daily minimum drinking water requirement per person is 5 litres (Malawi Government, 2002). The need to augment potable water for domestic use through rainwater harvesting is thus attainable and cannot be overemphasized. This study evaluated water services, development and consumption in order to provide the justification for integration of rainwater harvesting in the water economy of peri-urban households using orphan care centres as a model.

2.2 Methodology

2.2.1 Choice of sites

Extensive consultations were made with the Lilongwe Water Board to learn about provision of water to peri-urban areas. A list was drawn of peri-urban locations that were not provided with tap water or that are provided with water kiosks. Further consultations were made with the Ministry of Community Services and Social Welfare to detail orphanages or orphan care centres in Lilongwe City. The lists from the Water Board and from the Ministry were compared and potential sites visited for ground-truthing. Six locations were chosen based on unique characteristics each location provided as detailed in Section 2.3.1.

2.2.2 Baseline survey

A baseline study at each of the six locations was conducted. A set of three questionnaires were prepared for interviewing three groups of respondents.

1. Key informants: these were coordinators of the orphan care centres and chairpersons or local leaders of any committees overseeing the centres
2. Focus group discussions: a group of six to eight women at each centre was assembled for focus group discussions
3. General household interviews: respondents for household interviews for each site targeted five persons from each of the categories listed below:
   a) Physically challenged
   b) Foster male parent
   c) Foster female parent
   d) Male spouse
   e) Female spouse
   f) Single male (widowed, divorced, etc.)
   g) Single female (widowed, divorced, etc.)
   h) Boy child, orphaned
   i) Girl child, orphaned

Questionnaires were circulated to coordinators of centres and were pre-tested. The identification of respondents, dates and survey protocols were arranged by centre coordinators after two thorough training/sharing sessions. This was done in order to engender ownership of the process.

2.2.3 Data analysis

Data from household interviews were analysed using the Statistical Package for Social Sciences (SPSS). Descriptive analysis such as frequencies and ages were computed to show the quantitative and qualitative features of responses.

2.3 Results

2.3.1 Characteristics of study locations

Location 1, Kauma: Kauma Orphan Support Initiative (Adziwa Ministry)
The centre is coordinated by the Capital City Baptist Church as an organ of its outreach ecclesiastical programmes. Orphans are housed together with foster parents that are relatives of the orphans. These “families” are issued a plot of land to produce food and allocated income generating enterprises such as poultry (layers, broilers) and production of high value dry season crops. There are 155 guardians in 15 houses housing 767 orphans. There is an established community committee to oversee activities guided by an outreach office located at the centre.

Location 2, Mchezi: Recapo Orphan Care Centre

The centre is coordinated by Mr. Matengula, former Member of Parliament, 1999-2004. Funding is from contributions by villagers and occasionally, well wishers. It caters for 411 orphans from 10 villages. The centre has various committees for different livelihood activities. The operations are non-residential but orphans congregate daily for meals and extracurricular livelihood learning activities. Immediately after sensitization meetings, a committee to run the rainwater harvesting initiative was established.

Location 3, Lumbadzi: Mtendere Orphan Care Centre

Mtendere Orphan Care Centre is housed adjacent to Blessings Hospital and a vitameal (nutritious food) processing factory complex at Lumbadzi Township, 30 km from Lilongwe City. It is run by a Malawian entrepreneur, Mr. Napoleon Dzombe, with a few overseas benefactors, particularly from the United States. Mtendere is a residential centre where orphans, whose lives are at risk from debilitating diseases or malnutrition and poverty, are housed for rehabilitation. The centre has satellite (outreach) centres where home-based/ community-based orphan care programmes are run including provision of medication and vitameal.

Location 4, Dzenza: Dzenza Girls Boarding Primary School

The centre enrols needy girls at primary school level on residential basis. It is coordinated by the Church of Central African Presbytery, Lilongwe. Funding is provided by the local church adjacent to the centre and well wishers.

Location 5, Ngwenya: House of Hope Orphan Care Centre

The centre is coordinated by a local committee made up of chiefs and local development leaders. It was started in the year 2000 and caters for 600 orphans from five villages on non-residential basis. It specialises in feeding and ecumenical programmes. Funding is exclusively from foreign and local well-wishers.

Location 6, Mtsiriza: Faith Christian Academy

The centre is coordinated as an outreach programme of the African Bible College that receives partial support from evangelical churches in the USA. It specialises in feeding and ecumenical programmes on non-residential basis for 670 orphans. It caters for nursery school, primary and secondary school educational programmes for 270 orphans while another 400 attend public primary and secondary schools.

2.3.2 Characteristics of respondents

The numbers of respondents interviewed in the general household survey are shown below in Table 2.1. The study ably identified respondents that were evenly spread across the intended categories. Their occupation is shown in Table 2.2

Table 2.1: The number and category of respondents in the baseline survey

Centre	Orphans		Singe parents		Spouses		Foster parents		Physically challenged	Total
	Girl	Boy	Male	Female	Male	Female	Male	Female		
Kauma	7	5	4	6	3	5	5	4	2	**40**
Ngwenya	6	6	5	7	6	6	1	6	3	**47**
Mtsiriza	6	5	3	5	5	6	4	7	5	**46**
Lumbadzi	5	5	1	7	9	7	4	6	1	**45**
Dzenza	5	4	4	7	6	6	4	5	4	**45**
Mchezi	6	5	4	5	5	6	4	5	5	**45**
Total	35	30	17	37	34	36	22	33	20	**268**
% of Total	**13.1**	**11.2**	**6.3**	**13.8**	**12.7**	**13.4**	**8.2**	**12.3**	**7.5**	**100**

Table 2.2: Nature of occupation of respondents

Occupation		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Quarry stone making	Count	2	1	2				**5**
	Column %	4.9	2.3	5.6				**2.2**
Farming	Count	26	18	6	9	5	24	**88**
	Column %	63.4	41.9	16.7	24.3	17.2	58.5	**38.8**
Business	Count	2	6	9	7		4	**28**
	Column %	4.9	14.0	25.0	18.9		9.8	**12.3**
Student	Count	9	10	11	12	13	10	**65**
	Column %	22.0	23.3	30.6	32.4	44.8	24.4	**28.6**
Casual labour	Count	2	6	3	7	10	3	**31**
	Column %	4.9	14.0	8.3	18.9	34.5	7.3	**13.7**
Artisan	Count		2	3	1	1		**7**
	Column %		4.7	8.3	2.7	3.4		**7**
Teaching	Count			2	1			**3.1**
	Column %			5.6	2.7			**3**
Total		**41** **100.0**	**43** **100.0**	**36** **100.0**	**37** **100.0**	**29** **100.0**	**41** **100.0**	**227** **100.0**

2.3.3 Some characteristics of households

Some characteristics of the households are shown in Tables 2.3-2.5. Households where both spouses were present were only about 33% while 21% of the households were each headed by male foster parents and single female parents, respectively (Table 2.3). The occupation of household heads in the employment category were either working in the civil service (21%), farmers (36%) or were labourers (36%) (Table 2.4). Overall, the average household size ranged from 5.33 to 6.35 persons while the overall average was 5.81 persons per household (Table 2.5).

Table 2.3: Nature of household head

Head of household		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Single parent, male	Count	5	1	5	5	4	3	**23**
	Column %	13.9	2.7	10.9	11.4	10.0	6.7	**9.3**
Single parent, female	Count	5	8	13	10	8	10	**54**
	Column %	13.9	21.6	28.3	22.7	20.0	22.2	**21.8**
Female foster parent	Count	1	3	2	3	1	5	**15**
	Column %	2.8	8.1	4.3	6.8	2.5	11.1	**6.0**
Male foster parent	Count	6	6	9	9	11	11	**52**
	Column %	16.7	16.2	19.6	20.5	27.5	24.4	**21.0**
Orphan girl-child	Count		2	1		1		**4**
	Column %		5.4	2.2		2.5		**1.6**
Orphan boy-child	Count		1	2	1	3		**7**
	Column %		2.7	4.3	2.3	7.5		**2.8**
Headed by other relatives	Count	2	1			1		**4**
	Column %	5.6	2.7			2.5		**1.6**
Both spouses present	Count	13	15	14	16	11	15	**84**
	Column %	36.1	40.5	30.4	36.4	27.5	33.3	**33.9**
Other (specify)	Count	4					1	**5**
	Column %	11.1					2.2	**2.0**
Total		**36**	**37**	**46**	**44**	**40**	**45**	**248**
		100.0	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.4: Nature of occupation of some of the household heads

Occupation		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Civil Servant	Count	1	1	5	1	1	2	**11**
	Column %	7.1	5.9	27.8	5.9	5.9	11.8	**11.0**
Farmer	Count	11	7	3	2	2	11	**36**
	Column %	78.6	41.2	16.7	11.8	11.8	64.7	**36.0**
Business	Count		2	4	7	2	2	**17**
	Column %		11.8	22.2	41.2	11.8	11.8	**17.0**
Labourer	Count	2	7	6	7	12	2	**36**
	Column %	14.3	41.2	33.3	41.2	70.6	11.8	**36.0**
Total		**14**	**17**	**18**	**17**	**17**	**17**	**100**
		100.0	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.5: Total number of people living in house

Household location	Minimum	Maximum	Mean	N	Std. Deviation
Dzenza	1	11	5.56	45	2.63
Mchezi	1	12	5.71	45	2.29
Ngwenya	1	13	5.87	47	2.58
Mtsiriza	1	12	5.33	46	2.33
Kauma	1	10	6.35	40	2.20
Lumbadzi	2	12	6.09	45	2.28
Mean	1	13	5.81	268	2.40

2.3.4 Access to water

In terms of access to water, 90% of respondents argued that water is a problem for their families (Table 2.6) while 89% indicated that access to water was a problem in their areas (Table 2.7). About 38% indicated that other households do not have problem of access to water (Table 2.8) due to the observations that (a) they have their own wells, boreholes or have running tap water, (b) are near the water sources, or (c) pay workers to draw water (Table 2.9).

Table 2.6: Proportion of respondents indicating difficulty in access to water for the household

Difficult at household level		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	45	44	36	40	36	42	243
	Column %	100.0	97.8	76.6	87.0	90.0	93.3	90.7
No	Count		1	11	6	4	3	25
	Column %		2.2	23.4	13.0	10.0	6.7	9.3
Total	**Count**	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.7: Proportion of respondents indicating difficulty in accessing water in the area

Difficult for the area		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	40	43	43	40	36	37	**239**
	Location %	88.9	95.6	91.5	87.0	90.0	82.2	**89.2**
No	Count	3	2	4	6	4	6	**25**
	Location %	6.7	4.4	8.5	13.0	10.0	13.3	**9.3**
Missing	Count	2					2	**4**
	Location %	4.4					4.4	**1.5**
Total	**Count**	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.8: Proportion of respondents indicating other households in the area that do not have the problem of access to water

No problem to access water		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	11	11	19	23	16	23	**103**
	All location %	10.7	10.7	18.4	22.3	15.5	22.3	**100.0**
	Location %	24.4	24.4	40.4	50.0	40.0	51.1	**38.4**
No	Count	34	34	28	23	24	22	**165**
	All location %	20.6	20.6	17.0	13.9	14.5	13.3	**100.0**
	Location %	75.6	75.6	59.6	50.0	60.0	48.9	**61.6**
T**otal**	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	All location %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.9: Some explanations given for residents having no problem of water

Reasons for adequate water		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Have their own well	Count	3		5	11	3	9	**31**
	All location%	9.7		16.1	35.5	9.7	29.0	**100.0**
	Location%	27.3		26.3	50.0	20.0	40.9	**31.0**
Have own boreholes	Count	3	2	1				**6**
	All location%	50.0	33.3	16.7				**100.0**
	Location%	27.3	18.2	5.3				**6.0**
Houses close to water source	Count	4	8	9	3	6	4	**24**
	All location%	40.0	12.5	37.5	12.5	20.8	16.7	**100.0**
	Location%	36.4	27.3	47.4	13.6	33.3	18.2	**24.0**
Paid workers draw water	Count		1					**1**
	All location%		100.0					100.0
	Location%		9.1					**1.0**
Have tap water	Count			4	8	6	7	**25**
	All location%			16.0	32.0	24.0	28.0	**100.0**
	Location%			21.1	36.4	40.0	31.8	**25.0**
Missing	Count	1					2	**2**
	All location%	100.0					100.0	**100.0**
	Location%	9.1					9.1	**2.0**
Total	Count	**11**	**11**	**19**	**22**	**15**	**22**	**100**
	All location%	**11.0**	**11.0**	**19.0**	**22.0**	**15.0**	**22.0**	**100.0**
	Location%	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.5 Sources of water and their development

The principal sources of water for the households were boreholes (32%) and kiosks (34%). Shallow wells were the alternative sources to either boreholes or kiosks (Table 2.10). Overall, individuals have developed their own water points (Table 2.11) while a handful of water facilities were developed by NGOs such as CPAR and Plan International. Government and its institutions such as the Lilongwe Water Board and MASAF were mentioned by about 40% of the respondents for developing a number of water facilities. About 67% of the respondents indicated that local governance structures (committees, chiefs, villagers) and individuals are responsible for operating the water facilities (Table 2.12). In a similar manner, about 65%of the respondents indicated that local resources (committees, villagers, individuals and paid workers) are used for maintenance of water facilities (Table 2.13).

Table 2.10: Sources of water for domestic use

Sources of water		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
River	Count					3		**3**
	Column %					5.8		**0.9**
Borehole	Count	28	41	1	7	6	24	**107**
	Column %	59.6	80.4	1.6	13.0	11.5	36.9	**32.1**
Kiosk	Count	1		36	24	34	20	**115**
	Column %	2.1		56.3	44.4	65.4	30.8	**34.5**
Well (near house)	Count	1	2	20	14	5	14	**56**
	Column %	2.1	3.9	31.3	25.9	9.6	21.5	**16.8**
Well (dambo)	Count	17	8	6	7	4	6	**48**
	Column %	36.2	15.7	9.4	13.0	7.7	9.2	**14.4**
Other (specify)	Count			1	2		1	**4**
	Column %			1.6	3.7		1.5	**1.2**
Total	**Count**	**47**	**51**	**64**	**54**	**52**	**65**	**333**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.11: Some indication of institutions and individuals that developed the water source

Developer of water source		**Source of water**					**Total**
		Borehole	Kiosk	Well (near house)	Well (dambo)	Other (specify)	
CIPA	Count Column %	12 13.2		1 2.0			**13** **4.4**
Individual	Count Column %	2 2.2	7 6.5	39 79.6	32 74.4	2 50.0	**82** **27.9**
Paid workers	Count Column %	1 1.1		3 6.1			**4** **1.4**
MASAF	Count Column %	14 15.4	14 13.1		1 2.3		**29** **9.9**
Villagers	Count Column %	6 6.6	7 6.5	6 12.2	10 23.3		**29** **9.9**
Government	Count Column %	29 31.9	6 5.6				**35** **11.9**
Plan International	Count Column %	27 29.7	5 4.7				**32** **10.9**
Lilongwe Water Board	Count Column %		68 63.6			2 50.0	**70** **23.8**
Total	Count Column %	**91** **100.0**	**107** **100.0**	**49** **100.0**	**43** **100.0**	**4** **100.0**	**294** **100.0**

Table 2.12: Institutions and individuals responsible for operating the water facility

Responsibility for operation of water facility		**Source of water**					**Total**
		Borehole	Kiosk	Well (near house)	Well (dambo)	Other (specify)	
Committee	Count Column %	22 23.2	6 5.6	2 4.4			**30** **10.2**
Individual	Count Column %	27 28.4	14 13.1	36 80.0	32 72.7	2 50.0	**111** **37.6**
Chief	Count Column %	4 4.2	2 1.9	1 2.2	1 2.3		**8** **2.7**
Villagers	Count Column %	20 21.1	11 10.3	6 13.3	11 25.0	1 25.0	**49** **16.6**
Government	Count Column %	21 22.1	5 4.7				**26** **8.8**
Water Board worker	Count Column %	1 1.1	69 64.5			1 25.0	**71** **24.1**
Total	Count Column %	**95** **100.0**	**107** **100.0**	**45** **100.0**	**44** **100.0**	**4** **100.0**	**295** **100.0**

Table 2.13: Institutions and individuals responsible for maintenance work

Responsibility for maintenance work		**Source of water**					**Total**
		Borehole	Kiosk	Well (near house)	Well (dambo)	Other (specify)	
Committee	Count Column %	25 25.0	5 4.8	2 4.4			**32** **10.7**
Individual	Count Column %	23 23.0	11 10.5	34 75.6	32 72.7	2 50.0	**102** **34.2**
Paid workers	Count Column %	4 4.0		3 6.7			**7** **2.3**
Villagers	Count Column %	26 26.0	8 7.6	6 13.3	12 27.3		**52** **17.4**
Government	Count Column %	20 20.0	6 5.7				**26** **8.7**
Water board	Count Column %	2 2.0	75 71.4			2 50.0	**79** **26.5**
Total	**Count** **Column %**	**100** **100.0**	**105** **100.0**	**45** **100.0**	**44** **100.0**	**4** **100.0**	**298** **100.0**

In general, half of the respondents did not pay or contribute to the development of their water sources (Table 2.14). However, payment or contribution to development of water source appeared not new. About 94% of the respondents were willing to pay or contribute to development of additional water sources. They cited a number of reasons for wanting to assist in the development of additional sources of water (Table 2.15). Provision of free water was cited by only 10 % of the respondents while reduction of congestion at water points and reduction of distance of travel to water sources were mentioned by more respondents.

Table 2.14: Proportion indicating payment or contribution to the development of water sources

Contribution to develop- -ment of water source		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count All location % Location %	29 21.2 64.4	37 27.0 82.2	13 9.5 27.7	18 13.1 39.1	22 16.1 55.0	18 13.1 40.0	**137** **100.0** **51.1**
No	Count All location % Location %	15 11.5 33.3	8 6.2 17.8	34 26.2 72.3	28 21.5 60.9	18 13.8 45.0	27 20.8 60.0	**130** **100.0** **48.5**
Not applicable	Count All location % Location %	1 100.0 2.2						**1** **100.0** **0.4**
Total	Count All location % Location %	**45** **16.8** **100.0**	**45** **16.8** **100.0**	**47** **17.5** **100.0**	**46** **17.2** **100.0**	**40** **14.9** **100.0**	**45** **16.8** **100.0**	**268** **100.0** **100.0**

Table 2.15: Proportion indicating reasons for assisting in development of new sources of water

Reasons for assisting dev -elopment of water source		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Present sources giving them problems	Count	5	13	1	2		3	**24**
	All location%	20.8	54.2	4.2	8.3		12.5	**100.0**
	Location%	11.1	29.5	2.4	5.6		7.0	**9.7**
Inadequate for their population	Count	4	2	1	4	3	1	**15**
	All location%	26.7	13.3	6.7	26.7	20.0	6.7	**100.0**
	Location%	8.9	4.5	2.4	11.1	7.9	2.3	**6.0**
Water source is of great help	Count	6	4	6	1	2	5	**24**
	All location%	25.0	16.7	25.0	4.2	8.3	20.8	**100.0**
	Location%	13.3	9.1	14.3	2.8	5.3	11.6	**9.7**
The borehole will help the village	Count	7		3	1		3	**14**
	All location%	50.0		21.4	7.1		21.4	**100.0**
	Location%	15.6		7.1	2.8		7.0	**5.6**
Water will be near	Count	5	10	7	12	14	6	**54**
	All location%	9.3	18.5	13.0	22.2	25.9	11.1	**100.0**
	Location%	11.1	22.7	16.7	33.3	36.8	14.0	**21.8**
Have safe and hygienic water	Count	8	1	6	6	1	5	**27**
	All location%	29.6	3.7	22.2	22.2	3.7	18.5	**100.0**
	Location%	17.8	2.3	14.3	16.7	2.6	11.6	**10.9**
Reduce congestion at borehole	Count	7	8	4	7	4	9	**39**
	All location%	17.9	20.5	10.3	17.9	10.3	23.1	**100.0**
	Location%	15.6	18.2	9.5	19.4	10.5	20.9	**15.7**
Provide free water	Count	1	1	9		9	7	**27**
	All location%	3.7	3.7	33.3		33.3	25.9	**100.0**
	Location%	2.2	2.3	21.4		23.7	16.3	**10.9**
Develop the village	Count	2	5	5	3	5	4	**24**
	All location%	8.3	20.8	20.8	12.5	20.8	16.7	**100.0**
	Location%	4.4	11.4	11.9	8.3	13.2	9.3	**9.7**
Total	Count	**45**	**44**	**42**	**36**	**38**	**43**	**248**
	All location%	**18.1**	**17.7**		**14.5**	**15.3**	**17.3**	**100.0**
	Location%	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.6 Water services

Overall, 77% of the respondents indicated that they do not pay for water services (Table 2.16). The highest number of respondents that pay for water services were recorded at Ngwenya and Mtsiriza. It was noted that at Ngwenya, those that have wells sell their water while at Mtsiriza, kiosks are the main water selling points. Only about 30% were satisfied with provision of water services (Table 2.17) and another 31% indicated that payment for water services affect the amount of water drawn for domestic use (Table 2.18).

Table 2.16: Proportion indicating whether they pay for water or water services

Payment for water services		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	1	4	26	14	10	6	**61**
	Row %	1.6	6.6	42.6	23.0	16.4	9.8	**100.0**
	Column %	2.2	8.9	55.3	30.4	25.0	13.3	**22.8**
No	Count	44	41	21	32	30	39	**207**
	Row %	21.3	19.8	10.1	15.5	14.5	18.8	**100.0**
	Column %	97.8	91.1	44.7	69.6	75.0	86.7	**77.2**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Row %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.17: Proportion indicating whether satisfied with water services they are buying

Satisfaction with services		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	1	4	25	14	23	15	82
	Row %	1.2	4.9	30.5	17.1	28.0	18.3	100.0
	Column %	2.2	8.9	53.2	30.4	57.5	33.3	30.6
No	Count		4	17	19	12	19	71
	Row %		5.6	23.9	26.8	16.9	26.8	100.0
	Column %		8.9	36.2	41.3	30.0	42.2	26.5
Not applicable	Count	44	37	5	13	5	11	115
	Row %	38.3	32.2	4.3	11.3	4.3	9.6	100.0
	Column %	97.8	82.2	10.6	28.3	12.5	24.4	42.9
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Row %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.01**	**100.0**	**100.0**	**100.0**

Table 2.18: Proportion indicating whether payment for the water affects the amount of water drawn

Payment on amount of water drawn		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count			26	17	22	19	**84**
	All location %			31.0	20.2	26.2	22.6	**100.0**
	Location %			55.3	37.0	55.0	42.2	**31.3**
Not applicable	Count	44	41	13	19	13	19	**149**
	All location %	29.5	27.5	8.7	12.8	8.7	12.8	**100.0**
	Location %	97.8	91.1	27.7	41.3	32.5	42.2	**55.6**
No	Count	1	4	8	10	5	7	**35**
	All location %	2.9	11.4	22.9	28.6	14.3	20.0	**100.0**
	Location %	2.2	8.9	17.0	21.7	12.5	15.6	**13.1**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	All location %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.7 Sourcing water and its utilisation

The girl child draws water the most (68.7%) followed by the mother/wife (54.1%) and the boy child (29.1%) (Table2.19). About 92.1% of the respondents draw water from the same source throughout the year and indicated several reasons shown in Table 2.20 for using the same source.

Table 2.19: Members of the household responsible for drawing water

Who draws water?		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Boy child	Count	8	11	13	16	16	14	**78**
	Column %	17.8	24.4	27.7	34.8	40.0	31.1	**29.1**
Girl child	Count	33	31	33	29	29	29	**184**
	Column %	73.3	68.9	70.2	63.0	72.5	64.4	**68.7**
Mother/Wife	Count	21	19	26	26	26	27	**145**
	Column %	46.7	42.2	55.3	56.5	65.0	60.0	**54.1**
Foster mother	Count	6	7	2	2	6	8	**31**
	Column %	13.3	15.6	4.3	4.3	15.0	17.8	**11.6**
Father/ Husband	Count					2		**2**
	Column %					5.0		**0.7**
Relative	Count	3	3	6	2	4	2	**20**
	Column %	6.7	6.7	12.8	4.3	10.0	4.4	**7.5**
Piece worker/ house worker	Count	1			1		1	**3**
	Column %	2.2			2.2		2.2	**1.1**
Others (granny, friends etc)	Count	6	10	14	10	6	4	**50**
	Column %	13.3	22.2	29.8	21.7	15.0	8.9	**18.7**
Total		**45**	**45**	**47**	**46**	**40**	**45**	**268**

Table 2.20: Reasons given for drawing water from the same source

Why same source?		**Source of water**						**Total**
		River	Borehole	Kiosk	Well(near house)	Well (dambo)	Other (specify)	
Water is safe/hygienic	Count		36	76	1	1	4	**118**
	Column %		40.0	80.0	2.2	3.5	66.7	**44.1**
No alternative water source	Count	1	6		6	6		**19**
	Column %	50.0	6.7		13.0	20.7		**7.1**
Only nearest water source	Count		34	19	21	16	2	**92**
	Column %		37.8	20.0	45.7	55.2	33.3	**34.2**
It is free water	Count	1	14		18	6		**39**
	Column %	50.0	15.6		39.1	20.7		**14.6**
Total	Count	**2**	**90**	**95**	**46**	**29**	**6**	**268**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

To determine reasons for differences in water use between seasons and within weekdays, the study, employing facilities for drawing, storing and using water by households, physically quantified the amount of water used by the households. The results for the wet and dry seasons, for weekdays (Monday to Friday), and, weekends (Saturday and Sunday) are shown in Tables 2.21-2.24. The data were further summarised as shown in Tables 2.25 and 2.26.

In Table 2.25, using the location means, peri-urban populations sampled are using between 18.39 and 27.59 litres of water per person per day. Using the overall mean, the range is 20.76-24.73 with the overall mean at 22.74 litres per person per day. The location with the lowest per capita consumption of water is Mchezi.

Slightly higher amounts are used in the dry season and during weekends. In Table 2.26, there is about a 23% increase in the amount of water used in the dry season compared to that used in the wet season. When days of the week are compared, it evident that there is an overall 18% increase in the amount of water that is used during weekends compared to that used during weekdays. Substantive increases in the amount of water used in the dry season comes from a 43-45% and 52-63% increase in the amount of water used for drinking and that used for gardening, respectively. During weekends when compared to weekdays, increase in water used came from a 49-66% increase in the amount of water used for washing clothes. The lowest amounts are used at Dzenza and Mchezi locations (Table 2.25).

Table 2.21: Some indication of total litres of water used by households during working days (Monday- Friday) in dry season

Location	Activity	Minimum	Maximum	Mean	N	Std. Deviation
Dzenza	Drinking	2.5	25.0	7.34	45	4.81
	Bathing	50.0	300.0	112.22	45	51.57
	Cooking + utensils	15.0	500.0	168.72	39	132.40
	Cleaning (house)	2.0	150.0	54.86	21	43.62
	Washing (clothes)	30.0	2000.0	215.94	16	483.13
	Gardening	0.2	1200.0	411.46	8	449.71
	Total	**0.2**	**2000.0**	**970.54**	**174**	**205.63**
Mchezi	Drinking	0.9	25.0	7.35	44	5.14
	Bathing	5.0	200.0	81.25	44	45.29
	Cooking + utensils	25.0	400.0	153.67	45	94.62
	Cleaning (house)	2.0	200.0	51.63	34	51.97
	Washing (clothes)	20.0	360.0	103.08	13	92.41
	Gardening	1.5	1000.0	467.17	3	502.63
	Total	**0.9**	**1000.0**	**864.15**	**183**	**108.39**
Ngwenya	Drinking	1.3	20.0	7.09	47	4.29
	Bathing	20.0	300.0	103.66	47	61.15
	Cooking + utensils	5.0	500.0	184.89	47	116.34
	Cleaning (house)	10.0	400.0	92.03	37	84.39
	Washing (clothes)	10.0	1800.0	296.43	21	379.05
	Gardening	300.0	1000.0	658.33	6	290.55
	Total	**1.3**	**1800.0**	**1342.43**	**205**	**191.76**
Mtsiriza	Drinking	1.5	25.0	7.95	47	6.17
	Bathing	30.0	300.0	170.85	47	426.95
	Cooking + utensils	20.0	400.0	159.79	47	92.11
	Cleaning (house)	2.0	500.0	103.97	32	105.55
	Washing (clothes)	20.0	600.0	189.00	20	173.98
	Gardening	1000.0	1000.0	1000.00	1	.
	Total	**1.5**	**3000.0**	**1631.56**	**194**	**242.60**
Kauma	Drinking	1.5	40.0	7.82	39	7.44
	Bathing	5.0	1000.0	156.25	40	157.92
	Cooking + utensils	20.0	1000.0	208.75	40	212.34
	Cleaning (house)	10.0	300.0	92.00	36	66.04
	Washing (clothes)	20.0	2500.0	373.50	28	618.07
	Gardening	50.0	2500.0	893.33	9	947.40
	Total	**1.5**	**2500.0**	**1731.66**	**192**	**379.27**
Lumbadzi	Drinking	1.5	25.0	7.38	45	4.82
	Bathing	10.0	700.0	135.62	45	120.31
	Cooking + utensils	15.0	700.0	220.44	45	131.01
	Cleaning (house)	10.0	450.0	87.59	29	90.57
	Washing (clothes)	20.0	1000.0	210.60	25	22.94
	Gardening	200.0	1500.0	862.50	4	540.64
	Total	**1.5**	**1500.0**	**1524.13**	**194**	**191.68**
Total	Drinking	0.9	40.0	7.48	267	5.45
	Bathing	5.0	3000.0	126.42	268	199.51
	Cooking + utensils	5.0	1000.0	182.38	263	134.62
	Cleaning (house)	2.0	500.0	81.97	189	79.28
	Washing (clothes)	10.0	2500.0	248.15	123	399.22
	Gardening	0.2	2500.0	681.72	31	626.13
	Total	**0.2**	**3000.0**	**1328.12**	**1141**	**236.94**

Table 2.22: Some indication of total litres of water used by households during weekends in dry season

Location	Activity	Minimum	Maximum	Mean	N	Std. Deviation
Dzenza	Drinking	1.0	10.0	2.94	45	1.92
	Bathing	20.0	120.0	44.89	45	20.63
	Cooking + utensils	6.0	200.0	69.26	38	52.53
	Cleaning (house)	4.0	150.0	34.88	25	35.08
	Washing (clothes)	30.0	400.0	101.25	24	85.94
	Gardening	0.6	400.0	266.87	3	230.59
	Total	**0.6**	**400.0**	**520.09**	**180**	**64.79**
Mchezi	Drinking	0.6	10.0	3.34	37	1.99
	Bathing	2.0	80.0	36.81	37	16.39
	Cooking + utensils	20.0	160.0	69.26	38	35.85
	Cleaning (house)	1.0	80.0	23.16	25	22.36
	Washing (clothes)	40.0	210.0	120.00	14	55.33
	Gardening	0.6	400.0	200.30	2	282.42
	Total	**0.6**	**400.0**	**452.87**	**153**	**52.37**
Ngwenya	Drinking	0.5	8.0	2.88	46	1.70
	Bathing	10.0	120.0	42.26	46	24.14
	Cooking + utensils	2.0	200.0	76.36	45	46.03
	Cleaning (house)	4.0	160.0	43.28	40	38.02
	Washing (clothes)	20.0	800.0	167.03	32	171.63
	Gardening	120.0	400.0	263.33	6	116.22
	Total	**0.5**	**800.0**	**595.14**	**215**	**95.50**
Mtsiriza	Drinking	0.6	10.0	3.18	47	2.47
	Bathing	12.0	1200.0	68.34	47	170.78
	Cooking + utensils	8.0	160.0	63.91	47	36.84
	Cleaning (house)	2.0	200.0	46.68	29	43.12
	Washing (clothes)	10.0	400.0	118.75	32	92.80
	Gardening	400.0	400.0	400.00	1	.
	Total	**0.6**	**1200.0**	**700.86**	**203**	**102.20**
Kauma	Drinking	0.6	16.0	3.05	39	2.94
	Bathing	2.0	400.0	60.83	40	63.73
	Cooking + utensils	8.0	400.0	83.50	40	87.32
	Cleaning (house)	4.0	120.0	37.08	36	27.15
	Washing (clothes)	4.0	1000.0	180.87	30	235.57
	Gardening	20.0	1000.0	355.56	9	380.37
	Total	**0.6**	**1000.0**	**720.89**	**194**	**153.53**
Lumbadzi	Drinking	0.6	10.0	3.00	44	1.92
	Bathing	4.0	280.0	54.09	45	48.28
	Cooking + utensils	6.0	280.0	88.27	45	52.35
	Cleaning (house)	4.0	180.0	41.17	29	35.29
	Washing (clothes)	10.0	1000.0	188.95	21	204.90
	Gardening	200.0	600.0	366.67	3	208.17
	Total	**0.6**	**1000.0**	**742.15**	**187**	**103.30**
Total	Drinking	0.5	16.0	3.06	258	2.17
	Bathing	2.0	1200.0	51.56	260	80.74
	Cooking + utensils	2.0	400.0	75.16	253	54.27
	Cleaning (house)	1.0	200.0	38.40	184	34.67
	Washing (clothes)	4.0	1000.0	148.03	153	162.40
	Gardening	0.6	1000.0	311.72	24	261.83
	Total	**0.5**	**1200.0**	**627.93**	**1132**	**102.70**

Table 2.23: Some indication of total litres of water used by households during working days in wet season

Location	Activity	Minimum	Maximum	Mean	N	Std. Deviation
Dzenza	Drinking	0.6	15.0	4.90	45	3.53
	Bathing	50.0	225.0	103.00	45	35.94
	Cooking + utensils	25.0	500.0	165.24	41	116.06
	Cleaning (house)	10.0	200.0	61.11	18	54.55
	Washing (clothes)	20.0	500.0	128.82	17	11.80
	Total	**0.6**	**1000.0**	**463.07**	**166**	**117.10**
Mchezi	Drinking	0.3	20.0	4.78	45	3.96
	Bathing	10.0	200.0	82.79	43	43.04
	Cooking + utensils	4.0	300.0	137.90	41	81.50
	Cleaning (house)	2.0	200.0	56.68	30	58.25
	Washing (clothes)	35.0	200.0	102.92	12	63.62
	Gardening	40.0	40.0	40.00	1	.
	Total	**0.3**	**300.0**	**425.07**	**172**	**72.27**
Ngwenya	Drinking	1.3	50.0	5.76	47	8.77
	Bathing	15.0	300.0	106.60	47	59.16
	Cooking + utensils	5.0	500.0	199.57	47	119.09
	Cleaning (house)	10.0	400.0	118.59	32	92.23
	Washing (clothes)	10.0	1800.0	293.39	28	336.88
	Gardening	160.0	750.0	403.33	3	308.27
	Total	**1.3**	**1800.0**	**1127.24**	**204**	**175.89**
Mtsiriza	Drinking	1.3	25.0	5.49	46	4.89
	Bathing	30.0	300.0	106.20	46	67.77
	Cooking + utensils	20.0	400.0	159.13	46	91.05
	Cleaning (house)	3.0	500.0	104.43	30	100.78
	Washing (clothes)	40.0	900.0	223.06	18	218.52
	Total	**1.3**	**900.0**	**598.31**	**186**	**116.90**
Kauma	Drinking	0.9	25.0	5.40	40	5.79
	Bathing	50.0	1000.0	170.38	40	176.73
	Cooking + utensils	20.0	500.0	165.63	40	103.45
	Cleaning (house)	10.0	300.0	99.85	34	68.11
	Washing (clothes)	30.0	1000.0	264.53	32	239.28
	Gardening	100.0	500.0	340.00	3	211.66
	Total	**0.9**	**1000.0**	**1045.79**	**189**	**164.92**
Lumbadzi	Drinking	1.5	50.0	4.71	45	7.23
	Bathing	50.0	700.0	135.89	45	111.32
	Cooking + utensils	50.0	700.0	242.95	44	67.74
	Cleaning (house)	10.0	200.0	80.52	29	67.74
	Washing (clothes)	40.0	400.0	170.87	23	95.34
	Gardening	200.0	1000.0	600.00	2	565.69
	Total	**1.5**	**1000.0**	**1234.97**	**188**	**142.17**
Total	Drinking	0.3	50.0	5.17	268	5.97
	Bathing	10.0	1000.0	116.62	266	96.45
	Cooking + utensils	4.0	700.0	179.32	259	113.17
	Cleaning (house)	2.0	500.0	89.36	173	79.07
	Washing (clothes)	10.0	1800.0	215.77	130	227.37
	Gardening	40.0	1000.0	447.00	10	358.70
	Total	**0.3**	**1800.0**	**1053.24**	**1106**	**139.61**

Table 2.24: Some indication of total litres of water used by households during weekends in wet season

Location	Activity	Minimum	Maximum	Mean	N	Std. Deviation
Dzenza	Drinking	0.3	6.0	1.99	44	1.41
	Bathing	10.0	90.0	41.36	44	14.72
	Cooking + utensils	10.0	200.0	68.46	39	46.37
	Cleaning (house)	4.0	90.0	32.27	30	25.90
	Washing (clothes)	30.0	350.0	106.74	23	74.22
	Gardening	400.0	400.0	400.00	1	.
	Total	**0.3**	**400.0**	**648.12**	**181**	**55.45**
Mchezi	Drinking	0.6	8.0	2.21	36	1.62
	Bathing	20.0	80.0	38.86	35	13.45
	Cooking + utensils	2.0	120.0	63.45	33	30.72
	Cleaning (house)	1.0	180.0	33.73	21	41.60
	Washing (clothes)	20.0	380.0	136.19	21	83.09
	Total	**0.6**	**380.0**	**274.44**	**146**	**56.51**
Ngwenya	Drinking	0.5	20.0	2.30	47	3.51
	Bathing	6.0	120.0	42.64	47	23.66
	Cooking + utensils	2.0	200.0	79.83	47	47.64
	Cleaning (house)	4.0	160.0	47.89	35	36.87
	Washing (clothes)	20.0	800.0	163.55	38	167.71
	Gardening	80.0	300.0	166.67	3	117.19
	Total	**0.5**	**800.0**	**502.88**	**217**	**93.14**
Mtsiriza	Drinking	0.5	10.0	2.20	46	1.96
	Bathing	12.0	120.0	42.71	45	27.37
	Cooking + utensils	8.0	160.0	64.18	45	36.66
	Cleaning (house)	2.0	200.0	42.07	30	40.18
	Washing (clothes)	20.0	400.0	130.64	31	104.43
	Total	**0.5**	**400.0**	**281.80**	**197**	**63.31**
Kauma	Drinking	0.6	10.0	2.20	39	2.33
	Bathing	20.0	400.0	68.15	40	70.69
	Cooking + utensils	8.0	200.0	66.25	40	41.38
	Cleaning (house)	4.0	120.0	39.94	34	27.24
	Washing (clothes)	40.0	400.0	155.35	34	96.56
	Gardening	40.0	200.0	120.00	2	113.14
	Total	**0.6**	**400.0**	**451.89**	**189**	**75.30**
Lumbadzi	Drinking	0.6	20.0	1.88	45	2.89
	Bathing	20.0	280.0	54.36	45	44.53
	Cooking + utensils	20.0	280.0	97.18	44	52.99
	Cleaning (house)	4.0	80.0	35.23	30	26.05
	Washing (clothes)	50.0	400.0	147.52	29	89.50
	Gardening	200.0	200.0	200.00	1	.
	Total	**0.6**	**400.0**	**536.17**	**194**	**69.14**
Total	Drinking	0.3	20.0	2.13	257	2.42
	Bathing	6.0	400.0	47.96	256	38.70
	Cooking + utensils	2.0	280.0	73.91	248	44.98
	Cleaning (house)	1.0	200.0	39.05	180	33.15
	Washing (clothes)	20.0	800.0	142.84	176	112.55
	Gardening	40.0	400.0	191.43	7	126.42
	Total	**0.3**	**800.0**	**431.32**	**1124**	**71.48**

Table 2.25: Summary of litres of water used per households and per person between seasons and days of the week

Location	Season/ days of the week	Total amount of water for activities		Average amount of water for household activities per day		Overall average per person per day	
		including gardening	household chores only	per household	per person	for season	for location
Dzenza	Weekdays, wet season	463.07	463.07	92.61	16.66	19.49	20.46
	Weekends, wet season	648.12	248.12	124.06	22.31		
	Weekdays, dry season	970.54	559.08	111.82	20.11	21.44	
	Weekends, dry season	520.09	252.22	126.61	22.77		
Mchezi	Weekdays, wet season	425.07	385.07	77.01	13.49	18.76	18.39
	Weekends, wet season	274.44	274.44	137.22	24.03		
	Weekdays, dry season	864.15	396.98	79.40	13.90	18.01	
	Weekends, dry season	452.87	252.57	126.29	22.12		
Ngwenya	Weekdays, wet season	1127.24	723.91	144.82	24.67	26.66	26.22
	Weekends, wet season	502.88	336.21	168.11	28.64		
	Weekdays, dry season	1342.43	684.1	136.82	23.31	25.79	
	Weekends, dry season	595.14	331.81	165.91	28.26		
Mtsiriza	Weekdays, wet season	598.31	598.31	119.66	22.45	24.45	25.20
	Weekends, wet season	281.80	281.80	140.90	26.44		
	Weekdays, dry season	1631.56	631.56	126.31	23.70	25.96	
	Weekends, dry season	700.86	300.86	150.43	28.22		
Kauma	Weekdays, wet season	1045.79	705.79	141.16	22.23	24.18	25.88
	Weekends, wet season	451.89	331.89	165.95	26.13		
	Weekdays, dry season	1731.66	838.32	167.66	26.40	27.59	
	Weekends, dry season	720.89	365.33	182.67	28.77		
Lumbadzi	Weekdays, wet season	1234.97	634.94	126.99	20.85	24.23	25.25
	Weekends, wet season	536.17	336.17	168.09	27.60		
	Weekdays, dry season	1524.13	661.63	132.33	21.73	26.28	
	Weekends, dry season	742.15	375.48	187.74	30.82		
Overall mean across all locations	Weekdays, wet season	1053.24	606.24	121.25	20.87	20.76	22.74
	Weekends, wet season	431.32	239.89	119.95	20.64		
	Weekdays, dry season	1328.12	646.4	129.28	22.25	24.73	
	Weekends, dry season	627.93	316.21	158.11	27.21		

Table 2.26: Percent difference in the amount of water used by households between wet and dry seasons and between days of the week

Household activities	Percent difference in the amount of water used during weekdays and weekends in the wet season	Percent difference in the amount of water used during weekdays between weekends in the dry season	Percent difference in the amount of water used between weekends between the dry and wet seasons	Percent difference in the amount of water used between weekdays and the dry and wet seasons
Drinking	44.7	43.7	3.4	2.3
Bathing	8.4	7.5	2.8	2.0
Cooking + cleaning utensils	1.7	1.7	3.0	3.0
Cleaning house	-8.3	-1.7	9.3	17.1
Washing clothes	15.0	3.6	65.5	49.1
Gardening	52.5	62.8	7.1	14.3
Mean	22.8	23.52	18.22	17.6

2.3.8 Time taken to draw water

The respondents (77%) indicated that there are differences in the amount of time taken to draw water in the dry season compared to the wet season (Table 2.27). About 74% indicated that time taken to draw water also differs at different times of the day (Table 2.28). In Table 2.29, 62% felt that time taken to draw water affects amount of water drawn while 56% indicated that time taken to fetch water does not affect other livelihood activities (Table 2.30). Nevertheless, various sentiments and actions were mentioned with respect to the effect of time taken to fetch water as reported in Table 2.31. A combined 42% indicated they do not have a choice but to spend time at water points due to scarcity of water and having no other alternatives.

Table 2.27: Proportion indicating whether the amount of time to draw water differs between dry and wet seasons

Differences in time taken to draw water		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
YES	Count	40	38	34	35	22	37	**206**
	Column %	88.9	84.4	72.3	76.1	76.1	82.2	**76.9**
NO	Count	5	7	13	11	11	8	**62**
	Column %	11.1	15.6	27.7	23.9	23.9	17.8	**23.1**
Total	Count	**45**	**45**	**47**	**46**	**46**	**45**	**268**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.28: Proportion of respondents indicating whether time taken to draw water differs at different time of the day

Whether time taken to draw water differs within the day		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
YES	Count	42	33	34	34	25	29	**197**
	Column %	93.3	73.3	72.3	73.9	62.5	64.4	**73.5**
NO	Count	3	12	13	12	15	16	**71**
	Column %	6.7	26.7	27.7	26.1	37.5	35.6	**26.5**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.29: Proportion of respondents indicating whether time to draw water affects amount of water drawn

Whether time to draw water affects amount of water drawn		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	31	30	23	30	26	27	**167**
	All location %	18.6	18.0	13.8	18.0	15.6	16.2	**100.0**
	Location %	68.9	66.7	48.9	65.2	65.0	60.0	**62.3**
No	Count	14	15	24	16	14	18	**101**
	All location %	13.9	14.9	23.8	15.8	13.9	17.8	**100.0**
	Location %	31.1	33.3	51.1	34.8	35.0	40.0	**37.7**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	All location %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.30: Proportion of respondents indicating whether amount of time it takes to draw water affects livelihood activities

Whether time to draw water affects livelihood activities		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	8	4	2	10	7	7	**38**
	All location %	21.1	10.5	5.3	26.3	18.4	18.4	**100.0**
	Location %	34.8	57.1	18.2	52.6	50.0	53.8	**43.7**
No	Count	15	3	9	9	7	6	**49**
	All location %	30.6	6.1	18.4	18.4	14.3	12.2	**100.0**
	Location %	65.2	42.9	81.8	47.4	50.0	46.2	**56.3**
Total	Count	**23**	**7**	**11**	**19**	**14**	**13**	**87**
	All location %	**26.4**	**8.0**	**12.6**	**21.8**	**16.1**	**14.9**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.31: Some actions and explanations in dealing with the impact of time taken to draw water

Actions/ explanations		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Just draw water at the well due to congestion	Count	13	1	6	6		4	**30**
	All location %	43.3	3.3	20.0	20.0		13.3	**100.0**
	Location %	28.9	2.6	13.0	13.3		8.9	**11.5**
Reduce amount because water source is very far	Count	4	3	2	2	5	4	**20**
	All location %	20.0	15.0	10.0	10.0	25.0	20.0	**100.0**
	Location %	8.9	7.7	4.3	4.4	12.5	8.9	**7.7**
No choice, water is scarce during the dry season	Count	12	9	4	9		3	**37**
	All location %	32.4	24.3	10.8	24.3		8.1	**100.0**
	Location %	26.7	23.1	8.7	20.0		6.7	**14.2**
Given chance to draw first coz he is a man	Count	1					2	**3**
	All location %	33.3					66.7	**100.0**
	Location %	2.2					4.4	**1.2**
Water source is near so have time to do other things	Count	7	6	12	8	12	5	**50**
	All location %	14.0	12.0	24.0	16.0	24.0	10.0	**100.0**
	Location %	15.6	15.4	26.1	17.8	30.0	11.1	**19.2**
Borehole/ kiosk only source of safe,reliable water	Count	7	16	16	16	20	24	**99**
	All location %	7.1	16.2	16.2	16.2	20.2	24.2	**100.0**
	Location %	15.6	41.0	34.8	35.6	50.0	53.3	**38.1**
Rotate with children to draw water	Count		2		1			**3**
	All location %		66.7		33.3			**100.0**
	Location %		5.1		2.2			**1.2**
Draw less water due to sickness/ old age than time	Count		1			1		**2**
	All location %		50.0			50.0		**100.0**
	Location %		2.6			2.5		**0.8**
Draw amount wanted	Count	1	1	5	2	1	3	**13**
	All location %	7.7	7.7	38.5	15.4	7.7	23.1	**100.0**
	Location %	2.2	2.6	10.9	4.4	2.5	6.7	**5.0**
It is her duty to draw water irres-pective of time	Count			1	1			**2**
	All location %			50.0	50.0			**100.0**
	Location %			2.2	2.2			**0.8**
Draw less water due to lack of money than time	Count					1		**1**
	All location %					100.0		**100.0**
	Location %					2.5		**0.4**
Total	Count	**45**	**39**	**46**	**45**	**40**	**45**	**260**
	All location %	**17.3**	**15.0**	**17.7**	**17.3**	**15.4**	**17.3**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.9 Amount of effort taken to draw water

Tasks that require manual effort in drawing water may include walking, drawing, pumping and carrying water. These require human energy and may affect performance of other livelihood activities. Overall, 57% of the respondents indicated that the amount of effort it takes to draw water affects the amount of water drawn (Table 2.32). Slightly above half of the respondents indicated that the effort required drawing water affects other livelihood activities (Table 2.33). There are several strategic and opportunistic actions taken to contend with efforts required to draw water as reported in Table 2.34.

Table 2.32: Proportion indicating whether the amount of effort it takes to draw water affects the amount of water drawn

Effort to draw water and amount of water drawn		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	21	20	19	27	20	19	**126**
	Row %	16.7	15.9	15.1	21.4	15.9	15.1	**100.0**
	Column %	60.0	57.1	43.2	65.9	62.5	57.6	**57.3**
No	Count	14	15	25	14	12	14	**94**
	Row %	14.9	16.0	26.6	14.9	12.8	14.9	**100.0**
	Column %	40.0	42.9	56.8	34.1	37.5	42.4	**42.7**
Total	Count	**35**	**35**	**44**	**41**	**32**	**33**	**220**
	Row %	**15.9**	**15.9**	**20.0**	**18.6**	**14.5**	**15.0**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.33: Proportion indicating whether the amount of effort it takes to draw water affects livelihood activities

Effort to draw water and livelihood activities		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	30	23	22	21	26	22	**144**
	Row %	20.8	16.0	15.3	14.6	18.1	15.3	**100.0**
	Column %	66.7	51.1	46.8	45.7	65.0	48.9	**53.7**
No	Count	15	22	25	25	14	23	**124**
	Row %	12.1	17.7	20.2	20.2	11.3	18.6	**100.0**
	Column %	33.3	48.9	53.2	54.3	35.0	51.1	**46.3**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Row %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

In Table 2.35, respondents suggested several solutions to reducing drudgery associated with both the time (Tables 2.27-2.31) and effort (Tables 2.32-2.34) required in drawing water. About 70% of the respondents wanted water points constructed near their homesteads. Indeed, 14% suggested the provision of running water in the homes.

Table 2.34: Proportion expressing constraints and different actions taken to contend with effort required to draw water

Constraints and actions		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
No choice, draw water till tired	Count	18	11	14	17	16	6	**82**
	Row %	22.0	13.4	17.1	20.7	19.5	7.3	**100.0**
	Column %	40.0	24.4	29.8	37.0	40.0	13.3	**30.6**
Draw only required amount of water	Count	5	14	13		5	9	**46**
	Row %	10.9	30.4	28.3		10.9	19.6	**100.0**
	Column %	11.1	31.1	27.7		12.5	20.0	**17.2**
Water table low dry season, no choice, water has to be drawn	Count	10	8	1	6	1	7	**33**
	Row %	30.3	24.2	3.0	18.2	3.0	21.2	**100.0**
	Column %	22.2	17.8	2.1	13.0	2.5	15.6	**12.3**
Water source is near, but has to be carried	Count	1	1	11	8	9	6	**36**
	Row %	2.8	2.8	30.6	22.2	25.0	16.7	**100.0**
	Column %	2.2	2.2	23.4	17.4	22.5	13.3	**13.4**
It is a duty to draw water irre-spective of amount of effort	Count	3	2	4	5	1	6	**21**
	Row %	14.3	9.5	19.0	23.8	4.8	28.6	**100.0**
	Column %	6.7	4.4	8.5	10.9	2.5	13.3	**7.8**
Draw less water due to physical disability	Count	1	1	1				**3**
	Row %	33.3	33.3	33.3				**100.0**
	Column %	2.2	2.2	2.1				**1.1**
Difficult to draw water during the wet season due to mud	Count	2						**2**
	Row %	100.0						**100.0**
	Column %	4.4						**0.7**
Share the task when there are a lot of people to assist	Count	4	5	2	6	5		**22**
	Row %	18.2	22.7	9.1	27.3	22.7		**100.0**
	Column %	8.9	11.1	4.3	13.0	12.5		**8.2**
Water source very far; water has to be carried the distance	Count			1	3	3	10	**17**
	Row %			5.9	17.6	17.6	58.8	**100.0**
	Column %			2.1	6.5	7.5	22.2	**6.3**
Missing	Count	1	3		1		1	**6**
	Row %	16.7	50.0		16.7		16.7	**100.0**
	Column %	2.2	6.7		2.2		2.2	**2.2**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	Row %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.10 Water, health and sanitation

Incidences of water-borne diseases reported in the year are shown in Table 2.36. It is evident that wells provide the most important source of water-borne diseases. There were no incidences of diseases reported arising from use of water from kiosks. Overall, the incidence of water-borne diseases appeared to be small. The respondents cited three principal ways of disposing of water that comes off from bathing, cleaning and washing. Eight percent of the respondents throw it into the toilet, 10% use it to water lawns and fruit trees, while 82% just throw it into drainage channels around the houses. It is this latter form of disposal of used water that provides unsanitary conditions and water-borne vectors of diseases.

Table 2.35: Proportion indicating solutions to reducing drudgery associated with time and effort expended on drawing water

Options to reducing drudgery		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Have another water source nearby	Count	22	15	13	14	11	15	**90**
	Row %	24.4	16.7	14.4	15.6	12.2	16.7	**100.0**
	Column %	75.9	75.0	72.2	82.4	50.0	68.2	**70.3**
Given treadle pump for gardening	Count	1						**1**
	Row %	100.0						**100.0**
	Column %	3.4						**0.8**
Other women should assist in drawing water	Count	2	1		1	2	1	**7**
	Row %	28.6	14.3		14.3	28.6	14.3	**100.0**
	Column %	6.9	5.0		5.9	9.1	4.5	**5.5**
Have containers for storing water	Count	1		2	2		2	**7**
	Row %	14.3		28.6	28.6		28.6	**100.0**
	Column %	3.4		11.1	11.8		9.1	**5.5**
Provide running water	Count	1	1	3		9	4	**18**
	Row %	5.6	5.6	16.7		50.0	22.2	**100.0**
	Column %	3.4	5.0	16.7		40.9	18.2	**14.1**
Boreholes should be maintained	Count	1	3					**4**
	Row %	25.0	75.0					**100.0**
	Column %	3.4	15.0					**3.1**
Total	Count	**28**	**20**	**18**	**17**	**22**	**22**	**128**
	Row %	**22.7**	**15.6**	**14.1**	**13.3**	**17.2**	**17.2**	**100.0**
	Column %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.36: The number of incidences and sources of water-borne diseases

Location	Disease	Source of water			Total
		River	Boreholes	Wells	
Dzenza	Diarrhoea	1	4	6	**11**
	Dysentery			3	**3**
	Cholera			4	**4**
	Malaria			1	**1**
Mchezi	Diarrhoea		1	3	**4**
	Cholera			4	**4**
	Skin	1	2		**3**
Ngwenya	Diarrhoea			1	**1**
	Cholera			1	**1**
	Dysentery		1		**1**
Mtsiriza	Diarrhoea		1	5	**6**
	Cholera			1	**1**
	Skin		1	1	**2**
Kauma	Diarrhoea	1		6	**7**
	Cholera			1	**1**
	Malaria			1	**1**
	Skin			1	**1**
Lumbadzi	Diarrhoea		3	1	**4**
	Cholera		1	2	**3**

2.3.11 Experience with rooftop rainwater harvesting

Respondents were asked whether they have ever attempted to get rainwater form the roof. About 80% had attempted to catch water from the roof catchments for various purposes or reasons as cited in Table 2.37. The 20% that had not attempted harvesting rainwater cited three reasons: (a) they did not have a corrugated iron sheet roof; (b) they wanted better source of water rather than rainwater; and (c) they have other sources of water. Eighty eight percent of the respondents had drunk or used rainwater and felt that rainwater is: cooler, safer, gets soapy faster, does not have chemicals and lighter than water from other sources. Others felt though that it is saltier (11.7%), bitter (9.6%) and dirtier (5.0%) than other sources (Table 2.38).

Table 2.37: Some reasons given for capturing rainwater

Reasons for rainwater capture		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
To use rainwater for drinking	Count	3		1	2		1	**7**
	All location %	42.9		14.3	28.6		14.3	**100.0**
	Location %	10.3		2.3	5.1		4.2	**3.4**
Wanted better water	Count	6	1	4			3	**14**
	All location %	42.9	7.1	28.6			21.4	**100.0**
	Location %	20.7	2.7	9.3			12.5	**6.8**
To use rainwater for bathing	Count	1	1	2	1	1	1	**7**
	All location %	14.3	14.3	28.6	14.3	14.3	14.3	**100.0**
	Location %	3.4	2.7	4.7	2.6	2.9	4.2	**3.4**
For domestic use	Count	6	20	9	16	7	5	**63**
	All location %	9.5	31.7	14.3	25.4	11.1	7.9	**100.0**
	Location %	20.7	54.1	20.9	41.0	20.6	20.8	**30.6**
To drink during dry season	Count	2		1				**3**
	All location %	66.7		33.3				**100.0**
	Location %	6.9		2.3				**1.5**
To get water right from the house	Count	4	5	2	11	11	2	**35**
	All location %	11.4	14.3	5.7	31.4	31.4	5.7	**100.0**
	Location %	13.8	13.5	4.7	28.2	32.4	8.3	**17.0**
Because rainwater is clean	Count	1			2		4	**7**
	All location %	14.3			28.6		57.1	**100.0**
	Location %	3.4			5.1		16.7	**3.4**
To fetch more water in a short time	Count	6	9	6	1	4	4	**30**
	All location %	20.0	30.0	20.0	3.3	13.3	13.3	**100.0**
	Location %	20.7	24.3	14.0	2.6	11.8	16.7	**14.6**
Borehole is very far	Count		1					**1**
	All location %		100.0					**100.0**
	Location %		2.7					**0.5**
To save money	Count			17	6	11	4	**38**
	All location %			44.7	15.8	28.9	10.5	**100.0**
	Location %			39.5	15.4	32.4	16.7	**18.4**
To taste rainwater	Count			1				**1**
	All location %			100.0				**100.0**
	Location %			2.3				**0.5**
Total	Count	**29**	**37**	**43**	**39**	**34**	**24**	**206**
	All location %	**14.1**	**18.0**	**20.9**	**18.9**	**16.5**	**11.7**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.38: Proportion of respondents describing characteristics of rainwater compared to water from other sources

Characteristics of rainwater		Household location						Total
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Rainwater is cooler than borehole water	Count	13	5	7	10	2	8	**45**
	All location %	28.9	11.1	15.6	22.2	44	17.8	**100.0**
	Location %	31.7	12.5	15.9	23.8	5.6	22.2	**18.8**
Rainwater is dirty	Count	1	3	1	3	2	2	**12**
	All location %	8.3	25.0	8.3	25.0	16.7	16.7	**100.0**
	Location %	2.4	7.5	2.3	7.1	5.6	5.6	**5.0**
Rainwater is safer than water from a well	Count	3				1		**4**
	All location %	75.0				25.0		**100.0**
	Location %	7.3				2.8		**1.7**
Both rain and borehole water are clear	Count	10	14	13	9	13	14	**73**
	All location %	13.7	19.2	17.8	12.3	17.8	19.2	**100.0**
	Location %	24.4	35.0	29.5	21.4	36.1	38.9	**30.5**
Rainwater gets soapy faster than borehole	Count		1	3		3		**7**
	All location %		14.3	42.9		42.9		**100.0**
	Location %		2.5	6.8		8.3		**2.9**
Rainwater doesn't have chemicals	Count			1	1	2		**4**
	All location %			25.0	2.50	50.0		**100.0**
	Location %			2.3	2.4	5.6		**1.7**
Rainwater is more slippery than borehole water	Count	10	6	8	6	7	5	**42**
	All location %	23.8	14.3	19.0	14.3	16.7	11.9	**100.0**
	Location %	24.4	15.0	18.2	14.3	19.4	13.9	**17.6**
Rainwater is more bitter than water from a borehole	Count	2	4	4	5	3	5	**23**
	All location %	8.7	17.4	17.4	21.7	13.0	21.7	**100.0**
	Location %	4.9	10.0	9.1	11.9	8.3	13.9	**9.6**
Rain water is saltier than dambo water	Count	2	6	7	8	3	2	**28**
	All location %	7.1	21.4	25.0	28.6	10.7	7.1	**100.0**
	Location %	4.9	15.0	15.9	19.0	8.3	5.6	**11.7**
Rain water is lighter than borehole water	Count		1					**1**
	All location %		100.0					**100.0**
	Location %		2.5					**0.4**
Total	Count	**41**	**40**	**44**	**42**	**36**	**36**	**239**
	All location %	**17.2**	**16.7**	**18.4**	**17.6**	**15.1**	**15.1**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.3.12 Storage tanks for rainwater

Respondents were shown colour pictures of four different types of storage tanks (brick, stone, plastic, and drums) to evaluate suitability according to their perception. They were asked their preferred storage tank (Table 2.39) and the advantages and disadvantages of each storage tank (Tables 2.40-2.43). Forty-four percent ranked brick tanks as the best; followed by 36.5% for plastic tanks, 10.8% for stone-walled (masonry) tanks and lastly, 8.5% for drums.

The main disadvantage cited for stone-walled tanks was need for money for cement and other materials. For brick tanks, they cited money as well and brick work that would need skills during construction and to prevent mould growth. They feared damage and fire against plastic tanks while dust was the main concern for containers and drums. For the various storage tanks, respondents indicated that materials for construction of the tanks were readily within reach. The make of all tanks appeared strong and durable and they provided opportunity for long storage of clean water.

Table 2.39: Ranking of type of storage tanks for rooftop rainwater harvesting

Type of tank		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Rank for masonry tank	Count	6	7	8	1	3	3	**28**
	All location %	21.4	25.0	28.6	3.6	10.7	10.7	**100.0**
	Location %	13.6	17.1	17.0	2.2	7.9	6.7	**10.8**
Rank for plastic tanks	Count	15	6	12	24	18	20	**95**
	All location %	15.8	6.3	12.6	25.3	18.9	21.1	100.0
	Location %	34.1	14.6	25.5	53.3	47.4	44.4	**36.5**
Rank for brick tanks	Count	17	27	20	19	15	18	**116**
	All location %	14.7	23.3	17.2	16.4	12.9	15.5	**100.0**
	Location %	38.6	64.3	42.6	42.2	39.5	40.0	**44.4**
Rank for drum	Count	6	2	7	1	2	4	**22**
	All location %	27.3	9.1	31.8	4.5	9.1	18.2	**100.0**
	Location %	13.6	4.9	14.9	2.2	5.3	8.9	**8.5**
Total	Count	**44**	**42**	**47**	**45**	**38**	**45**	**261**
	All location %	**16.9**	**16.1**	**18.0**	**17.2**	**14.6**	**17.2**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.40: Some perceived advantages and disadvantages of stone-walled tanks

Advantages	**n**	**%**	**Disadvantages**	**n**	**%**
Can increase size in order to store a lot of water	5	17.2	Needs a lot of money i.e. cement	13	52.0
It is strong and durable	16	55.2	Difficult to find stones	4	16.0
Stones are not too difficult to find	3	10.3	Requires a skilled technician to construct	2	8.0
Water can be stored for a long time	1	3.4	*Missing value*	6	24.0
Safe and clean water	3	10.3			
Missing value	1	3.4			
Total	**29**	**100.0**	**Total**	**25**	**100.0**

Table 2.41: Some perceived advantages and disadvantages of brick-walled tanks

Advantages	n	%	Disadvantages	n	%
Can increase size in order to store a lot of water	17	14.9	Needs a lot of money for materials	31	30.4
It is strong and durable	37	31.6	Bricks will need to be plastered inside	12	11.8
Bricks are not difficult to find	34	29.8	Difficult to clean	12	11.8
It is cheaper	1	0.9	Easily develop moulds after some time	26	25.5
Water can be stored for a	6	5.3	Doesn't see any disadvantage	6	5.9
Safe and clean water	15	13.2	Requires a skilled technician to construct	3	2.9
Missing value	4	3.5	Reliable in rainy season If not properly built it can develop cracks Can not be replaced	1 1 2	1.0 1.0 2.0
			Missing value	8	7.8
Total	**114**	**100.0**	**Total**	**102**	**100**

Table 2.42: Some perceived advantages and disadvantages of plastic tanks

Advantages	n	%	Disadvantages	n	%
Can increase size in order to store a lot of water	1	1.1	Difficult to clean	4	5.7
It is strong and durable	19	21.5	Others can burn or damage it	42	60.0
It is ready made	2	2.2	Water become too hot to drink	7	10.0
Tanks are easily found	9	10.1	It is very expensive	8	11.4
It is cheaper	11	12.4	It can get punctured	1	1.4
Water can be stored for a long time	7	7.9	Reliable in rainy season	1	1.4
Plastic can not become rusty	13	14.6	Easily robbed	2	2.9
Safe and clean water	24	27.0	*Missing value*	5	7.1
Missing value	3	3.4			
Total	**89**	**100.0**	**Total**	**70**	**100.0**

Table 2.43: Some perceived advantages and disadvantages of storage drums/containers

Advantages	n	%	Disadvantages	n	%
Can increase size in order to store a lot of water	4	25.0	Difficult to clean	3	15.8
Materials are easily found	6	37.5	Dust can easily go inside	11	57.9
It is cheaper	2	12.5	Metal tanks become rusty easily	3	15.8
Safe and clean water	2	12.5	It is very expensive	1	5.3
It is removable	1	6.3	*Missing value*	1	5.3
Missing value	1	6.3			
Total	**16**	**100.0**	**Total**	**19**	**100**

2.3.13 Investing in rainwater storage tanks

Ninety-four percent of the respondents indicated willingness to pay or invest in a rainwater storage tank. Amongst these, 82% opted to invest in kind rather than through cash outlay (Table 2.45). Various in-kind investments were mentioned as reported in Table 2.46 but the most popular were moulding bricks and providing manual labour. A similar trend of results was obtained when asked whether they would be willing to invest in storage tanks as groups. Ninety three percent of the respondents were willing to contribute in cash or in kind if the structures belonged to a group rather than to individual households.

Table 2.44: Proportion indicating willingness to pay or invest in the rainwater storage tank for use by the household

Whether can pay or invest in storage tank		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Yes	Count	44	42	41	42	38	45	**252**
	All location %	17.5	16.7	16.3	16.7	15.1	17.9	**100.0**
	Location %	97.8	93.3	87.2	91.3	95.0	100.0	**94.0**
No	Count		1	6	3	1		**11**
	All location %		9.1	54.5	27.3	9.1		**100.0**
	Location %		2.2	12.8	6.5	2.5		**4.1**
missing	Count	1	2		1	1		**5**
	All location %	20.0	40.0		20.0	20.0		**100.0**
	Location %	2.2	4.4		2.2	2.5		**1.9**
Total	Count	**45**	**45**	**47**	**46**	**40**	**45**	**268**
	All location %	**16.8**	**16.8**	**17.5**	**17.2**	**14.9**	**16.8**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.45: Proportion indicating willingness to pay or invest in cash or in kind for rainwater storage tank

Mode of investment		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
In cash	Count	2	5 10	9	7	4	37	
	All location %	5.4	13.5	27.0	24.3	18.9	10.8	**100.0**
	Location %	4.4	11.4	22.7	20.0	17.9	8.9	**14.1**
In kind	Count	40	37 33	35	31	40	216	
	All location %	18.5	17.1	15.3	16.2	14.4	18.5	**100.0**
	Location %	88.9	84.1	75.0	77.8	79.5	88.9	**82.4**
Both cash and kind	Count	2	1			1	4	
	All location %	50.0	25.0			25.0	100.0	
	Location %	4.4	2.3			2.2	1.5	
Missing	Count	1	2	1	1		5	
	All location %	20.0	40.0		20.0	20.0		**100.0**
	Location %	2.2	4.5	2.2	2.6		1.9	
Total	Count	**45**	**44**	**44**	**45**	**39**	**45**	**262**
	All location %	**17.2**	**17.2**	**16.8**	**17.2**	**14.9**	**17.2**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2.46: Some suggested means of investing in kind for rainwater storage tanks

Methods of investing in kind		**Household location**						**Total**
		Dzenza	Mchezi	Ngwenya	Mtsiriza	Kauma	Lumbadzi	
Mould bricks	Count	22	10	4	6	10	10	**62**
	All location %	35.5	16.1	6.5	9.7	16.1	16.1	**100.0**
	Location %	52.4	26.3	12.1	17.6	29.4	24.4	**27.9**
Any duty assigned	Count	4	6	10	8	5	4	**37**
	All location %	10.8	16.2	27.0	21.6	13.5	10.8	**100.0**
	Location %	9.5	15.8	30.3	23.5	14.7	9.8	**16.7**
Labour for digging, hauling materials	Count	9	19	15	17	16	18	**92**
	All location %		20.7	16.3	18.5	17.4	19.6	**100.0**
	Location %		50.0	45.5	50.0	47.1	43.9	**41.4**
Cooking food	Count	3	3	1			4	**11**
	All location %	27.3	27.3	9.1			36.4	**100.0**
	Location %	7.1	7.9	3.0			9.8	**5.0**
Provide land for the construction	Count	3		1	1		1	**6**
	All location %	50.0		16.7	16.7		16.7	**100.0**
	Location %	7.1		3.0	2.9		2.4	**2.7**
Drawing water	Count			1	1	1	4	**7**
	All location %			14.3	14.3	14.3	57.1	**100.0**
	Location %			3.0	2.9	2.9	9.8	**3.2**
Missing values	Count	1		1	1	2		**5**
	All location %	20.0		20.0	20.0	40.0		**100.0**
	Location %	2.4		3.0	2.9	5.9		**2.3**
Total	Count	**42**	**38**	**33**	**34**	**34**	**41**	**222**
	All location %	**18.9**	**17.1**	**14.9**	**15.3**	**15.3**	**18.5**	**100.0**
	Location %	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

2.4 Discussion

2.4.1 Sources of water and their development

In terms of access to water, 90% of respondents argued that water is a problem for their families while about 38% indicated that other households do not have problem of access to water because: (a) they have their own wells, boreholes or running tap water; (b) they are near the water sources; or (c) they pay workers to draw water. The principal sources of water for the households were boreholes (32%) and kiosks (34%). Shallow wells were the alternative sources to either boreholes or kiosks. There is heavy reliance by the urban population on the use of unimproved pit latrines which can result in contamination of groundwater (Malawi Government, 2002). This has significant implications on attempts at reducing the incidence of water borne diseases arising out of contamination of shallow wells through seepage.

Overall, individuals have developed their own water points while a handful of water facilities were developed by NGOs such as CPAR and Plan International, government and its institutions such as the Lilongwe Water Board and MASAF. About 67% of the respondents indicated that local governance structures (committees, chiefs, villagers) and individuals are responsible for operating and repairing the water facilities. Malawi Government/UNDP (1993) reported that the planned optimum distance that a woman should carry water is 500 metres. But as women have a particular obligation in maintaining a continual supply of water, they have often been involved in providing time and resources for the maintenance of boreholes and other water points.

About 94% of the respondents were willing to pay or contribute to development of additional water sources. They cited a number of reasons for wanting to assist in this endeavour. Provision of free water was cited by only 10 % of the respondents while reduction of congestion at water points and reduction of distance to travel to water sources were mentioned by more respondents. Overall, 77% of the respondents indicated that they do not pay for water services. The highest number of respondents that pay for water services were recorded at Ngwenya and Mtsiriza. It was noted that at Ngwenya, even those that have wells sell their water while at Mtsiriza, kiosks are the main water selling points. Only about 30% were satisfied with provision of water services and another 31% indicated that payment for water services affects the amount of water drawn for domestic use.

2.4.2 Labour for fetching water

The girl child draws the most water (68.7%) followed by the mother/wife (54.1%) and the boy child (29.1%). Overall, 57% of the respondents indicated that the amount of effort it takes to draw water affects the amount of water drawn. Tasks that require manual effort in drawing water included walking, drawing, pumping and carrying water. These require human energy and appeared to affect performance of other livelihood activities. A major implication of labour constraint is the increased burden on women who are already severely stressed with their manifold responsibilities and the limited availability of affordable labour-saving technologies (Malawi Government/UNDP, 1993). For the girl- or boy-child, and the girl in particular, it is the inordinate amount of time and energy taken away from school activities that is detrimental to their well-being and life-long vocational development.

2.4.3 Water consumption and hygiene

In general, peri-urban populations sampled are using between 20.76 and 24.73 litres of water per person per day. Slightly higher amounts are used in the dry season and during weekends. There was a 23% increase in the amount of water used in the dry season compared to that used in the wet season. When days of the week are compared, it is evident that there is an overall 18% increase in the amount of water that is used during weekends compared to that used during weekdays. Substantive increases in the amount of water used in the dry season comes from a 43-45% and 52-63% increase in the amount of water used for drinking and that used for gardening, respectively. During weekends when compared to weekdays, increase in water use came from a 49-66% increase in the amount of water used for washing clothes. The lowest amounts are used at Dzenza and Mchezi locations. The Malawi Government (2002) reported that per capita consumption for high income connections and for public standpipes are about 100 and 25 litres per day, respectively.

The study showed that 80% of the respondents dispose wastewater haphazardly. This is in tandem with studies that have shown that 75-95% of the population in towns where sanitation studies have been conducted had no access to adequate storm water drainage (Malawi Government, 2002). This results in the pollution of local water sources and may contribute to the likelihood of waterborne diseases. In this study, it was shown that wells provide the main source of water-borne diseases. There were no incidences of diseases reported arising from use of water from kiosks. Overall, the incidence of water-borne diseases appeared to be small.

2.4.4 Potential of rooftop rainwater harvesting

About 80% had attempted to catch water from the roof catchments for various purposes or reasons. The 20% that had not attempted harvesting rainwater cited three reasons: (a) they did not have a corrugated iron sheet roof, (b) they wanted better sources of water rather than rainwater; and (c) they have other sources of water. Eighty eight percent of the respondents had drunk or used rainwater and felt that rainwater is cooler, safer, gets soapy faster, does not have chemicals and is lighter than water from other sources. Other felt though that it is saltier (11.7%), bitter (9.6%) and dirtier (5.0%) than other sources. These observations could be ascribed to contamination of roof surfaces or collection receptacles used.

Respondents were shown colour pictures of four different types of storage tanks (brick, stone, plastic, and drums) and were asked for their preferred storage tank and the perceived advantages and disadvantages of each storage tank. Forty four percent ranked brick tanks as the best; followed by 36.5% for plastic tanks, 10.8% for stone-walled (masonry) tanks and lastly, 8.5% for drums. Ninety four percent of the respondents indicated willingness to pay or invest in a rainwater storage tank.

Amongst these, 82% opted to invest in kind rather than through cash outlay. Various in-kind investments were mentioned but the most popular were moulding bricks and providing manual labour.

2.5 Conclusion

This baseline study has shown that peri-urban populations sampled were using between 21 and 25 litres of water per person per day, most of which is fetched by the girl-child, adult females, and the boy-child. Slightly higher amounts of water are used in the dry season owing to increases in the amount of water used for drinking and that used for gardening, respectively. When water use during days of the week was compared, it was evident that more water is used during weekends compared to that used during weekdays as a result of increase in the amount of water used for washing clothes. Water for gardening and washing clothes can easily be harvested from roof catchments. It was found that peri-urban communities were willing to pay or contribute to development of additional water sources; this was not necessarily to obtain free water, but to reduce the drudgery associated with lifting and fetching water from distant sources. The quality of rainwater for domestic use was appraised favourably and communities were willing to invest in water harvesting and storage endeavours.

Chapter Three

Construction of Rooftop Rainwater Harvesting Systems

3.1 Introduction

During the rainy season, a lot of water is generated from roof catchments, which goes to waste. This amount of water can be harvested and stored in surface tanks for various uses. However, many people who would like to harvest rainwater lack the resources and technical know-how to store it. Tanks can be made of plastic or metal and can be constructed from bricks, cement, or stone. In Malawi, nearly everyone makes bricks and therefore it represents a ready-made option. The choice of a suitable tank size will depend on: (a) availability of funds; (b) amount of water required by the household between rain seasons (consumption); (c) roof catchment area; (d) total seasonal rainfall; and (e) available materials and technology (Wanyonyi, 2004). It is noted that there is no need to have a tank capacity equal to the annual run-off volume from the roof catchment as water is being consumed on a daily basis. To keep the tank from getting contaminated, it is recommended that tanks should be located away from drainage from livestock, housing, bath or toilets.

The efficiency of any rainwater catchment depends to a great extent on the gutter and downpipes. Qualified tinsmiths' (or plumbers') work is required to fix gutters for catchment and indeed, maintenance of the architectural look of ready-built structures especially needs precise workmanship. In planning and designing for integration of rooftop rainwater harvesting in existing infrastructure, consideration will need to be placed on review of policies and ordinances that govern such infrastructure (Lazaro *et al.*, 2000). Ultimately, high quality harvested water suitable for human consumption does justify more meticulous storage methods than for other use. Therefore, each kind of water harvest and the intended purpose must be taken into account when designing water-storage facilities.

Elsewhere, experience has shown that unless beneficiaries contribute in some way towards the implementation of activities in their communities, they do not identify with them, treat them as their own and most importantly, do not maintain them (Mills, 2004). Contributions can take many forms but the most favoured input is in the form of unskilled labour and the provision of locally available construction materials.

3.2 Methodology

Roof catchments, location of tanks, bill of quantities, and community contribution were determined and discussed with coordinators of centres. They in turn briefed their committees for their acceptance of the same. Follow up meetings at each site were held with local leaders (chiefs, development committee leaders, community-based organisation leadership) for sensitization on rainwater harvesting technologies and they were informed about the project, using pictorial briefs prepared in the local language and distributed.

Communities contributed to the project costs by providing local construction materials, namely river sand, quarry and bricks. They also provided labour for drawing water and identified their own local builders to be trained by masons employed by the project. Construction protocols were modified following those used by the Lilongwe Water Board and similar work detailed by the Kenya Rainwater Association.

Roof catchment sizes and corresponding yield of water and bill of quantities were determined. But based on the funds available, tanks containing only 50 m^3 of water were designed for construction. The tank at Lumbadzi was twice the size of other tanks constructed to contain about 100 m^3 of water. The centre voluntarily provided matching funds for the purpose. At Mchezi and Kauma, gutters were made by local professional welders using flat iron sheets while at Lumbadzi, gutters were made from PVC pipes by local carpenters. This was deliberate to compare and demonstrate expertise that would be required to make and erect the gutters. The rainwater harvesting systems were completed at three locations, namely, Lumbadzi, Kauma, and Mchezi before the rains in October 2005.

3.3 Results

3.3.1 Location 1, Kauma: Kauma Orphan Support Initiative (Adziwa Ministry)

The centre has 15 houses in three rows of five and each with a roof size of about 72 m^2. Three of the five houses are adjacent to one another and the rainwater harvesting system was modelled on these three houses. The actual roof catchment size based on the three roof houses was 215.8 m^2 with a potential yield of water in the quantity of 122 m^3 as tabulated below.

Table 3.1: Roof catchment size and potential yield of water at Kauma

Tank size	Roof catchment area (m^2)	Volume of tank (m^3)	Radius of tank (m)	Height of tank (m)
Measured/ actual	215.8	122.4	3.95	2.5
Constructed	215.8	50	2.8	2.0

A 50-m^3 brick storage tank was constructed and the approximate total costs incurred by the project and the community are shown in Table 3.2. The tank required MK 248,218.12 or US$2,277.23. This is quite close to the figure of US$2,112.16 in the project support document or the estimate discussed with communities. However, the community contributed 30 % of the project costs, which was higher than the 21.4 % estimated. This was because the time for providing materials required for construction work was very short and communities resorted to purchasing them rather than providing them through their collective labour. Gutters were constructed by experienced artisans out of flat metal sheets. Pictorial elements of the work are shown in the following pages.

Table 3.2: Cost of construction of 50 m^3 brick tank and guttering at Kauma

Item Contribution by project (based on 50 m^3 tank)	**Cost in MK**	**Item** Contribution by beneficiary community	**Cost in MK**
Cement	71,500.00	Bricks + transport	14,000.00
Mesh in slabs	20,920.68	River sand + transport	24,000.00
Reinforcement	9,525.94	Poles	900.00
Builders' accessories	13,754.00	Quarry stone+ transport	18,000.00
Roofing woodwork	7,775.00	Labour	17,000.00
Taps/ yard piping	6,902.50		
Gutters/ materials	21,475.00		
Gutters/ fixing	10,500.00		
Labour for mason and handyman	11,965.00		
Total	**174,318.12**	**Total**	**73,900.00**
Overall total = MK 248,218.12 Estimated total= MK 230,673.80 Overall total US$ (at US $1 = MK109) = 2,277.23			

3.3.2 Location 2, Mchezi: RECAPO Orphan Care Centre

Construction of the brick storage tank was sited at the house belonging to the coordinator for the orphan care centre. The house is used as the nerve centre for coordination of activities of this community-based organisation known as RECAPO. The amount of roof area determined was 182.6 m^2 with a potential yield of 125 m^3 of rainwater as tabulated below.

Table 3.3: Roof catchment size and potential yield of water at Mchezi

Tank size	Roof catchment area (m^2)	Volume of tank (m^3)	Radius of tank (m)	Height of tank (m)
Determined	182.57	124.88	4.46	2.5
Constructed	182.57	50	2.8	2.0

A 50-m^3 brick storage tank was constructed and the approximate total costs incurred by the project and the community are shown in Table 3.4. The tank required MK226,718.12 or US$2,079.98. This is quite close to the figure of US$2,112.16 in the project support document or the estimate discussed with communities. The community contributed 23 % of the project costs which was closer to the 21.4 % estimated. At this location as well, the time available for providing materials required for construction work was very short, so the communities resorted to purchasing them rather than providing them through their collective labour. Gutters were constructed by experienced artisans out of flat metal sheets. Pictorial elements of the work are shown in figures 3.1-3.4.

Table 3.4: Cost of construction of 50 m^3 brick tank and guttering at Mchezi

Item Contribution by project (based on 50 m^3 tank)	**Cost in MK**	**Item** Contribution by beneficiary community	**Cost in MK**
Cement	71,500.00	Bricks + transport	15,900.00
Mesh in slabs	20,920.68	River sand + transport	5,100.00
Reinforcement	9,525.94	Dambo sand+ transport	6,600.00
Builders' accessories	13,754.00	Quarry stone+ transport	7,800.00
Roofing woodwork	7,775.00	Labour	17,000.00
Taps/ yard piping	6,902.50		
Gutters/ materials	21,475.00		
Gutters/ fixing	10,500.00		
Labour for mason and handyman	11,965.00		
Total	**174,318.12**	**Total**	**52,400.00**
Overall total = MK 226,718.12 Estimated total= MK 230,673.80 Overall total US$ (at US $1 = MK109) = 2,079.98			

3.3.3 Location 3, Lumbadzi: Mtendere Orphan Care Centre (Blessings Hospital)

There are 25 houses in three rows of eight each housing 12 children at this centre. A storage tank was constructed midway between two houses. The total roof catchment size based on two houses was 175 m^2 with a potential yield of water in the amount of 120 m^3 as tabulated below.

Table 3.5: Roof catchment size and potential yield of water at Lumbadzi

Tank size	Roof catchment area (m^2)	Volume of tank (m^3)	Radius of tank (m)	Height of tank (m)
Measured/ actual	175.04	119.73	4.365	2.0/2.32
Constructed	175.04	119.73	4.365	2.0

A 100-m^3 brick storage tank was constructed to drain two houses and the approximate total costs incurred by the project and the centre are shown in Table 3.6. The tank required MK364,505.55 or US$3,344.09. This is slightly lower than the estimated figure of MK391,412.40 or US$3,590.94 in the project support document or presented to the centre. The centre contributed 35.6 % of the project costs, which was matching funds to the project's contribution which was equal to the cost of a 50 m^3 tank calculated at MK 230,673.80. At this location, the owner provided matching funds to construct a 100-m^3 tank. Gutters were constructed out of PVC pipes. The pipes required accessories such as elbows, stoppers and others for installation use so as to remove the need for bending and welding of gutters made out of sheet metal. Pictorial elements of the work are shown in figures 3.9-3.12.

Table 3.6: Cost of construction of 119.73 m^3 brick tank and guttering

Item Contribution by project (based on 50 m^3 tank)	**Cost in MK**	**Item** Contribution by beneficiary community	**Cost in MK**
Cement	71,500.00	Bricks	18,000.00
Mesh in slabs	41,841.36	Sand	5,000.00
Reinforcement	19,051.88	Quarry stone	24,000.00
Builders' accessories	13,754.00	Cement	65,000.00
Roofing woodwork	15,550.00	Labour	17,640.00
Taps/ yard piping	13,805.00		
Gutters/ materials	30,433.31		
Gutters/ fixing	5,000.00		
Labour for mason and handyman	23,930.00		
Total	**234,865.55**	**Total**	**129,640.00**
Overall total = MK 364,505.55 Estimated total = MK 391,412.40 Overall total US$ (at US$1 = MK109) = 3,344.09			

3.4 Discussion

3.4.1 Construction works

The brick work was ably accomplished by local builders after training them and using materials sourced locally as community contribution to the project. There was a need, however, to critically make sure that the bricks used were of high quality to provide the needed structural strength required for storage of water.

The placement of gutters, while it appeared simple, provided a unique challenge as ably articulated by local artisans. The most critical challenges for both iron sheet and PVC piped gutters was to provide the necessary slope to carry roof runoff away without water standing in the gutter. It was observed that most houses, including the ones in the project, were constructed without the consideration of gutters in terms of roof shape (protrusions and roof height), lengths, and direction of slope. Placement of gutters was therefore a challenge wherein the right slope had to be maintained without loosing facial outlook or beauty of the original structures. The study further found out that shaping and placement of PVC gutters was simpler than for iron sheet gutters.

3.4.2 Construction costs

At all locations, the work was completed without setbacks arising from failure by the recipients to provide construction materials. However, there were delays in receiving initial materials from recipients to start construction. Further, because of the time remaining before the onset of the rains, communities resorted to buying materials such as bricks or quarry, instead of making them. This added to the cost incurred by the communities.

The cost of erecting gutters inclusive of materials and labour was K175.14 and K202.43 per m^2 of roof catchment area for metal and PVC gutters, respectively. In terms of cost of erecting the entire water harvesting system, the cost for each were MK248,218.12 or US$2,277.23 for Kauma, MK 226,718.12 or US$2,079.98 for Mchezi, and MK364,505.55 or US$3,344.09 for Lumbadzi. Alternatively, the costs per m^3 of water were US$33.45 for Lumbadzi, US$41.59 for Mchezi and US$45.55 for Kauma, respectively. The beneficiaries contributed 23% and 30% of the cost at Mchezi and Kauma, respectively, compared to an estimated contribution of 21.4%. At Lumbadzi, the centre contributed 35.6% of the cost as matching funds.

In Kenya at Laikipia, where a cost-sharing approach was used, self-help groups were contributing 40% to the cost of erecting 6 m^3 ferrocement tanks which was equivalent to 27,000 Kenyan shillings or US$386 per tank or US$64 per m^3 of water (Mbugua, 2003). However, the total cost per 6 m^3 tank was US$915 or US$154 per m^3 of water. Based on simple calculations using these Kenyan figures, to construct a 50 m^3 would cost US$7,625. In Tigray, Ethiopia, in 2003 as well, brick tanks of 10 m^3 capacity cost US$259.34 to construct (Mills, 2004). Again, based on simple extrapolation, this would translate to US$25.9 per m^3 of stored water or US$1,297 for a 50 m^3 tank.

In Malawi, a few demonstration brick tanks of 4 m^3 were built by the Department of Land Resources Conservation in 2003 at US$636.36 each without community contribution (Nthara, pers. communication). Extrapolating from these figures, it would cost US$8,750 to construct a 50 m^3 tank.

3.5 Conclusion

The construction of storage tanks for rooftop rainwater harvesting was accomplished using local artisans and cost-sharing partnerships with grassroots' structures running orphan care centres in peri-urban areas of Lilongwe City. Technical expertise in the brick work was ably transferred to the local builders. The construction and placement of gutters was also accomplished using local artisans. However, because of lack of designing for gutters in most housing and corporate structures, it will be advisable to use experienced artisans lest harvesting runoff drainage through gutters proves too challenging. The work will contribute to laying down standard procedures of construction as well as techniques of erecting and positioning various sections of the tank and gutters.

Chapter Four

Financial Analysis of Rooftop Rainwater Harvesting Systems

4.1 Introduction

This section illustrates several steps that have been taken in the process of project financial analysis. The *Economic Cost-Benefit Analysis* was not carried out because of insufficient national numçraire (unit of account) for determination of the shadow prices for commodities; a very important aspect in evaluating economic project worth. The project focused mainly on one consumer group (low income communities/ orphanages) as communal water points. Under this section the following have been discussed:

1. Analysis of present water consumption (before implementation)
2. Determination of water demand
3. Financial Cost-Benefit Analysis.

Data used in the analysis were derived from the questionnaires that were given to the concerned communities; from the Ministry of Irrigation and Water Development, and from the Lilongwe Water Board. The 2005 populations at the orphanages were used to further formulate and design this project. No demographic projection was carried out because they are community-based institutions. Instead a 5% population increase has been considered for the design horizon of five years from 2005 to 2010. Further data in the analysis were based on information collected from the following sources:

1. Ministry of Community Services and Social Welfare
2. Lilongwe Water Board
3. Site visits
4. Socio-Economic Survey data by the Project Team.

Without the Water Harvesting Project in the target areas of study, the quality and quantity of water sources do not meet required standards. This report has utilised the savings made by the Lilongwe Water Board and the benefits from boreholes and wells accruing to the beneficiary communities within the project.

All prices are expressed in constant values of the base year, 2005. The currency is Malawi Kwacha (MK) based on an exchange rate of 1 Euro = MK 152. The project lifetime was put at five years because of the sizes of the brick wall tanks; year 2010 being the last year when benefits and costs due to the project are expected to accrue. The tanks were downsized in order to cut costs but of course be able to exert the necessary impact to the affected communities.

4.2 Analysis of Volume and Cost of Present Demand

4.2.1 Present water consumption

In the analysis of volume and cost of present demand, this report has considered a random sampling of the current set up in the area in question. The principal sources of water for the orphanages and surrounding households are boreholes (32%) and Lilongwe Water Board's water kiosks (34%). Other sources of water are wells and rivers and account for the remainder. Detailed data for the present consumption, according to the survey, shows that it is 22.74 litres per capita per day (lpcd). The consumption was estimated on the basis of daily quantities of water collected from specific sources. In the second step, estimate was collected for number of days and months the sources were not used. The normal estimated demand for non-connected households for the purposes of this report is 30 litres per capita per day (lpcd) and the average household size is six.

4.2.2 Present cost of supply

A larger percentage of all the orphanages and households around them obtain water from alternative sources other than Lilongwe Water Board piped water. The costs relate to collecting time, cash expenditure for expensive water, investments in wells, medication and death costs due to water borne diseases are also high.

The average collecting time per household is a minimum of 30 minutes per trip or pail and the average consumption per household is 150 litres per day. It thus takes a household in excess of three hours per day to collect 0.15 m^3 of water. The value of time is estimated on the basis of the observed wage rate for unskilled labour in construction works pegged at MK12 per hour in the project area.

The cash expenditure for water obtained from kiosks, neighbours and wells constitute a major part of the supply cost. These households obtain water from their neighbours at high prices, in extreme cases at MK3.00/pail (works out to MK150/m^3) as opposed to MK47/m^3 at LWB source.

The investment cost for alternative sources range from MK5,000.00 for shallow wells to MK 500,000.00 for motorised boreholes. The cost of storage facilities in this part of the city is MK 6,000.00 per 200-litre plastic container at Lilongwe Urban Market.

Table 4.1 depicts the present supply cost of water from the most important alternative sources as they are used by both connected and non-connected households and orphanages. Also shown is the proportion of water obtained from that source as a percentage of total water consumed.

Table 4.1: Present supply cost of water from the most important alternative sources as they are used by both connected and non-connected households

Facility	Water consumed (%)	Financial demand price (MK)/ m^3		
		Source	Storage	Total
Lilongwe Water Board	34%	47	106	153
Wells/Boreholes	66%	100	106	206
Total / Average	100%	74	106	180

The financial demand price of water obtained from wells and neighbours is approximately MK206/ m^3 while the financial demand price for water obtained from LWB piped water supply is MK153/ m^3. Thus, the weighted average financial demand price is MK180/m^3.

4.3 Water Demand Forecast

4.3.1 Introduction

The population that would be saved by the project in the year 2005 is illustrated in Section 2.3. The project supply capacity is projected to be 300m^3. Benefits are expected to accrue from 2005 to 2006. It is important to note that in this project, the roof area as catchment has mainly determined the capacity of the tank because the actual demand surpassed the roofing capacity to catch rainwater. Therefore, the pilot project aims at empowering people and transfer of knowledge, and it may only offset a maximum demand of 20% during the dry season (tank water would be used for drinking only during the dry season) and 100% during the rainy season (tank may get filled anytime). For the purpose of evaluation the cost-benefit analysis, 80% of the project water is considered conservative. The rest of the demand will still be met by the other sources.

4.3.2 Population coverage

The population in the service area (4,172 people in 2005) is expected to grow at an average annual rate of 5%, over the five years due to expansion of the orphanages. The population is expected to increase to 7440 by the year 2010. Demographic increase of population of the orphanages has not been considered as their growth is basically dependent on the operators. Therefore a rate of increase of 5% (Lilongwe Water Board rate of increase for institutions) has been employed.

Table 4.2.: Population projections for the service area served by project

	Unit	Year 2005	Year 2010
Population growth rate	%		5
Population at and around the orphanages	Persons	4,172	7,440
Coverage	%	75	75
Population served with project	Persons	3,129	5,580

4.3.3 Demand without project

Existing consumers

Without the project, the water supply systems will be maintained and operated at a level that is required to continue providing the existing level of service. In the absence of the country economic indices, this report only considers the rise of price of water per year of 20%. The total per capita demand of water of 30 lpcd in 2005 will be maintained because there is no inducement for an increase.

Consumers of water from other sources

The relevant data is presented in Table 4.3. In the 'without project' demand projection, the focus is on the without-project demand for water obtained from other (than rainwater harvesting tanks) sources for the portion of population that will be supplied as a result of the project. It is the consumption of water from other sources that will be displaced as a result of the project. The number of new consumers is obtained by deducting the existing population served (Table 4.3) from the targeted population to be served. Ultimately, 5,580 additional consumers will benefit from the project in 2010.

Table 4.3: Demand for water without project

Without Project	Unit	Year 2005	Year 2010
Persons served	Person	3,129	5,580
Increase in per capita demand	%	0	0
Total per capita demand	lpcd	30	30
Per capita rainwater consumption	lpcd	0	0
Per capita water consumption (other source)	lpcd	15	15
Total rainwater consumption	m^3	0	0
Total water consumption (other sources)	m^3	47	84
Total water consumption (rainwater + other sources)	m^3	47	84

4.3.4 Demand with the project

According to Engineering Studies and Water Services Sector Study (carried out by COWIconsult and NORCONSULT in 1994) the standard consumption levels for low-income high density areas in Lilongwe City range from 40 – 60 lpcd. This report recommends an average of 40 lpcd (based on similar orphanage set up in other supplied low-income areas).

In accordance with the report quoted above, the per capita water demand is expected to increase moderately in a linear direction from 15 lpcd before the project in 2005 to 40 lpcd by 2010. After 2010 no further per capita demand increase is expected.

Table 4.4: Demand for water with project

With Project	Unit	Year 2005	Year 2010
Persons served	Person	3,129	5,580
Increase in per capita demand	%	15	30
Total per capita demand	lpcd	30	40
Per capita rainwater consumption	lpcd	22.5	30
Per capita water consumption (other source)	lpcd	7.5	10
Total rainwater consumption	m^3	70.4	167.4
Total water consumption (other sources)	m^3	23.47	55.8
Total water consumption (rainwater + other sources)	m^3	93.87	223.5

4.3.5 Consumers base and project water consumption

Since the financial demand price of water from wells and boreholes is above the price of utilising rainwater, and since supplies of piped water are constrained, the rainwater-harvesting project is expected to replace a bigger proportion of water previously obtained from other sources. The demand forecast has assumed that a bigger proportion of water from other sources (apart from rainwater) will be replaced, which is the difference between the 'with-project' and the 'without-project' consumption.

4.4 Financial Cost–Benefit Analysis

4.4.1 Project revenues

The project water has been converted into equivalent financial revenues had the water been from Lilongwe Water Board. All other data needed to calculate the financial revenues (i.e., the project water sold, tariffs and connections) stem from previous inclusion of infraction. From year 2005 onwards, very few influences arising from the project have been projected and hence are minimal.

Table 4.5: Project financial revenues per year

Project water sold	Unit	Year 2005	Year 2010
Project water sold/day	m^3	25,696	61,101
Tariff	MK/m^3	81	117
Project revenues from sales	MK'000	2,081.38	7,148.82
Total project Revenues	**MK'000**	**2,081.38**	**7,148.82**

4.4.2 Tariff assumptions, investments, operation and maintenance

The following tariff assumptions were assumed:

1. Full cost recovery for the system installation..
2. All customers in the project area will fall within the tariff category of domestic customers.
3. An average tariff of the first two bands of the domestic tariff category has been used.

4. The tariff adjustment has been based on changes in the level of inflation at 20% annually from the current base rate onwards to the end of the project period.

In terms of investment, the cost of the chosen mode of harnessing rainwater includes metallic roofing, gutters, down pipes, brick tank and physical contingencies. These items were calculated at 10 % of the project cost sub total. Thus, the initial project cost is estimated to be MK237,468.12 (the average cost of one 50 m^3 tank) and this report is based on the product of six sites, the amount of which would be MK1,424,808.72. The investment costs assumed 100% disbursement during 2005.

In the absence of the national adjustment factors to transform the financial values to economic values that reflect the difference between financial and economic values, the assessment of previous similar structures has demonstrated that the operation and maintenance cost regimes of the tanks are as follows (expressed as a age of the total project investment): labour (0.05 %); chlorine for purification (0.07 %); and other materials (0.9 %) throughout the life of the facility. An adjustment for increase of the price of labour has been made. The wages have been assumed to increase by 20% on income per annum, in line with inflation.

4.5 Conclusion

The data for calculating Financial Investment Rate of Return (FNPV) and Financial Net Present Value (FIRR) are presented in the Table 4.6. The project costs are deducted from the project revenues on an annual basis to estimate the net present cash flow of the project.

The Financial Investment Rate of Return (FIRR) of 48% is well above the 22.5 % borrowing rate, and a positive Financial Net Present Value (FNPV) of MK 12 million by 2010, with a payback of 6.7 months, which is much less than five years (Project Lifetime), indicate that the project is financially viable.

An NGO/CBO that would like to invest in safe water in any low income community that is not provided with municipal water can exploit this technology and realise the maximum benefits of the investment.

Table 4.6: Financial cost–benefit analysis

DESCRIPTION	Unit	Year 2005	Year 2006	Year 2,007.00	Year 2008	Year 2009	2010	Total
Investment								
Initial Investment	MK	1,424,808.72						1,424,808.72
10% Contingencies	MK	142,480.87						142,480.87
Total Initial Investment	MK	**1,567,289.59**	-	-	-	-	-	**1,567,289.59**
Operation and maintenance								
Labour	MK		783.64	940.37	1,128.45	1,354.14	1,624.97	5,831.57
Chemicals	MK		1,097.10	1,316.52	1,579.83	1,895.79	2,274.95	8,164.20
Other O&M materials	MK		14,105.61	16,926.73	20,312.07	24,374.49	29,249.39	104,968.28
Total O&M	MK		**15,986.35**	**19,183.62**	**23,020.35**	**27,624.42**	**33,149.30**	**118,964.05**
Total Expenditure	MK	**1,567,289.59**	**15,986.35**	**19,183.62**	**23,020.35**	**27,624.42**	**33,149.30**	**1,686,253.64**
Total project benefits								
Assumed Savings		**2,081,380.00**	**2,204,220.00**	**3,427,060.00**	**4,649,900.00**	**5,872,740.00**	**7,148,820.00**	**25,384,120.00**
Net cash flow	MK	514,090.41	2,188,233.65	3,407,876.38	4,626,879.65	5,845,115.58	7,115,670.70	23,697,866.36
NPV Factors @ 22.5%	Fig.	1.00	0.82	0.67	0.54	0.44	0.36	
NPV @ 22.5%	MK	514,090.41	1,786,313.18	2,270,971.35	2,516,981.00	2,595,665.64	2,579,499.20	12,263,520.78
Discounted Payback Period	Months	6.70						
FIRR (Financial Internal Rate of Return)	% 48%							

Chapter Five

Evaluation of Performance of Rooftop Rainwater Harvesting Systems and Framework for Scaling up

5.1 Introduction

The key to unlocking Malawi's water potential is enabling users of all types and stakeholders to undertake new initiatives by lessening or removing constraints to increased access to water. This may require that policies and water provision mechanisms and technologies are appropriate for users' needs; that dissemination mechanisms for the same are broadened, and that water provision mechanisms and technologies are realistic in terms of inputs and costs. Indeed, oblivious of various financing mechanisms, there is often the overemphasis on cost of technology. This report highlights various financing mechanisms to aid farmers to access the rainwater harvesting technologies apart from the community contributory approach used in this project.

Further, it is noted that in planning and designing rainwater harvesting, consideration should be placed on existing policies and ordinances that govern various land-use practices and infrastructure development (Lazaro *et al*., 2000). Yet, present water policy documents and frameworks of the Malawi Government such as the Strategic Plan for the Ministry of Water Development (2003-2006), Water Policy of 2005 (which is a revision of the 1994 and 2000 policies), the Water Resources Act (1969), all remain inexplicit on water harvesting. The work reported herein and other works remain persuasive pieces of evidence to argue for policy and institutional reviews towards garnering this important water resource.

It is also noted that water resources issues touch on the interests of many people and institutions. This project attempts to model processes that will enrich the planning of water and sanitation programmes and projects with rainwater harvesting components. Based on these observations, project activities towards synthesizing a framework for scaling up rooftop rainwater harvesting were assessed.

5.2 Methodology

A questionnaire was prepared and administered to six individuals (three women and three men), at Kauma and Mchezi orphan care centres. A check-list of questions was also prepared and administered to two key informants, namely, the coordinators and a committee member of the centres, respectively. The check-list was also administered to a focus group for discussion. The study evaluated the project based on methods used elsewhere using criteria that include: suitability of the technology, required maintenance and operational skills, environmental and health impacts, and cost. The study also invited stakeholders that included: policy makers, NGOs, CBOs, institutions, civil society and others for an exhibition tour and assessment of the project using a different format of the same evaluation criteria. The stakeholders scored on a scale of 1-5, each evaluation criterion against a narrative by the beneficiaries and iterative exchange between the two, and their own informed judgement.

5.3 Results

5.3.1 Adequacy of water

At Mchezi, the beneficiaries indicated that they started drawing water from the tank in May 2006. Water was being drawn for use at the orphan care centre only. In August, the tank was open to all other users. Each household was allowed two 20-litre pails per day. The water lasted till the second week of October 2006. At Kauma, the beneficiaries started drawing water in September 2006 and the water lasted for only six weeks. Each household was allowed up to five 20-litre pails per day. All beneficiaries indicated that the water was barely sufficient for their household needs although they mostly had stopped drawing water from other sources. To make up for any deficits, they drew water from the river and wells since there was very little flow at the boreholes and kiosk. During the rains, the beneficiaries drew water from the overflow when the tanks filled-up. They were not allowed to draw water from the tanks through the tap. The beneficiaries were asked whether they thought it was possible to get more water from the rain having seen the rainwater harvesting system that was installed. The most interesting response was from Mchezi where it was suggested that gutters be installed on other roofs and be connected to the tank that had been built. This had been done at Kauma.

5.3.2 Requirements for operation and maintenance

The beneficiaries indicated that the tap for the tank at Kauma needed replacement because it had clogged due to accumulation of waste material. They were able to replace it because there was a spare tap bought by the centre. At Mchezi, the tank wall developed a crack. The users were able to repair the crack after contributing funds for purchase of sealant/cement. It was learnt that the tank at Kauma filled up once while the one at Mchezi filled up three times. They effectively used the overflow by capturing it in drums. When asked whether there were any problems faced by women, the aged or disabled, or any member of the community in ability to draw water from the tank, the beneficiaries indicated that none of the members had experienced any problems.

5.3.3 Permanence of structure and risk of failure

The beneficiaries were asked about the ease of work and durability of the brick and mortar tank during and following construction. Their responses are captured in Table 5.1. In general; they felt that the systems were well constructed given that reinforcement steel was used in the foundation and tank wall. There were also problems articulated that included concern for the environmental impacts from use of fuelwood to cure bricks.

Table 5.1: Evaluation of the construction and performance of brick tanks

Positive elements	Problems
1. Bricks locally made and cheap	1. Burnt bricks require fuelwood for curing
2. Tank was built strong and looked beautiful	2. Bricks absorb water and can lead to break down of tank if not well constructed
3. Water is clean	3. Requirement of hard and strong bricks difficult to attain
4. Short period of time to construct	

In terms of operational risks, the users were asked if they ever thought the gutters, taps and tank could breakdown while collecting or storing water. Those that thought so felt that pressure of water could destroy the tank while others indicated that they were used to seeing underground storage tanks for water. Those that did not think of breakdown felt that the reinforcements in the foundation and tank wall were adequate to maintain structural integrity of the tank. They had no contingency plans except for reverting back to other sources of water and the constructors if a breakdown were to occur.

5.3.4 Environmental and health impacts

Beneficiaries were asked whether the rooftop rainwater harvesting system had any impact on water conservation and management. They felt that: (a) the system reduced runoff and soil erosion; (b) the system captured rainwater which could otherwise go to waste; and (c) since the tank is covered, the system provides water that is less contaminated and safer. The beneficiaries used the water for (a) washing, (b) cleaning house, (c) bathing, and (d) cooking. At Mchezi, they used the water for drinking as well after treating it with chlorine at a rate of one teaspoon per 20 litres of water. They stated that rainwater was different from other types of water in the following ways: (a) less soap is used; (b) not salty; (c) lighter to the taste and feel; and (d) uses less energy for cooking than other water. There were no incidences of illness arising from use of water from the tanks.

5.3.5 Costs of construction and maintenance

When asked whether the rainwater harvesting system was worth the investment or effort, beneficiaries indicated that it was worthwhile and cited that: (a) they had averted using unsafe water from the wells and river and water scarcity during dry months; (b) orphan children benefited from the water as the nursery school used to be closed during the dry months; and, (c) the facility had lessened the distance to fetch water in view of old age of some of the users. The beneficiaries felt that the contribution by the community or centre was reasonable or affordable. They indicated that, in fact, their contribution of brick, mortar and labour, was far less compared to the total cost of the project. They were willing to pay or contribute to the maintenance cost of the systems constructed as personal and community obligations as well as having seen the advantages of storing rainwater for averting water deprivation in dry months. They pointed out that they were ready to construct an additional (institutional/ community) tank. However, in view of rampant poverty, they stated that the best way to finance this kind of project was to follow a similar approach which further engendered ownership of the facilities. When asked whether they would be willing to pay or invest in the system for their own use at their households, they all indicated a wish to have their own systems. Very few methods were mentioned for financing similar household projects but one that stood-out was the merry-go-round method where groups co-sponsor a project at a time until all projects for members of the group are financed.

5.3.6 Requirements for scaling-out and scaling-up

The beneficiaries were not aware of any individual or centre that had constructed their own rooftop rainwater harvesting system, having seen the system at hand. However, at Mchezi, the centre had recorded up to 1000 visitors that included eight schools and CBOs expressing interest in adopting the technology. At Kauma, the centre registered up to 300 visitors and 10 schools and CBOs expressing interest in the technology.

The beneficiaries were asked to mention any project that had been initiated as a result of the rainwater harvesting system. At Kauma, the centre has constructed a large underground tank to capture runoff to supplement water for irrigation previously harnessed through a solar powered borehole whose water is salty and not suitable for the purpose. At Mchezi, the tank provided water to complement water requirements for vegetable and pig production schemes that had been initiated as shown in Table 5.2.

Table 5.2: Enterprises developed parallel to water harvesting initiatives

Attributes of enterprises	Enterprise 1	Enterprise 2
Type of enterprise	Vegetable production	Pig production
Size of enterprise	10 beds x 3 m^2	2 pigs/ household for 23 households/ kraals
How water was used	Watering the plants once a day from used water	Making feed For pigs to drink
How much water was used	Depended on availability of waste water ~3 water cans (30l) /bed/day	5 litres/day
Economic benefits	Vegetables were fed to livestock, not yet slaughtered for sale	Not sold yet
Social benefits	Not indicated	Potential to assist orphans/ vulnerable households after sales
Environmental benefits	Not indicated	Not indicated

The beneficiaries were asked what they would advise any organization that intended to scale-out this project. They indicated the following:

1. It is a cheap and economic method of storing water because of use of local materials
2. The system can be constructed anywhere and appears adaptable to rural areas
3. There is reduction of soil erosion from runoff arising from built areas
4. It is a way of reducing water-borne diseases once water is well-treated by chlorine
5. The construction is permanent and strong, making it a lasting investment
6. It is an ideal means to avert water scarcity in dry months
7. There are no additional expense accruing from daily cost of purchasing water
8. The distance to fetch water is reduced by having a point source of water
9. Commitment is needed by all members concerned before and after construction

5.4 Discussion

5.4.1 Access to water: the gender dimension

Apart from contributing time and energy to agricultural production tasks, women also manage household activities including the care of family members. The Malawi Government (1994) reported studies which showed that women in Malawi spent almost as much time in farm work (20%) as in domestic activities (23%). Yet, domestic responsibilities are often viewed as deterrent for women in increasing agricultural production. In a study conducted in two villages in Lilongwe, Central Malawi, a man's work day lasted 4-6 hours while a woman's work day lasted 12 hours with household tasks taking 4-6 hours, where gathering firewood and collecting water were the two major time consuming activities carried out by women. It was further reported that women spend 39 days in a year caring for the sick or being sick themselves (Malawi Government, 1994). Perhaps what is further critical to note is that most of the woman's tasks include odious physical work and distance, which must be performed daily with the crudest tools, under the toughest conditions. There is thus a limit to how far women's time and energies can be stretched. When the limit is reached, agricultural production or household needs suffer. Given that not much has been achieved in the area of work load reduction, the roof rainwater harvesting initiative remains a vital option towards reducing drudgery associated with access to water for domestic use particularly, to ease the pressure of work on women.

5.4.2 Adequacy of water

The size of the storage tank to be built will depend on the rainfall amount and distribution, the roof catchment area, anticipated use, the number of users, the estimated daily consumption, the available funds and resources, and the availability and distance to alternative water supplies (Wanyonyi, 2004). In this study, the size of storage was determined by three principal factors: (1) the need to provide for the care centres; (2) the need to sell the technology; and (3) the availability of funds to cater for all the six sites envisaged for the project. However, utilisation, by hindsight may also determine adequacy as was shown in this work.

One of the anticipated consequences of the availability of water from the tanks was resolution on equitable usage of the water. This was left to the centres to negotiate a water-demand management protocol but with the knowledge that the tanks contained 50 m^3 of water. The centre at Mchezi provided water to the centre activities first for three months, and later provided access to households during the critical driest three months at 40 litres per household per day for another three months. In other words, water consumption improved by 40 litres per household per day or from 18 to 25 litres per person per day. At Kauma, the centre provided water to the households at 100 litres per day with the water lasting less than two months. Water consumption improved by 100 litres per household per day or from 27 to 43 litres per person per day. At both locations, it was learnt that in reality, households largely depended on this water during the dry period.

It is evident that the water rationing system at Mchezi was thought through properly and equitably. It is noted that leadership at Mchezi was vested in committee decisions unlike at Kauma where an outreach office backstops committee activities. Further, it should be noted that the water harvesting systems were constructed at centres rather than at households. The average household size at Mchezi is 5.71. The Malawi Government (2002) estimates water consumption of 25 and 30 litres per person per day for public standpipe and other sources, respectively for high density areas. It further argues that consumption rates are generally high for a developing country suggesting wastage as the reason. Using the latter consumption rate, a household in Mchezi would use water from the 50 m^3 tank for 292 days or nine months. Alternatively, given the three driest months in Malawi, a tank size of 15 m^3 would provide 30 litres of water per person per day for a household size of 5.71. It should be noted that the calculated annual total yield of water from the roof catchments at Mchezi and Kauma were 124.9 m^3 and 122.4 m^3 respectively, taking into account long term rainfall characteristics and runoff efficiencies.

While arguably rooftop rainwater harvesting cannot replace conventional domestic water delivery systems, and it is not intended to, it does provide substantial supplemental water both in the wet and dry seasons to meet a shared vision for clean and safe water and with many other spin-off social benefits that conventional systems do not provide.

5.4.3 Affordability of technology

The capital cost of the technology and the associated operational costs are important criteria for its acquisition or adoption. It is argued, however, (Makoko, 2001) that for some technologies, it would not be possible to recoup the capital cost from the end-users themselves and some alternative financing mechanisms are necessary in order for users to access the technology if it is considered suitable. Makoko (2001) further argues that for certain technologies, the operational costs, besides affecting the profitability of an enterprise, are influenced by the knowledge, skills and experience of operators and tend to increase with time. This report considers that it is the capital cost of erecting rooftop rainwater harvesting systems that is pivotal rather than costs of operation and maintenance because of the sedentary nature of the technology. If therefore, the materials and methods for construction are meticulously selected so as to lower capital costs, these systems appear a cost-effective lasting investment for accessing water. A number of innovative ways of funding construction of water harvesting systems have been attempted and are illustrated below and do show that these systems are within the means of communities.

The familiar cost-sharing approach at funding water harvesting projects was employed in Laikipia, Kenya, where 700 tanks of 6 m^3 or 10 m^3 were built in one year (Mbugua, 2003). The arrangement was through a partnership between local groups and a development agency where the agency contracted a partner in the private sector businesses who specialised in tank construction and was willing to provide technical training to self-help groups. The agency and local groups contributed 60% and 40% of the costs, respectively, with the agency paying for the services of the private sector partner.

In Bushenyi District in Uganda, an NGO, whose role was merely that of facilitating, piloted a project on domestic rainwater harvesting using grassroots democratic structures (Karungi, 2004). The communities met the total cost of tank construction. Three groups of 12 members with structured constitution and committees were identified and guided on requirements and costs for 5 m^3 tanks. However, they were left to negotiate amongst themselves on matters relating to raising total funds for the tanks and construction schedule and other parameters. For instance, members agreed that those that want tanks larger than 5 m^3 were to finance additional costs by themselves, and provide surety for members to access water from tanks that have been completed. These and other parameters are the premises of the merry-go-round approach to cost-sharing which even beneficiaries at Kauma used in construction of their houses at the orphan care centre, with guidance of the church.

Another approach used by women groups in Rakai, Uganda, is the raising of a savings programme known as a kitty (Rugasira *et al.*, 2002). The kitty-approach is where members contribute money and each month the kitty is given to one of the members in rotation for construction of a tank (and other activities). Other bylaws and agreements are developed to guide the group.

These approaches illustrated here are not by any means a panacea for technology scaling out in Malawi. However, the fact that these groups functioned well and had water harvesting systems to show means that communities have great potential that can be activated by development workers and donors without recourse to thinking (about affordability of a technology) on their behalf.

5.4.4 Health aspects of rainwater capture and storage

Access to good quality water is one of the most important factors that determine the public health status of people all over the world. Mbaka (2004) observed that water-associated health hazards are either biological or chemical, following ingestion of contaminated water or other material. In this study, owing to technical reasons, no determination was made of biological and chemical contamination of rainwater stored. However, studies elsewhere, such as in the peri-urban areas of the City of Nairobi, Kenya, showed that most water tanks were improperly designed, located and erected such that faecal contamination of the harvested water from wind-blown dust contaminated by humans, livestock, rodents, birds and other organisms had occurred. During the study, 73% of the samples collected failed the Kenya Bureau of Standards requirement for un-piped drinking water. It is therefore important that in order to safeguard public health, rainwater, just like other sources of water, be treated before consumption. The beneficiaries at Mchezi location in Lilongwe treated their water before utilization while those at Kauma indicated that they did not treat it because they did not use it for drinking. This justification was not adequate because adults cannot at all time monitor children who may be inclined to drink the water.

5.4.5 Grassroots governance structures and water and livelihood nexus

This evaluation study revealed different responses to the rainwater harvesting project based on differences in leadership and governance structures but with singular results. While previously there was no theme on water within the operational plan of the orphan care centre at Mchezi, upon inception of the project, the executive committee identified a sub-committee to look after water and sanitation issues and to work with the technical experts on the rainwater harvesting project. All members of the committees are volunteers with no salaries for their labour and other resources. The structure of committees, while sounding bureaucratic, appeared to have brought a sense of purpose and unity to members. They are not directly supported by any NGO or faith community but they solicit funds from various sources as an independent community-based organisation or contribute funds as community action. The centre is thus home-grown and looks after itself. In like manner, they financed their part contribution to the cost of constructing the tank as well as subsequent maintenance work undertaken. Using other sub-committees, the centre initiated parallel projects on vegetable cultivation and pig rearing to benefit from availability of water from the tanks. The water harvesting initiative attracted visitors and benefactors such as LEAD Southern Africa (www.lead.org), Sasakawa Global 2000, Monsanto, Plan International and Care International.

At Kauma, the project worked through paid employees for the care centre which is supported by a church. The community contributed their labour during construction of the tank but materials were provided by the church on behalf of the community. However, the centre has a large winter cultivation project and a poultry project where the orphan care community was heavily involved during construction of the tank. Owing to problems with brackish water being used for winter irrigation coming out of a solar-powered borehole, an underground tank has been built to capture all surface runoff from the centre to be used for irrigation. Expertise for winter cultivation was drawn from an international NGO, Sasakawa Global 2000, while that for construction of the underground tank was obtained from the Department of Land Resources Conservation.

The project provided a discussion forum on the hydrological cycle and its relationship to rainwater harvesting; on the project and other technologies and their linkages with livelihoods, and provided pictorial handouts on water harvesting technologies and the strategic plan for the Rainwater Harvesting Association of Malawi. It is satisfying therefore, to note that both centres have satisfactorily attempted to add value to the technology by engaging in socio-economic activities related to food and income security with water harvesting acting as a spring-board. This is what is contained in the handouts given and the discussion forums held. More importantly perhaps, their vision and direction are in concert with what the project had envisaged.

5.4.6 Evolution of an institutional and policy framework

The Africa Water Vision 2025 suggests that scarcity of water in Africa is not entirely due to natural phenomena (UN-Water/Africa Secretariat, 2004a). It suggests that it is due, in part, to low levels of development and exploitation of water resources even though there is a growing demand for water in response to population growth and economic development. The basic challenge is providing increased water supply to meet the various end use needs, mainly through increasing the capability to harness the flow and stock of available water resources, while improving the quality and efficiency of utilisation of water resources (UN-Water/Africa Secretariat, 2004b).. The main task for any institutional and policy framework is therefore, the need to meet individual, community and livelihood needs in a sustainable manner that conforms with the requisite technical, hydrological, environmental, economic and social and legal conditions. The following five lessons from this work highlights the parameters and bounds for establishing frameworks for integrating rainwater harvesting in multi-sector development of water resources for domestic use.

Knowledge base and capacity of decision makers and practitioners

It is argued that policy on its own is of little value without the political will and the resources to implement it. The corollary is that plans and strategies without policy tend to be haphazard and subject to the changing fashions of the development and donor agencies (Ngigi, 2003). In Malawi, there is evidence that the Ministry responsible for water supply and irrigation has adopted and included water harvesting as integral to the National Water Policy (Malawi Government, 2005). The objective of such policies should be that water harvesting initiatives and innovations need to be supported and improved, especially on various aspects that need standardisation. For this, team work and collaboration is required from several sectors and departments. They include those concerned with the physical environmental situation, technical soundness, socio-economic, and cultural aspects, all of which influence adoption and implementation.

Scientific capacities to study and monitor rainwater resources

The function of scientific study is to create innovations through research (knowledge creation, organization and management) and outreach. The present limitation in integrating water harvesting in conventional water supply programmes and projects in Malawi, like elsewhere, is linked to inadequate capacity for the collection, assessment and dissemination of data on how to achieve the integration in the development, planning and implementation of projects for the built environment. Studies should be consultative to ensure that research outputs remain relevant to national and regional development needs. In the context of this work, the aim would be to provide research services that promote equity, efficiency and sustainability in harnessing rainwater resources. Often research has been rather slow to adapt to changing demands in the development process owing to declining funding sources. There are also inequalities in the infrastructure and variant competence of the human resource to drive the transformation. This therefore requires resource mobilization and rationalization to exploit existing and potential opportunities that exist in present research establishments and other partner institutions engaged in civil works.

Capacity-building networks and financing mechanisms
One of the major constraints in the development of water resources in most of Africa has been identified as inadequate human and institutional capacity. Most countries do not have an adequate number of highly motivated, innovative, and skilled water professionals who can deal effectively with the complex issues of water scarcity. This project has attempted to achieve synergy and complementarity with emerging research and capacity building networks in implementing a key initiative in peri-urban areas.

In Malawi, the Malawi Water Partnership, a member of the Global Water Partnership, and the Rainwater Harvesting Association of Malawi, were established in 2001 and 2003, respectively. They both are programmes addressing research for development and capacity building, with the latter emphasising harnessing of rainwater resources. Perhaps what is critical about such networks is that they unearth vision drivers that spur governments, development partners, and the end users, into innovative thrusts towards the direction and speed of water resources development for now and the future. These networks need to be supported at policy and institutional level, and through increasing financial commitments towards achieving national anchoring of water resources development reforms and innovations.

Awareness of ethical, historical, cultural and social dimensions of water
Another important lesson from this work is where the question of 'who is responsible' for the water facility was no longer relevant as is the case with municipal water. Construction of the roof top system was rooted in recognition of ethical, cultural and social systems which created opportunities for response paradigms that were rooted in local relevance and ownership, and sound grassroots partnerships. It is often feared that poverty is the number one socio-economic factor that inhibits investments in water resources development by local people. Contrary to this, water harvesting was seen as a point of entry to better and extended management and care of orphans, reduction in the number of hours spent fetching water and the associated disruption of daily household and social calendars, and better management of households by the HIV/AIDS infected and affected. Rooftop water harvesting is indeed a cross-cutting and important driving force that governments and development partners can harness for the water vision for themselves and for Africa.

5.5 Conclusion

First, this project has shown that it is possible to short-circuit the processes behind water deprivation in poor households by investing in available technological and sociological resources. Thus, it is concluded that it is not necessarily the number of people water is made available to or the number of months that water is made available through water harvesting but the processes that contribute to unavailability of water where rainwater can arguably avert water deprivation for the vulnerable populations in peri-urban areas.

Second, the harvesting and supply of good quality water will depend on the formulation of sound policies that regulate the health aspects pertaining to the design, management, protection and utilization of not only the roof catchments but also the conduits of supply and receptacles in which the harvested water is stored. Regular monitoring should be carried out to determine the health quality of harvested water.

Third, it is noted that one of the gauges of a community's acceptance of a new idea is the willingness to participate and cost share. It was noted that in all the situations where the idea of cost sharing was introduced in the project, it was readily accepted and the part to be contributed by the community members was deemed to be within their reach. This is important for participatory technology development and promotion of innovation.

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