CRANFIELD UNIVERSITY

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Water Supply in Ndirande.
A case study of a peri-urban community in Blantyre, Malawi

School of Applied Science
MSc Thesis: Water Management
Option Community Water and Sanitation

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This thesis is submitted in partial fulfilment of the requirements for the degree of Water Management

ABSTRACT

Access to water and sanitation can lift people out of poverty by improving health and releasing resources to engage in income generating activity. The purpose of this study is to investigate the current water supply situation in the peri-urban community of Ndirande in Blantyre, Malawi and make recommendations for action by a small NGO. Within the specific context of water supply in Blantyre, the research aimed to identify key stakeholders both in the profit and non-profit sector, understand demand by discovering what water sources were being used and what for and finally to identify feasible water supply solutions. The research strategy is that of a case study to gain an understanding of the complex water and sanitation issues facing the people of Ndirande and assist in developing a strategy of water intervention that has both impact and sustainability. The study carried out a transect walk, 4 semi-structured interviews with stakeholders, surveyed 48 households and conducted 12 Water Source Assessment & Sanitation surveys. It was found that 85% of those surveyed had access to water kiosks though unimproved water sources were still in use. Both sources have a high risk of contamination due to poor sanitation, drainage and animal waste. Most water is sourced from Blantyre Water Board (BWB), however the current infrastructure is struggling to keep up with demand and there are periods where water is not available. The community has developed a number of coping strategies to manage periods without water and perceived poorer water quality. BWB faces growing pressures from a growing population, demands to increase coverage, increasing consumption associated with rising living standards and water losses. Under this scenario, water scarcity is likely to increase and areas increasingly affected by water rationing and disrupted supply. Key recommendations of this study are that further support is provided for water storage at both the community and household level and for water treatment at the point of consumption.

Keywords:

Water utility / demand / coverage / water usage / coping strategy

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LIST OF ABBREVIATIONS

BWB	Blantyre Water board
CBO	Community Based Organisation
DFID	Department for International Development
NGO	Non-Government Organisation
MDG	Millennium Development Goals
OFID	OPEC fund for International Development
WUA	Water User Associations

1 Introduction and Literature Review

Despite the efforts of the Millennium Development Goals (MDG's), it is estimated that globally 'Over 780 million people are still without access to improved sources of drinking water and 2.5 billion lack improved sanitation' (UNICEF, 2012). Access to Water and Sanitation can lift people out of poverty by improving health and releasing resources to engage in income generating activity (WHO, 2008).

Malawi is a small densely populated country with a rising population and increasing urban population. Despite overall an overall WATSAN coverage level of 83% (UNICEF, 2012), peri-urban areas still face poorer water quality and insufficient, limited access to water.

1.1 Water Supply - Blantyre

Blantyre is the second largest city in Malawi and arguably its business capital. The city has an established water governance and water supply infrastructure. Water supply is managed by the Blantyre Water Board (BWB), part of a national network of Water Boards under the control of the Ministry of Agriculture, Irrigation and Water (IWRM). BWB sources 90% of its water from the Shire River, which flows from Lake Malawi. Water is pumped from Walker's Ferry on the Shire River via the Chileka pumping station over a distance of 40km to an elevation of 800m (approximately); the remaining 10% is sourced from the MUDI reservoir (AFDB, 1992). Water is treated at both Walker's Ferry and the reservoir on a regular basis by the Water Board before being pumped via a piped network system to users (BWB 2010, AFDB 1992).

In approaches to serving the poor, the Dublin principles marked a movement away from supply driven to the demand-driven interventions to increase the sustainability of a WATSAN project (Matthews, 2006). This approach was widely adopted by governments and institutions e.g. World Bank and is reflected in the current water supply policy of the BWB. (IWRM, 2007 and World Bank, 2004). In the past, BWB had engaged in supply driven initiatives

(sometimes called ‘predict and serve’) where typically a massive amount of money was invested in infrastructure to serve the poor. For example, in Blantyre, after the commissioning of the MUDI scheme in 1953, demand increased rapidly, this led to the need for further developments such as the pump station at Walkers ferry. Due to the inability of cover its all of its costs (including borrowing), poor cash flow and inability to invest, the existing infrastructure fell into disrepair (AFDB, 1992). Brikke (2002) defined cost recovery as one of the keys to water utility sustainability and this was largely echoed by Rogers (2002) and OECD (2009). However, the challenges of setting appropriate tariffs to maintain service providers versus affordability have been recognised (IRC, 2003 and OECD, 2009) and still remain. Coats et al (2004) argued that the long term key to serving the poor effectively is a fully operational and sustainable water utility that is run along business lines. According to the BWB’s 2010 financial statements it is making a net profit, however its operating expenses exceed its revenue and it suffers from poor cash flow which restricts its ability to borrow to invest in its infrastructure (BWB, 2010).

1.1.1 Ndirande

The urban poor of Blantyre are mostly located in a slum outside the centre of the city in a peri-urban area called Ndirande. Coats et al (2004) identified the poor as low income consumers, distinct market segment, requiring different needs and services. BWB have expanded coverage into low income areas by working with NGO partners e.g. Water for People and private contractors by offering different type of water supply services such as water kiosks and private stand posts (BWB, 2010). In Ndirande, the water kiosks are commercially operated with water being pumped to the kiosk where a contract exists between the water seller and the water authority. The vendor then sells the water on at a higher price to those who wish to buy the water. This method reduces investment required to give wider access to water and attempts to ensure that water source (kiosk) covers its operation and maintenance costs and the water itself is managed sustainably. Water Kiosks are often managed privately or by

Water User Associations (WUA), (Water For People, 2012). However, whilst such as approach had been successful increasing coverage, more information on the quality of water at the point of consumption, ease of access to water sources, use of other competing water sources, quantity or continuity of supply is required for those who live and use water in Ndirande.

1.2 Research Focus

This research will focus on the understanding the current water supply situation in Ndirande, Blantyre and make recommendations for action by a small NGO. The study will focus on understanding the different stakeholders in particular the water users of Ndirande so an effective WATSAN intervention and improvement can be made.

Specifically, within the context of water supply in Blantyre, Malawi, the objectives of this research are:

1. Identify key stakeholders both in the profit and non-profit sector
2. Understand demand by discovering what water sources are currently being used and what the water is being used for
3. Identify feasible water supply solutions that meet Water and Sanitation for the Urban Poor (WSUP) water supply guidelines (WSUP, 2011)

WSUP guidelines are appropriate as they aim to create affordable, high quality (access, quantity, and water quality), profitable and sustainable water and sanitation services as an outcome of forging greater cooperation between different stakeholders in areas similar to Blantyre.

1.3 Identifying Stakeholders

The first two objectives of this research were chosen as a result of the evolving attempt to ‘synthesis’ all that had been learned into a single strategy for WATSAN development. Harvey and Reed (2004) identified understanding the following as crucial to a successful WATSAN project:

- Policy

- Institutional arrangements
- Financial and economic issues
- Community and social aspects
- Technology and the natural environment
- Spare parts supply
- Maintenance of systems
- Monitoring

Matthews (2006) argued the above were the 'building blocks' of a project. However, taking the concept of 'building blocks' for a successful project, Carter (2004) asserted (after comparing different projects with the same building blocks but different outcomes) that it was not just the building blocks that were important but how they are applied. Matthews (2006) called this a *holistic* approach which recognised the role of stakeholders and their need to be identified, their interests and influence assessed and then appropriate action taken to engage them in the WATSAN intervention to ensure a successful, beneficial and sustainable outcome.

1.3.1 More Stakeholders

The demand driven approach to WATSAN solutions expanded the idea of stakeholders from policy makers, engineers etc. It did this by recognising the role of people's participation (particularly women) and community management in successful WATSAN interventions (Narayan, 1995). This change has been coupled with the attempt to adopt successful commercial and marketing approaches of developed world utilities to low income developing world utilities such as BWB (Coates et al 2004). Both these shifts led to the identification of the peri-urban poor as both low income consumers and stakeholders, the acceptance of the need to tailor water services to them, innovations such as private and public sector partnerships and the need to identify other potential

stakeholders such as NGOs, WUAs and water vendors (Coates et al 2004; Water For People, 2012)

1.4 Understanding Demand

BWB is committed to improving water coverage for the low income poor and it's using a marketing approach to achieve this (BWB, 2010). Coates et al (2004) identified 8 technical methods of water service delivery to low income consumers (See Annex A1). BWB when reviewing its customer value chain (*know, target, sell and service*) differentiated its service using those technical solutions. These water services represent a *product mix* to meet the different types of demand that exist within the community. The aim was to increase coverage to align ultimately with the MDG's. However, Carter (2004) raised concerns about the reliability and validity of targets as coverage. UN/UNICEF/WHO (2012) reiterated these concerns urging caution as coverage targets often mask issues with water quality, cost and access that have varying degrees of impact on those in the community.

1.4.1 Benefits of Understanding Demand

A more detailed understanding of demand in Ndirande may identify vulnerable groups within the low income group that the utility is trying to serve through its range of services and give a clearer understanding of impact and sustainability of current and future initiatives. Carter et al (1999) suggested that without an understanding of impact and where impact was inadequate real consequences could not addressed. Also, the impact of initiatives is often not uniformly felt; DFID's (2000) definition of poverty suggests different reasons for poverty which establishes the poor as a non-homogenous group whose needs may have to be approached differently as they can often experience one or several dimensions of poverty (See Annex A2).

2 Methodology

2.1 Research Strategy

The research strategy adopted was that of a case study. The reason this strategy was chosen because a deep understanding of the WATSAN issues facing the people of Ndirande is required if a strategy of water intervention is to produce that has both impact and sustainability. Yin (2003) stated *'a case study is an empirical inquiry that 1) investigates a contemporary phenomenon within its real life context, especially when 2) the boundaries between phenomenon and context are not clearly evident'* and though not explicit in this quote Yin's work demonstrates that the case study approach requires both depth and time consuming analysis. This research is concerned with the in-depth study of WATSAN in the context of a peri-urban slum. In the slum it's not possible to isolate one variable such as water supply from other issues such as sanitation, community and the environment. They act on and influence each other, for example, Carter (2004) discussed that issues of poverty so closely associated with WATSAN could not be described as a '*problem tree'* with clear cause and effect but a 'bowl of spaghetti' that touched on many aspects of life. The case study is suitable strategy because it seeks to understanding the complex interaction between the phenomenon WATSAN, people and environment. This lack of separation and the attempt to understand the phenomenon in contemporary timeframe distinguishes it from other strategies such as experiment and historical as the most appropriate approach to achieving the project objectives.

2.2 Primary Data

Objective 1: Identify key stakeholders both in *the profit and non-profit sector*

2.2.1 Observation Walk and Informal Discussions

Preliminary observations and discussions were made to acclimatise to the environment, general orientation of the area and also to discover some of the WATSAN issues that were there. This researcher had the opportunity to talk informally to locals and clinic staff to get a better understanding of Blantyre society, local culture, political and institutional context. It was also an opportunity to explain the purpose of the research and get their views on what the issues were.

2.2.2 Rough and Resource Mapping

Desai and Potter (2006) suggests that a rough and resource mapping should contain all features such as roads, public buildings, natural features etc. as it would provide a useful context for those taking part in the project. However, it also suggested that in a peri-urban area the size of Blantyre and with the limited resources that a comprehensive resource mapping would not be feasible project. Nevertheless, both methods could still be used to highlight major features e.g. river and WATSAN sites. An attempt was made to get hold of an area map locally but none was available. The map was drawn roughly by hand and was not to scale.

2.2.3 Semi-Structured Interviews

Structured interviews were rejected as the purpose of the interviews was exploratory, so semi-structured interviews were conducted with a number of stakeholders because they allowed for more flexible approach that allowed a more natural flowing interview and for the interviewer to adapt when new or unexpected information became available (Robson, 2011). Four semi-structured interviews were conducted with representatives of BWB, USAID, the manager of a local health clinic and a local businessman. The aim of the interviews was to get some background knowledge about the Ndirande community and the civic environment. It was also useful to get their views on what they believed were the issues with water supply in the area. The interviews enabled this

researcher to triangulate data and discover some inconsistencies between what is known between the different stakeholder groups.

Objective 2: *Understand demand by discovering what water sources are currently being used and what they are being used for*

2.2.4 Water Usage and Coping Strategy Survey

Coats et al (2004) encouraged the use of consumer surveys to get to know the different current and potential consumer groups arguing so that water services can be delivered more effectively when consumed groups are known and understood. This was supported by Hooley's (1998) study which asserted that in general high performing organisations tended to have a greater marketing focus. The survey's (see Annex A5) purpose was to know and understand the low-income consumer group in Ndirande and was based on the consumer survey format produced by Coats et al (2004). The survey was designed to assist in understanding water use and buying habits (particularly in terms of service options). Pederson (2002) argued '*survey methods are an effective tool in collecting objective data, but "weak and wasteful" in collecting subjective and attitudinal data, particularly when dealing with illness beliefs and health behaviour'*. This was agreed and accepted by the researcher so survey was adapted to elicit more subjective and attitudinal data in addition to any data being evaluated alongside other more qualitative methods e.g. observation to ensure reliability and validity. For reliability and accuracy the survey was enumerator led (Coats et al 2004). Forty eight households were interviewed along a transect, at approximately 25 metres apart accept on occasions where we were invited by the householder themselves.

2.2.5 Water Source Assessment & Sanitation survey

Water Source Assessments & Sanitation surveys (See Annex A6 and A7) were used to identify water sources and assess current water sources and were based on. indicators identified by Howard (2002). Howard (2002) argued that the quality, cost and reliability of water could change over short time and distances. In terms of water quality he argued that '*We need to consider the quality of water within the whole water chain and not simply at sources'*. No

microbiological analysis was carried out on the water sources and quality of water was not assessed in terms of appearance, taste or colour despite these being a significant impact on choice. The surveys focused on assessing with each water source the risk of contamination and indicate where in the water chain that contamination could occur. Quantity and reliability were assessed as they often had an impact on choice of the amount of water taken from a source and lack of available water being associated with use of unimproved water sources. Both surveys gave a view of the entire water chain so that effective interventions and improvements could be identified.

2.2.6 Sampling population

The target population of the study are those that inhabit the Ndirande area of Blantyre, a random stratified sampling approach. Those interviewed were divided into identifiable groups (strata) based on the geographical location. This sampling approach was taken because the poor are not a homogenous group in terms of income, education, gender, religion and ethnicity; Ndirande itself was a mixture of informal & formal development, with a varying topography and levels of service. This data was collected as part of a Transect Walk whereby this researcher targeted different geographical areas to discover water usage and coping strategies of the target group, assess the range of water sources, sanitation facilities and any associated problems in the physical area. The Transect Walk acted as a useful data triangulation tool of data and as such was useful tool for the purposes of verification and appraisal.

2.2.7 Definition of drinking water and sanitation

The WATSAN sites were the assessed against the characteristics of improved and unimproved drinking water sources and sanitation as defined by the WHO and UNICEF (See Annex A3) so that a baseline assessment could be made of WATSAN conditions.

2.3 Limitations of Methodology

2.3.1 Practicalities

It often took time to arrange meetings despite having mobile phone. It was also difficult to arrange meetings as the internet connection was often lost and would not come back on line for several days.

2.3.2 Language issues

Initially, it was felt that language would not a major obstacle to the project as English was widely spoken in Malawi. However, it became clear quite quickly that this researcher's accent was causing issues with people not understanding everything that was said. Due to security issues, this researcher was to be escorted at all times in the slum but individuals were then selected on the basis of their language skills so they could act as translators into the local dialect. However, after a false start with one translator who disappeared and did not come back, this researcher did have a regular translator who it was possible to establish a rapport with and eventually ensure that those questioned understood the survey.

2.3.3 Water Usage and Coping Strategy Survey

48 household surveys were conducted. Having only one researcher to conduct research was a limitation to the project. However, the project was exploratory and having a single researcher supported flexibility to act when new information was discovered e.g. existence of an open, unprotected well. Also, it helped to identify weaknesses in the survey with one question in particular being amended to try and draw out more effectively consumer views.

2.3.4 Household surveys

A household sanitation section was part of the overall household survey. The survey was asked at the end of the survey and one or two users feeling a little insulted by the questions, particularly around cleanliness, being asked.

2.3.5 Potential Bias

Efforts were made to limit bias in the data collection by developing an adequate sampling strategy and a sample size (48 respondents out of a population of 118,000) which though small allowed sufficient depth within the time available to inform sufficiently challenges that the community faced. Triangulation used to add rigour to the researcher. However, bias remained in the data collection the study was conducted during the day for safety reasons. This meant that potentially some groups such as single working mothers who may not have been available during the day would not given the opportunity to participate in the study. Also, this researcher was often reliant on translation of responses that may have introduced bias where a misunderstanding or conflict of interest could have been introduced.

3 Results

The results presented are generated from data collected in Blantyre, Malawi between the 14th September and the 1st October 2011.

3.1 Rough and Resource Mapping

A rough map was drawn of the area by hand to get a feel of the major features of the area.

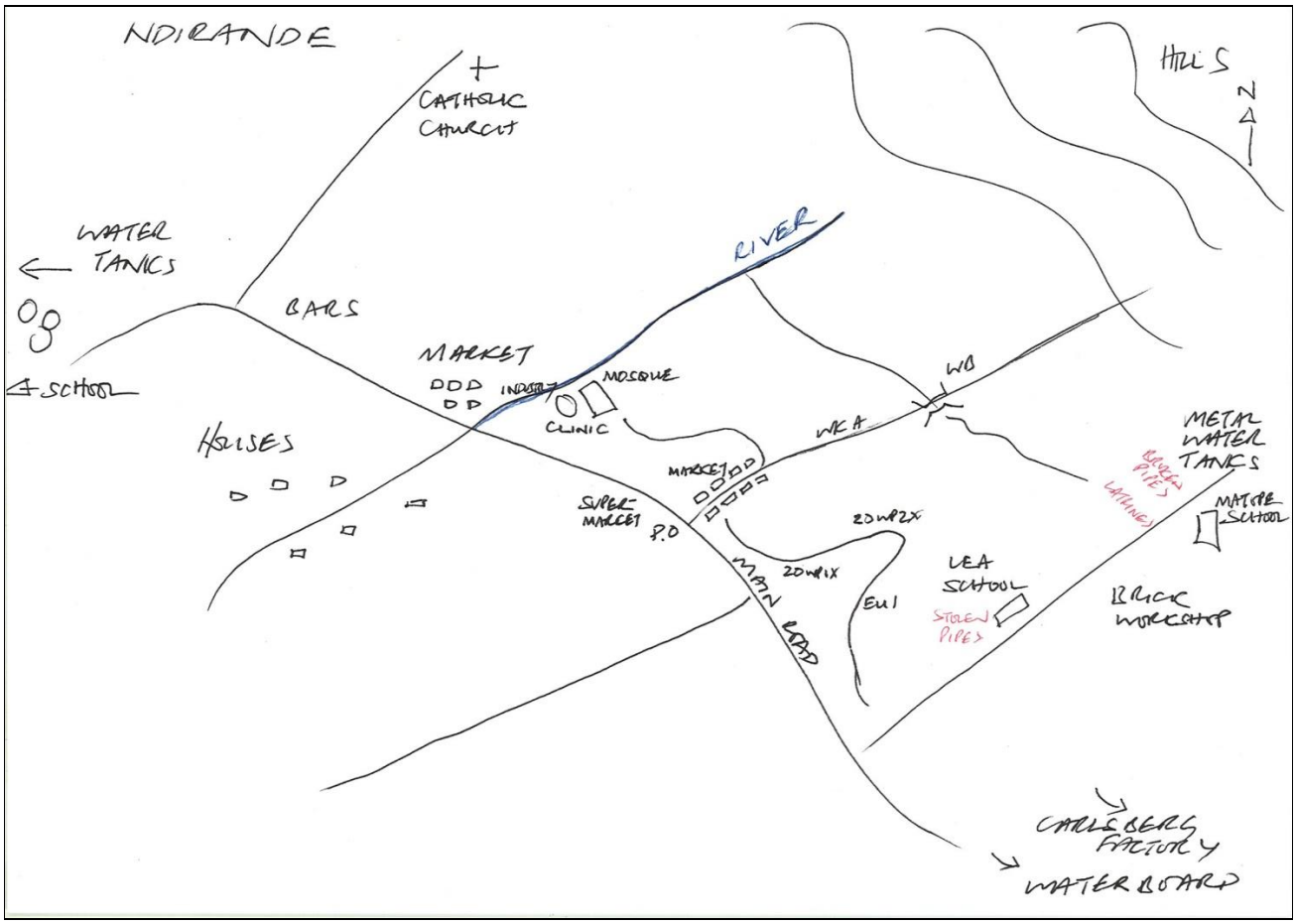

Figure 1: Rough map of Ndirande

Transect & Observation Walk and Informal Discussions

3.1.1 Water Supply

Ndirande has improved water sources such as water kiosks and public tap posts supplied by piped water supply by BWB (see figure 2)

Figure 2: Women at a Water Kiosk

Figure 3: Water tanks supplied by BWB

Water from the BWB is pumped to two sets of water tanks (see figure 3). A common complaint was that water was unavailable for hours or several days at

a time. CBO's had developed coping strategies such as boreholes and storage tanks to manage periods without water (see figure 4)

Figure 4: Water storage tank at local school

However, some CBO's efforts to manage periods without water were undermined by instances of theft and sabotage. For example, the school were able to show this researcher where pipes had recently been stolen (see figure 5).

Figure 5: Pipe work stolen at local school

The overall condition of the infrastructure varied with broken and exposed pipes visible. Leak detection processes, the ability to report to broken pipes to BWB using a telephone helpline and a declared target of average repairs being fixed within 4 hours repairs do not appear to be effective.

Figure 6: Children taking water from broken pipe

The broken pipe (shown in Figure 6) was being used as a water source and was exposed to contamination from nearby latrines (see Figure 7).

Figure 7: Latrines situated close to broken pipe being used as a water source

This researcher saw illegal connections to the water supply which BWB's patrols are supposed to eliminate. Of particular concern was the failure to control access to the ground water supply, for example, this researcher

discovered illegal but well-managed, sealed boreholes but also a totally exposed private open well (see Figure 8) all of which appeared to exist without challenge by BWB.

Figure 8: Private owned open well

3.1.2 Unimproved Water Sources

Unimproved water sources such as the local river springs were being used as a water sources despite the risk of contamination and the availability of other improved water sources.

Figure 9: Local River being used for washing and bathing

Figure 10: Women taking water from spring

3.1.3 Risk of Contamination

There was poor management of solid waste. The river itself was clogged with rubbish, animals roamed freely nearby and local businesses operated alongside the river.

Figure 11: Latrine that backs directly on to the river

There was open drainage, which was often leaking or blocked by rubbish. According to locals, the river and drainage systems would flood during the rainy season potentially contaminating the water supply where exposed.

3.1.4 Water Source Assessment & Sanitation surveys

12 water sources were surveyed, all were communal. 17% belonged to local schools, a further 17% belonged to CBOs, 42% were privately owned and the remainder not owned. 33% of the sources surveyed were unimproved – these were either privately owned or not owned. 100% of CBOs water sources were improved, as were 80% of privately owned sources and 100% of water sources belonging to local schools (both of which were free to children but allowed members of the public to use the water source at a charge).

Ownership	No of Water Sources	% of Water Sources	% Improved
CBO	2	17%	100%
No One	3	25%	0%
Private Owner	5	42%	80%
School	2	17%	100%
Total	**12**	**100%**	**66%**

Table 1: Water Source ownership and Assessment status

Efforts were being made to maintain the water source infrastructure by private owners, schools and CBOs. At 75% of water sources the caretaker/supervisor was able to identify those responsible for cleaning, repairs and maintenance of the source. Of that 75% only 11% were able to indicate planned maintenance, the rest did not know (67%) or said 'as needed' (22%). 50% of all water sources had been repaired , a further 25% were recent installations in good condition so no work had been carried out. Communal water sources that were not owned were not maintained or cleaned.

3.2 Semi-Structured Interviews

3.2.1 Manager of Health Clinic

There is established civic life with a number of CBOs built around the religious organisations. Relationships between the different communities in Ndirande are good. The CBO's often take action for City Assembly responsibilities as they are

often considered slow to act. There are no water committees but there are WATSAN programs. People influence what happens with their communities through the political system. Ndirande attracts a lot of politicians because of the number of voters. There is law and order in the community and it's generally safe during the day, however at night it is more dangerous. This is an issue for women who sometimes have to collect water at night with instances of lone women being raped. The health clinic sees cases of cholera, dysentery, diarrhoea, bilharzia, typhoid and malaria. Instances of disease vary with the seasons being particular bad during the rainy season. Water in the area was a breeding centre for mosquitoes particularly through the rainy season. Water is scarce. Water pressure seems to be the main cause of particularly during the day as people compete with local industry for water. He suggested that this was because the water tankers were on the lower side. Water tends to come on again at night. There are issues with contamination of the water supply. There is corruption in civil and political society in Malawi e.g. water treatment may not happen. Overall the attitude to the aid agencies is very positive as the people have seen the improvements in the area as a result of their projects.

3.2.2 Local Businessman

This businessman interviewed manages a local business that had been involved in civil engineering water projects for approximately 20 years and has worked on projects with the BWB. Projects have tended to be large infrastructure such as pipelines, reservoirs and storage tanks. Donors such as the World Bank, DFID and OFID fund large projects but need to focus more on ensuring long term operational capability (maintenance) and accountability. There was a lull in investment in infrastructure from the late 90s but there has been resurgence in recent years. Water is scarce: more investment is required in infrastructure such as pumping (capacity), maintenance and water treatment to meet growing population (in both formal and informal settlements) and growing demands. Water is being lost at several stages from pumping, storage to pipelines. There is a lack of political will to raise tariffs to sustainable levels (which keep out private providers) an issue that also effects electricity suppliers.

The Water board is adding more users to increase its revenue. Water board has the engineering expertise and do a fairly good job with the limited resources that they have and they have improved over recent years though purchasing control could be improved. However, over last 15 years piped water quality has deteriorated and the prevalence of boreholes (of which no formal record exists) has led to water table being contaminated. The focus is on replacing existing infrastructure which is reliant on large amounts of inconsistent electricity supply and not enough is spent on looking at other catchment areas which are less energy reliant. Security was a major challenge with fuel, steel and cement being stolen. This is addition to problems getting hold of raw materials such as fuel.

3.2.3 Representative of Blantyre Water Board

The board started in 1929, MUDI dam were built in the 1950s but the biggest developments e.g. Walkers Ferry are from the 1960s. Improvements to infrastructure happen in phases last phase was 2000. The existing infrastructure is old e.g. the manufacturers of the pumps no longer exist and they cannot spare parts so they have to have them specially made. Water is pumped up an elevation of 400m to Chileka and then a further 400m to Ndirande (800m lift) requiring a great deal of energy. Electricity costs are 40% of their volume costs (MK 80,000,000, $298,897). The electricity supply is not reliable and there are interruptions to the service. If there is an interruption it can take 3 hours to get water to Ndirande, which is well served compared with Limbe which may take several days to get its water supply back. Most areas of Ndirande have water. There are 3 concrete tanks in Ndirande which hold 14,000 m3 of water pumped from Chileka this pumps water to other tanks in Ndirande. However, there are informal settlements in Ndirande which are forming above the tanks which are hard to supply. There are different tariffs special provision (very low subsidised price for communal kiosks), domestic (household) and industry. Only the industrial tariffs are profitable. The growth in demand is in unplanned areas that pay a subsidised tariff so BWB is continuing not to cover its costs. They have the right to raise the tariff but when the tariff was raised in the past consumption fell (increasing use of less safe water

sources) so they must balance between social and political costs. The BWB works closely with other agencies such as Water for People (responsible for the management to Kiosks) but not with the Ministry of Health. They are piloting private vendors operating kiosks. Water is tested at various points, e.g. Walker ferry, Mudi reservoir and in Ndirande on a daily basis. Boreholes are a threat to the water supply particular if they are connected to the piped system. There is a team that visits areas to find illegal boreholes and closes them. There is a free telephone number and a patrol team that report breaks in the pipes. Sabotage is an issue with valves being closed to divert water, pipelines cut to steal water and pipes stolen for scrap metal.

3.2.4 Representative of USAID

This was a very quick interview but the interviewee queried why the focus was on Ndirande and argued that there were other areas in and around Blantyre that faced much greater water supply needs. The interviewee also advised that locally people used the term ‘Waterguard’ not just for the actual product but for any other methods of treating water such as chlorine.

3.3 Household Surveys

3.3.1 Demographics

A total of 48 households were surveyed. The majority of the respondents (96%) were female and 81% were married, 19% of households were single, women headed households. The average household size was 5.2, 40% were home owners; the mean age was 24 years. The age range of households is shown in figure 12.

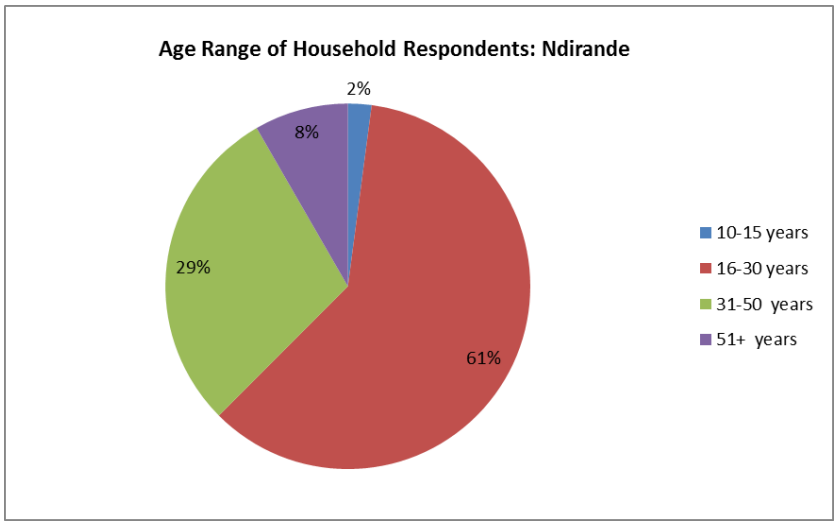

Figure 12: Age Breakdown of Surveyed respondents

3.3.2 Income and Spending Preferences

Income and spending preferences was assessed in terms of ownership of household wealth indicators such as consumer goods such as a TV, Fridge, Mobile phone, cooker, DVD, Radio and access to a garden/yard. 19% of households surveyed owned none of the household wealth indicators identified in the survey (see figure 13).

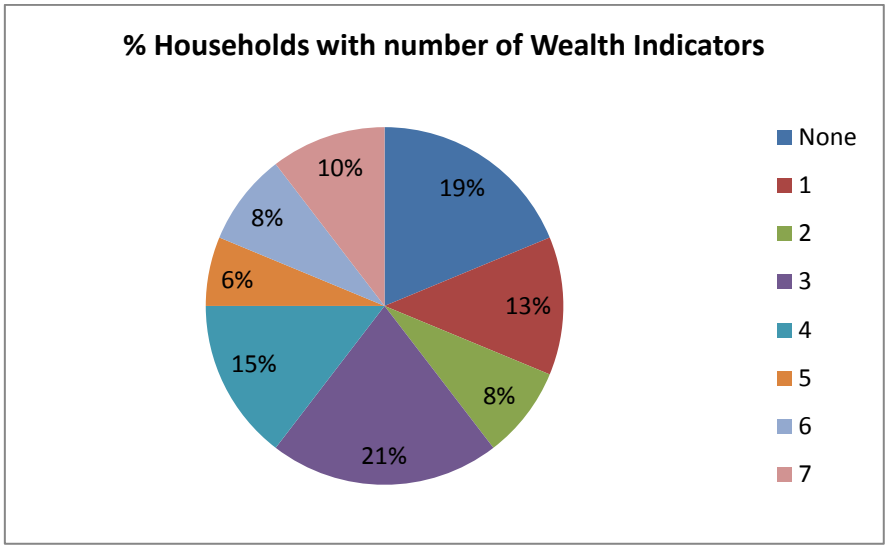

Figure 13: No of Household wealth indicators

Of the 40% of users who had less 2 or less household wealth indictors the most commonly owned were mobile phones (47%), radios (21%) and TV (5%). The most common items owned were TVs and mobile phones (see below).

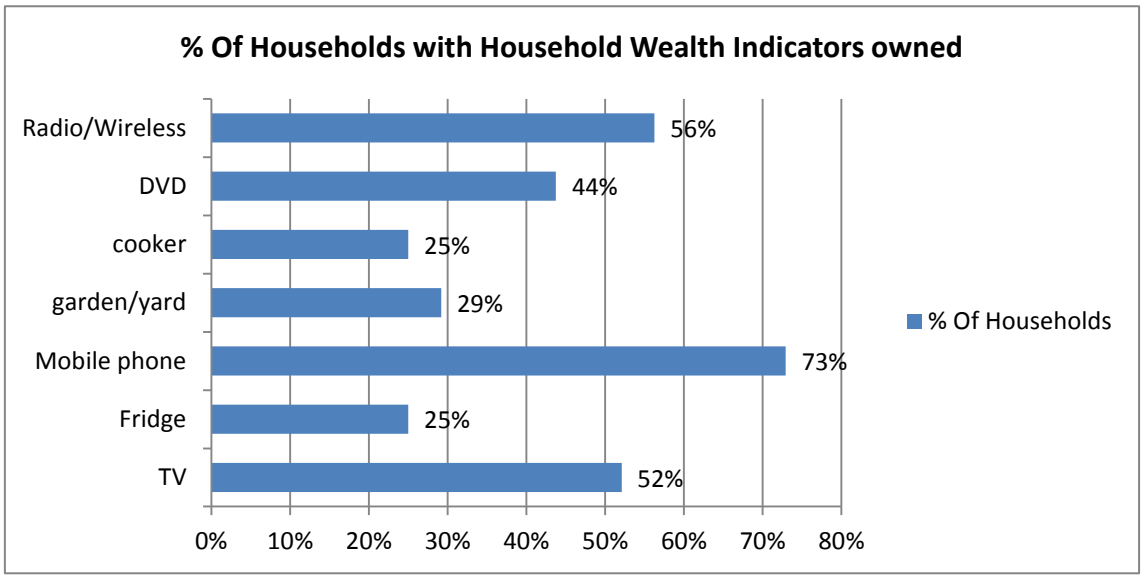

Figure 14: Households - Household Wealth Indicators owned

The least owned item was cooker which would have been expected to be an essential though the researcher did witness households cooking on fires.

3.3.3 Water Collection

Water collection is a predominately female task with 100% of respondents saying that women fetched the water, 40% said that children were also involved. 4% of households stated that men were involved in water collection but this was in exceptional circumstances when water had to be fetched from long distances. All users had access to a piped water source within 500 metres of their home meeting Malawi government guidelines. However, that does not always mean that water was available at that water source.

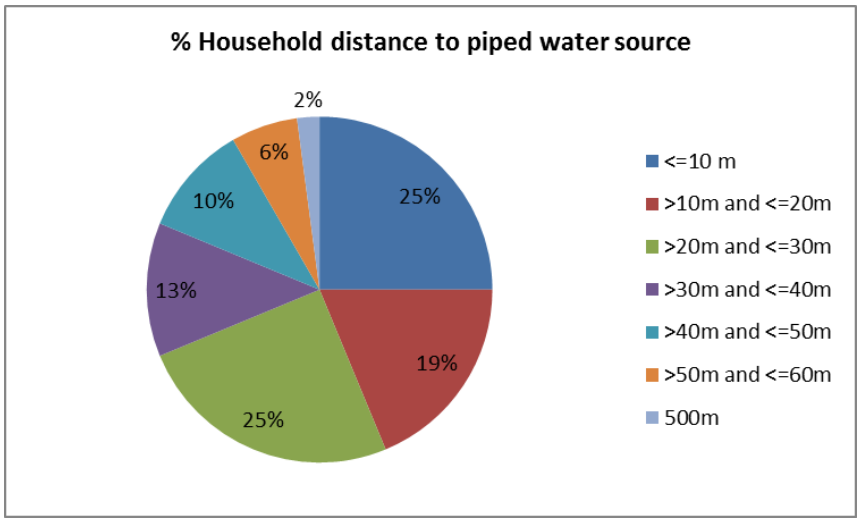

Figure 15: Households distance to a piped water source (metres)

Water availability defined as available water supply per week ranged from 0 to 7 days, with users responding with 'depends' as availability was often seasonal. Average hours available ranged from 2 to 24, with an average time of approx. 12 hours per day and average time to collect water ranged from 30 minutes to 6 hours.

	Min Availability (Days per week)	Max Availability Days (Days per week)	Min Availability (Hours per day)	Max Availability (Hours per day)
Mode	3.00	3.00	5.00	24.00
Median	3.00	3.00	5.00	6.00
Mean	3.00	4.27	11.95	9.16

Table 2: Water Availability

The time for collection exceeded WHO guidelines of 30 minutes, respondents indicated this was because of long queues.

	Min Collection Time (Mins per day)	Max Collection Time (Mins per day)
Mode	60.00	60.00
Median	60.00	60.00
Mean	94.83	109.74

Table 3: Time to collect Water

Also, users said water often available only at night or in the early hours of the morning.

3.3.4 Illness

60% of households reporting no recent illness, 29% of the households had a member of household sick with malaria (fatal in one case), only 6% of household reported illness that could be related to the water supply.

3.3.4.1 Understanding Demand &Usage

85% of households surveyed had access to water kiosks which are largely improved water sources which were considered by 65% as easier and 67% as preferable to use. In dry season, 85% of all water being used by households was being sourced from improved water sources with 55% (see graph) of all water used by households being sourced from water kiosks, with other improved water sources such as piped services such as shared yard connections (1%), piped water (in house) and piped water (out house) (3%,7%), boreholes (3%), private vendors (7%) and directly from the Water board (1%) through physical collection (using wheelbarrows) or tanks (7%) . 15% of water being used was being sourced from unimproved services such as open water (14%) or unprotected spring water (1%). In rainy season, there is a change in the pattern of water sources being used. The use of unimproved water sources such as spring water (7%) and open water (14%) falls to 5% and 6%

respectively. The use of improved water sources also falls due to competing alternatives such as rainwater.

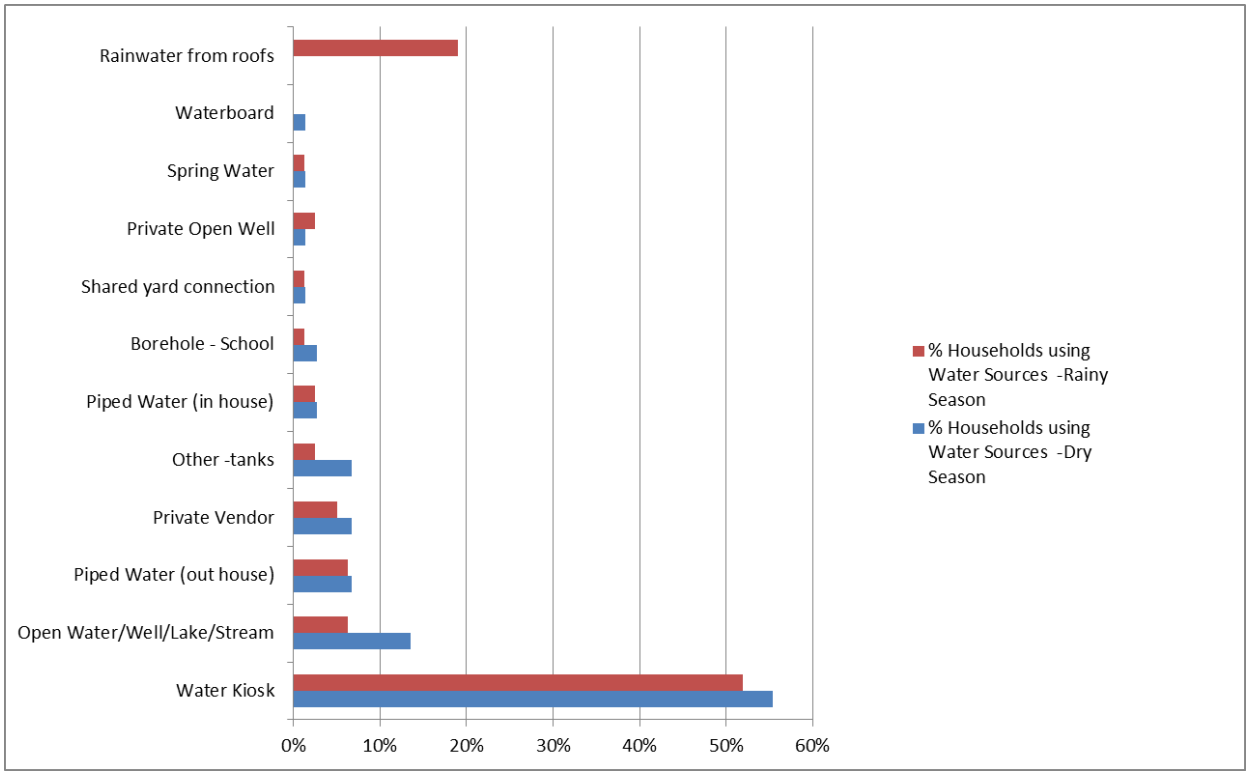

Figure 16: Water Sources - % Households – Dry and Rainy Season

As the study was conducted in dry season, it was difficult to assess whether this source was improved or unimproved. With 44% of users having access to 2 water sources and 4% having accessing to 3 water sources, householders clearly have choice. Householders were asked what water source they preferred. In terms of preference, 66% expressed a preference for using water kiosks, with those householders saying that water kiosks were their most reliable (91%), closest (83%), and easiest to use water service (90%). For those that expressed a preference for the water kiosk service, for only 54% was it cheapest of the water sources available. There seemed did not seem to be a strong relationship between income (as indicated by household wealth indicators) and water source with 66% of those who used an unimproved source in dry season having 3 or more household wealth indicators, in rainy season this rose to 75%. Households were also asked to describe why they preferred their chosen water source; 83% mentioned closeness and/or

perceived safety of the water as reasons for their choice. 91% all those surveyed understood the link between treating water and protecting from disease. There was also a perceived understanding of risk associated with different water sources which was influenced by whether it was dry season (lower risk) or rainy season (higher risk). For example, open water source usage fell from 21% in the dry season to 10% during the rainy season and water was more likely to be treated in rainy season that the rest of the year (see figure 17)

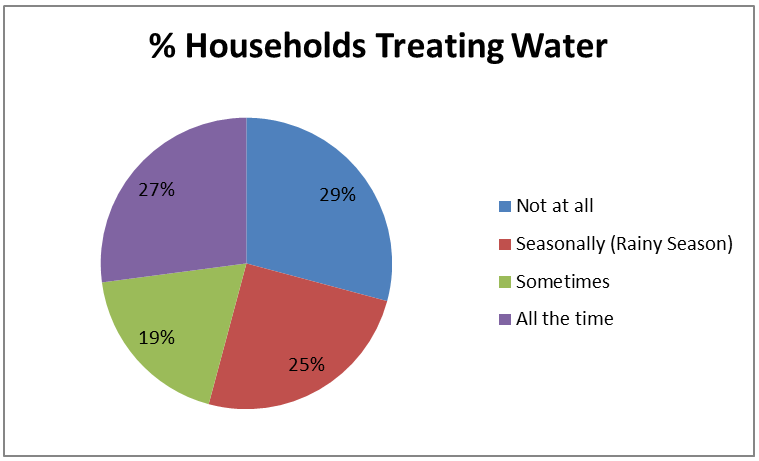

Figure 17: Household Water Treatment Practices

However, when water is in short supply (dry season), households may use higher risk sources such as springs and open water but often demonstrated a number of coping strategies. Householders perceiving poorer water quality either switched to another source, used water treatment and/or adapted the purpose to which water is put based on the perceived water quality of the water source. Such 'product mixing' is illustrated in figure 18 where householders to tend to use water kiosks for their drinking water but may use unimproved sources for their laundry. Other strategies such as using storage e.g. storage tanks and drums to manage periods without water were also used by one or two households but did not appear to be widespread.

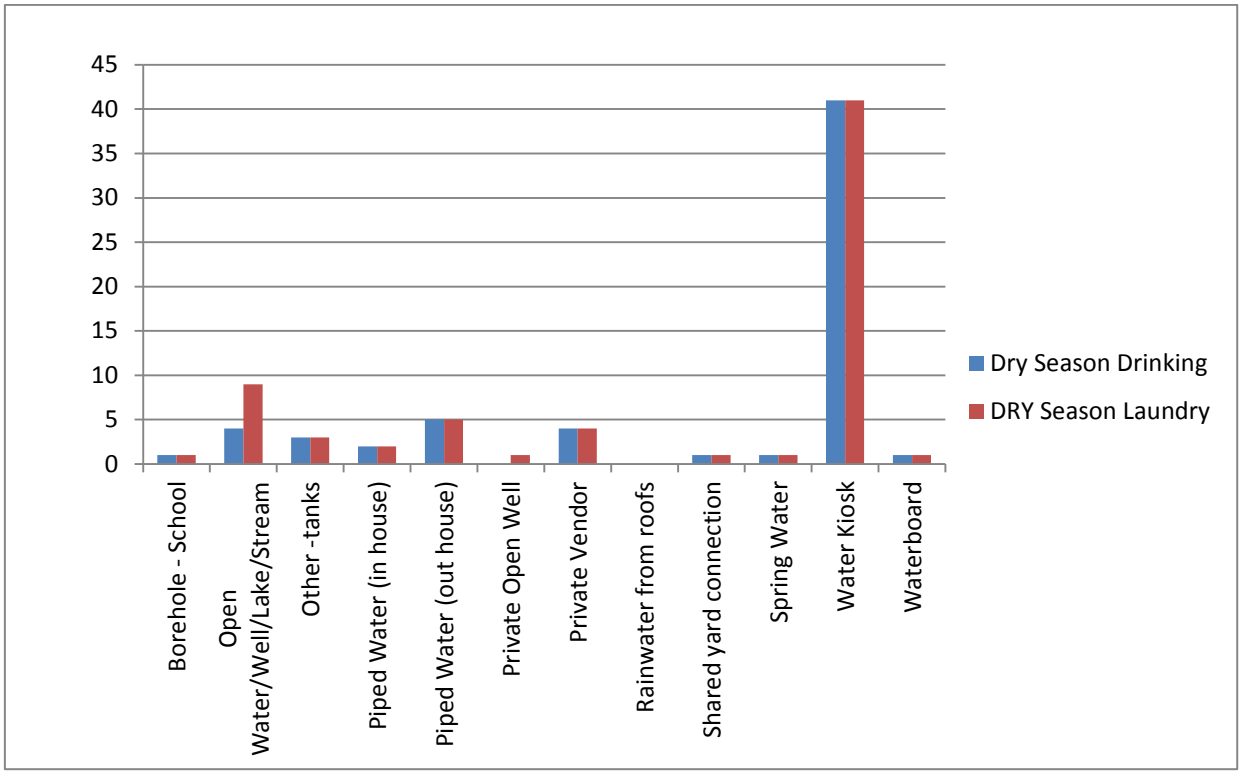

Figure 18: No of Households – Comparison of Water sources for drinking and laundry

3.3.4.2 Sanitation

At the household level, human waste was disposed of using latrines, with 100% of households have access a latrine, with 90% of households having access to some kind of sanitation system within 10m of their home, greatly reducing the risk of open defecation a preliminary step in preventing the faecal-oral disease transmission route.

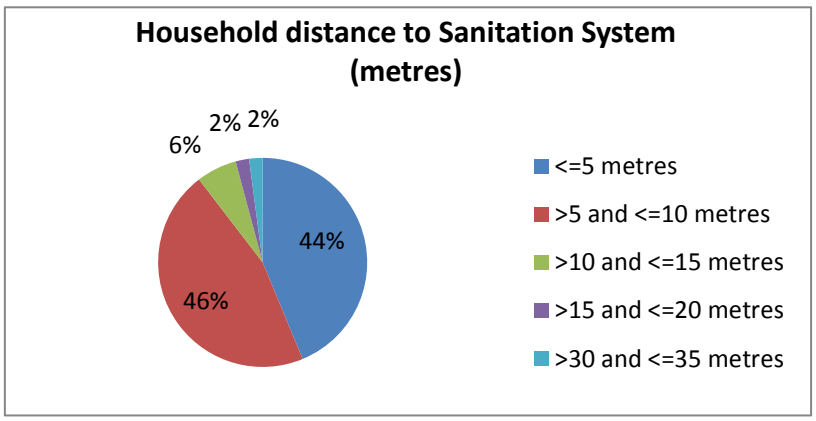

Figure 19: Household Sanitation Access – Distance (metres)

However, with no sewage, during the rainy seasons one household stated that the latrine is emptied straight into the river during the rainy season.

3.3.4.3 Water Storage

In Ndirande, nearly 100% of household used open plastic pails to collect water. In the household, nearly 96% of households kept drinking water separately but only 33% kept the containers off the floor and only 46% of those containers had a cover increasing the risk of contamination.

4 Discussion

4.1 Water Supply

BWB starkly demonstrates the difficulty of balancing affordability versus sustainability for a water utility. According to Brikke (2002), if BWB cannot cover its costs it is not a sustainable water utility and BWB's tariffs are not high enough to cover its operational costs despite is apparent profitability. It's got three main tariffs and only one is profitable (industry) and it is using cross-subsidies to fund the other two (subsidised, domestic). Despite the legal right to raise tariffs BWB is unlikely to be able to balance the social and political costs of doing so. Though the household wealth indicators showed perhaps that there was a greater ability if not willingness to pay. BWB's approach reflects that the conclusions of Rogers (2002), IRC (2003) and OECD (2009) that full cost recovery cannot be 'at all costs' and it has to be recognised that even in the developed world not all water utilities are able to cover their full capital cost (WSUP 2011). BWB supplies low income consumers with subsidised water and Rogers (2002) did not discourage this, but he argued the full costs should be accounted for. BWB is working in partnership with *Water for People* and pilot private vendors to build water kiosks in Ndirande reducing the amount of investment required to serve poor consumers at this subsidised rate. However, the subsidised community is growing at 6% per year. This is a significant burden for the BWB as the more the community grows the more money the water board loses and the cross-subsidies become harder to justify to other users. Faced with a challenge where there are no easy answers BWB needs to become much more efficient with the resources they do have e.g. BWB advised they had built 30 water kiosks but at least two of the water kiosks found by this researcher in Ndirande were recently built but were not operational confirming Carter (2004) concerns that crude coverage targets do not necessarily mean improved water supply. Other efficiencies will need to be gained from investments in infrastructure funds for which will need to obtained funds from elsewhere e.g. donors.

BWB's current infrastructure does not have the capacity to meet current or future demand and is struggling operationally with rising technological and economic issues. Water rationing and/or disrupted water supply is a real possibility. If that happens some households will consume less water, spend more time getting it and/or take greater risks. Efforts need to be made to conserve or increase supply. BWB could immediately act on addressing water losses from leaks and illegal connections. There are teams already in place to do this but they need to made more effective. CBO's could support this effort by identifying leaks, reporting them to BWB and following up when action is not taken. BWB, CBOs and NGOs should work together to encourage the use of grey water for those who have a garden or yard and support community and household water storage initiatives.

Alternative sources of water could be sought, making greater use of ground water supplies is one possibility but without regulation and control by BWB this may prove a greater threat to water quality than it currently is. BWB's has enough issues with its piped system, and even it was willing to engage with the NGOs and CBOs on this issue but it is unlikely CBOs will cooperate with BWB on regularising use of ground water unless there is an amnesty by BWB on their own boreholes. Rainwater collection combined with an appropriate water treatment method (see below) is a possibility as rainfall is sufficient during rainy season and this should be investigated.

Though this research found that water is generally regarded as safe to drink without treatment and that diarrhoeal disease did not appear to be widespread the threat to water quality remains and it does not appear to be managed by the BWB. This is been shown by sporadic cholera epidemics in recent years in, the most recent of which was in April 2012 (The Weekend express 2012, Malawi Clinics 2008). The periodic nature of the disease, its spread and the rapid deterioration of those infected often makes BWB's response seem slow and ineffective. Outbreaks will remain a risk while sewerage and household water purification remains low. To guard against this threat NGOs could support the use of water treatment particularly for unimproved water source users. Brikke

(2002) advised that any technology used should be appropriate to ability and willingness to pay. Water guard or chlorine are already in use in Ndirande and are familiar technologies to water users. The SODIS method of water treatment which involves disinfecting water in plastic bottles using solar radiation from sunlight should also be considered. The process has low operation costs, it's effective and can be operated at the household level if basic instructions are followed (WHO, 2012). It's particularly appropriate for Ndirande with its lack of available fuel for heating, low turbidity water supply and the availability of PET bottles and sunshine. Water kept in the plastic bottles could possibly replace the current use of open containers that increase the risk of household contamination.

According to WSUP, forging greater cooperation between stakeholders is key to a coordinated improvement in Ndirande. However, findings suggest a sense of isolation between the stakeholders in Blantyre. BWB seems unaware of what really happens in the Ndirande at both the community and household level e.g. citing targets of 4 hours on repairs that clearly were not being met. This extends beyond BWB; CBO's seem to fix issues themselves e.g. drainage issues rather than approaching the city assembly whose responsibility it is and do not appear to work with other CBOs or NGO's e.g. the manager of the health clinic was unaware of water committee's in the area. Even within the CBO's, there is perhaps little consultation with members of the community they represent in the decision making process.

There is a role for a small NGO in driving some of that coordination harnessing existing capacity and making it more effective and it could make more effective interventions if it partnered more with other existing organisations. However, it has to be said that Ndirande is better served than rural areas as urban areas often are (Franceys, 2008). The scarce resources of an NGO might have greater impact on water supply elsewhere or it could partner with other organisations to focus on improvements to sanitation and drainage to reduce the risk of malaria instead.

4.2 Limitations and Implications

This study would have benefitted from more knowledge of the internal workings of BWB, particularly to explain the gap between senior managers understanding and the reality on the ground. It also could have benefitted from wider consultation with other CBO's and NGO's in the area to get a more rounded view. Also, more research needs to be done on the ability and willingness to pay amongst users as findings suggest there may be more ability to pay than currently understood.

Coates et al (2004) argued that water utilities offer the best means of serving the world poor. However, it's a growing challenge in terms of costs and environmental sustainability and this study contributes to supporting the view that 'sustainable cost recovery' (OECD, 2009) rather than full cost recovery should be the aim of a water utility with this intention. This will require continued public and private sector initiatives to reduce water utility capital costs to expand coverage.

5 Conclusion

In summary, BWB faces growing pressures on its already stretched services and water sources from a growing population, demands to increase coverage in subsidised areas, increasing consumption associated with rising living standards and water losses. Under this scenario, water scarcity in Ndirande is likely to increase and areas increasingly affected by water rationing and disrupted supply. Efforts need to be made to secure water supply either through water storage or supplementary sources. Due to risk of contamination in the water chain, water treatment should be encouraged at the point of consumption. The CBOs have the capability and the capacity to assist in such implementations but they cooperate more with each other, BWB and NGOs to increase the sustainability of any improvements in the WATSAN area.

6 Recommendations

This research makes several recommendations for a local NGO.

1. Drive greater cooperation between CBOs, NGOs and BWB to improve water sources. This could be achieved helping to create a cross organisational committee which initially focuses on a single issue e.g. leak reporting to BWB which will provide a platform for greater collaboration.
2. Invest in water storage e.g. water storage tanks at the CBO level and support the use of supplementary water sources such as rainwater collection for both the CBO and at the household level.
3. Support water treatment at the point of consumption using cheap and simple technologies e.g. Waterguard and also SODIS which is free and does not rely on the affordability or availability of Waterguard.

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APPENDICES

Appendix A

A.1 Technical Methods of water service to Low Income Consumers

Coates et al (2004) 8 technical methods of water service delivery to low income consumers.

- Individual house connection

- Individual yard connections

- Shared group connections

- Bulk supply connections

- Water kiosks

- Stand posts

- Supply by vendors

- Supply by water tankers

A.2 Linkages between water and sanitation and poverty.

Poverty Dimensions	**Inadequate water, sanitation, hygiene – potential key effects**
Income	High proportion of household budget used on obtaining water Reduced income potential because of: - Poor Health - Increased time spent collecting water - Less opportunity for businesses requiring water inputs
Health	Increase in illness related to water and sanitation Stunting from diarrhoea caused by malnutrition Reduced life expectancy
Education	Reduced school attendance by children (especially girls) due to ill health or lack of sanitation or water collection points
Gender and Social Inclusion	Burdens borne disproportionately by women, limiting their entry into the cash economy

(Adapted from Bosch et al. 2001 in Coats et al 2004)

A.3 Definitions of improved and unimproved drinking water sources

	Drinking Water	**Sanitation**
Improved	Use of: ▫ Piped water into dwelling, yard or plot ▫ Public tap or standpipe ▫ Tubewell or borehole ▫ Protected spring ▫ Protected dug well ▫ rainwater collection	Use of: ▫ Flush or pour-flush to: – Piped sewer system – Septic tank – Pit latrine ▫ Ventilated improved pit (VIP) latrine ▫ Pit latrine with slab ▫ Composting toilet
Unimproved	Use of: ▫ Unprotected dug well ▫ Unprotected spring ▫ Cart with small tank or drum ▫ Tanker truck ▫ Surface water (river, dam, lake, pond, stream, canal, irrigation channel) ▫ Bottled water (considered to be improved only when the household uses drinking water from an improved source for cooking and personal hygiene)	Use of: ▫ Flush or pour-flush to elsewhere (that is, not to piped sewer system, septic tank or pit latrine) ▫ Pit latrine without slab, or open pit ▫ Bucket ▫ Hanging toilet or hanging latrine ▫ Shared or public facilities of any type ▫ No facilities, bush or field (open defecation)

Source: WHO/UNICEF

A.4 Water Supply Surveillance Indicators

a) Quality of water –the microbiological quality
b) Quantity of water – the amount of water used each day by individuals and Households
c) Continuity (or reliability) of the supply – how much of the time water is available from the water supply
d) Cost of water – how much people pay to obtain water services
e) Coverage of the population – the percentage of the population that has access to a recognisable water supply

Source: Howard (2006)

A.5 Water Usage and Coping Strategy Survey

WATER SECTOR USAGE AND COPING STRATEGIES

My name is Nina McVeigh and I am working for on behalf of the Mai Aisha charity investigating how water supply can be improved in the area. We would like you to assist us by taking time to answer the following few questions. If you do not wish to answer a particular question please leave it out. You have been chosen to take part in the survey on a purely random basis. Your answers will be treated confidentially. Thank you for your co-operation.

Survey location:

What language is used for the interview? Survey date

Respondent Name

GPS position

Male [ ] Female [ ] Age Range: 10-15 [ ], 16-30 [ ], 31-50 [ ], 51+ [ ]

Do you rent or own your property? Rent [ ] Own [ ]

Level of Education? primary or less [ ], some secondary [ ], secondary [ ]

What is the number of people in your household?

From where do you and other members of your household obtain water?

Please indicate all the water sources that are used by the people in your household and whether you use that water for drinking and cooking or other uses Please also estimate the average number [chosen container] that are collected each day from each source for your household (tick boxes as necessary)

	DRY SEASON							RAINY SEASON						
	Drinking	Cooking	Bathing	Laundry/Washing	Cleaning	Other	Average No of [Chosen Container]	Drinking	Cooking	Bathing	Laundry/Washing	Cleaning	Other	Average No of [Chosen Container]
i) Your own piped water connection (inside your house)														
ii) Piped water connection (outside their house)														
iii) Buy water from your neighbour														
iv) A shared yard water connection														
v) Private vendor														
vi) Water kiosk														
vii) Public stand post														
viii) Water tanker														
ix) Handcart /bicycle water vendor														
x) Private open well														
xi) Hand pump														
xii) Rainwater from roofs														
xii) Spring water														
xiii) From pools of water/lake or stream														
Other														

WATER SECTOR USAGE AND COPING STRATEGIES	
Which source is closer?	
Which source is more reliable? I.e. water availability	
Which source do you find easier to use? Why?	
Which source do you prefer to use? Why?	
Average number of days per week that water is available?	
What is the average number of hours of per day water is available?	
What is the average time to collect water for all the household each day? (minutes)	
What is the distance to the nearest piped water source that you can use?(metres)	
Which source do your friends use?	
Which source do your friends tell you to use?	
Which source have your been told to use by CBO, NGO etc.?	
Which source is cheaper?	
Which source is the most expensive?	
What is the average price of water from local vendors?	
What is the average total household expenditure on water? (per week)	
What containers do you use to collect water?	
Do you see any value in doing something to your water to make it safer for drinking?	
Tell me what you think of the water supply?	
In you household, what percentage of water is collected by:	
Women	
Children	
Men	
How far from your house is there a functioning sanitation system such as a latrine or toilet that you regularly use?(metres)	
Household goods: TV [ ], Fridge [ ] , Mobile phone [ ] , garden/yard [ ], cooker [ ] , DVD [ ], cable [ ],	
Have you or anyone in the household been ill in the last year?	
Comments (PTO to continue)	

(Adapted from Coates et al 2004)

Household water quality inspection

Source of water ……

1. Is drinking water kept in a separate container (ask to be shown this)?

❑ Yes ❑ No

2. Is drinking water container kept above floor level and away from contamination?

❑ Yes ❑ No

3. Do water containers have a narrow mouth/opening?

❑ Yes ❑ No

4. Do containers have a lid/cover?

❑ Yes ❑ No

5. Is this is in place at time of visit

❑ Yes ❑ No

6. How is water taken from the container?

❑ Poured ❑ Cup ❑ Other utensil

7. Is the utensil used to draw water from the container clean?

❑ Yes ❑ No

8. Is the utensil used to draw water the container kept away from surfaces and stored in a hygienic manner?

❑ Yes ❑ No

9. How often is the container cleaned?

❑ Every day ❑ Every month ❑ Neverwater

❑ Rarely ❑ Every week

10. How is the container cleaned?

……..

11. Is the inside of the drinking water container clean?

❑ Yes ❑ No

12. Is the outside of the drinking container clean?

❑ Yes ❑ No

13. Do you treat the water?

❑ Yes ❑ No

14. If yes, how do you treat the water?

……..

(Adapted from Howard 2006)

A.6 Water Source Assessment

Inventory observation and questionnaire

Urban and Peri-Urban Water Supply Surveillance: Ndiranhe

Inventory observation sheet and questionnaire

Water source No. ☐

Name of water source	
Location	
Parish	
Division	
Town	
Interviewer's name	
Date	

1 What is the water source: *Tick 1 box*

- ☐ Public standpost
- ☐ Private tapstand - water selling
- ☐ Landlord provided tap
- ☐ Protected spring in good condition
- ☐ Protected spring requiring repair
- ☐ Unprotected spring
- ☐ Borehole with handpump
- ☐ Dug well with no handpump/windlass
- ☐ Dug well with windlass Dug
- ☐ well with handpump
- ☐ Rooftop rainwater catchment
- ☐ Unprotected scoop well
- ☐ Pond/stream/swamp/lake

If the source is a pond, stream, swamp, lake, unprotected spring or unprotected scoop well, only answer questions 1-5 and 14-22

2 Who owns the water source: *Tick 1 box*

- ☐ Private owner
- ☐ NWSC
- ☐ Community
- ☐ Local Councils (LCI/II)
- ☐ City/Town Councils (LCIII-V)
- ☐ Project ☐
- ☐ No-one

3 Who supervises the water supply *Tick 1 box*

- ☐ Owner
- ☐ Community caretaker
- ☐ Other community representative
- ☐ Project staff
- ☐ Other ☐
- ☐ No-one

4 Is the water provided: *Tick 1 box*

- ☐ Free of charge
- ☐ Cost per bucket/jerry can
- ☐ Meter/flat rate

If water is free go to question 6

5 How much is charged for the water
Get information from source caretaker

USh ☐ per ☐

USh ☐ per ☐

6 Who did the actual construction of the water supply
Tick one box - get information from source caretaker or from your records

- Community ☐
- NGO/Donor ☐
- Contractor ☐
- Govt agency ☐
- Other (who) ☐
- City/Town/District council (LCIII-V) ☐

7 Which Project/Organisation sponsored the design and construction
Get information from source caretaker or from your records

☐

8 When was it constructed
one box - get information from source caretaker or from your records

- 0-6 months *Tick* ☐
- 6-12 months ☐
- More than 1 year ☐
- Don't know/don't remember ☐

9 Has any repair or rehabilitation work been carried out on the water supply
Tick one box - get information from source caretaker

- Yes ☐
- No ☐

If 'no' go to question 14

10 What was the most recent repair
Get information from source caretaker

☐

11 Who did this
If more than one organisation tick all the appropriate boxes

- Community
- City/Town/District Council (LCIII-V)
- Govt Agency ☐
- NGO/Donor ☐
- Owner

12 When was it done
one box - get information from source caretaker

- 0-6 months *Tick* ☐
- 6-12 months ☐
- More than 1 year ☐
- Don't know/remember ☐

13 Who paid for the work to be done
If more than one organisation tick all the appropriate boxes

- Community ☐
- City/Town Council (LCIII-V) ☐
- Govt Agency ☐
- NGO/Donor ☐
- Owner ☐

14 Who is responsible for maintenance of the source
If more than one organisation tick all the appropriate boxes

- Community ☐
- City/Town Council (LCIII-V) ☐
- Govt Agency ☐
- NGO/Donor ☐
- Owner ☐
- Don't know ☐
- No-one ☐

If 'don't know' or 'no-one' go to question 17

15 Who pays for maintenance work
If more than one organisation tick all the appropriate boxes

- Community ☐
- City/Town Council (LCIII-V) ☐
- Govt Agency ☐
- NGO/Donor ☐
- Owner ☐
- Don't know ☐
- No-one ☐

16 How often is this done
Tick one box - get information from source caretaker

- Daily ☐
- More than once a week ☐
- Weekly ☐
- More than once a month ☐
- Monthly ☐
- Less than once a month ☐
- Don't know ☐

17 Who is responsible for cleaning the area around the source
If more than one organisation tick all the appropriate boxes

- Community ☐
- City/Town Council (LCIII-V) ☐
- Govt Agency ☐
- NGO/Donor ☐
- Owner No-one Don't know ☐

If no-one go to question 19

18 How often is this done
Tick one box - get information from source caretaker

- Daily ☐
- More than once a week ☐
- Weekly ☐
- More than once a month ☐
- Monthly ☐
- Less than once a month ☐
- Don't know ☐

19	Do you restrict how much water each person can take	Yes No **If 'no' go to question 21**	☐ ☐

Tick one box - get information from source caretaker. NB: does not include restriction because of lack of m

20	Why is there a restriction *Tick one box - get information from source caretaker*	Source has low flow Too many people use source Limited time for caretaker Non-domestic uses of water Other (specify) Don't know	☐ ☐ ☐ ☐ ☐ ☐
21	Does the source dry up	Yes No **If 'yes' answer question 22**	☐ ☐

Tick one box - get information from source caretaker. NB: does not include disconnection)

22	If the source does dry up, does this happen *one box - get information from source caretaker*	Daily *Tick* Monthly Seasonally Occassionally	☐ ☐ ☐ ☐

A.7 Sample Sanitation Surveys

I. Type of Facility PIPED WATER

1. General Information : Division:

   :

2. Code Number

3. Date of Visit

4. Water samples taken? …….. Sample Nos. ……

II Specific Diagnostic Information for Assessment

(please indicate at which sample sites the risk was identified)

	Risk	**Sample No**
1. Do any tapstands leak	Y/N	…….
2. Does surface water collect around any tapstand?	Y/N	…….
3. Is the area uphill of any tapstand eroded?	Y/N	…….
4. Are pipes exposed close to any tapstand?	Y/N	…….
5. Is human excreta on the ground within 10m of any tapstand?	Y/N	…….
6. Is there a sewer within 30m of any tapstand?	Y/N	…….
7. Has there been discontinuity in the last 10 days at any tapstand?	Y/N	…….
8. Are there signs of leaks in the mains pipes in the area?	Y/N	…….
9. Do the community report any pipe breaks in the last week?	Y/N	…….
10. Is the main pipe exposed anywhere in the area?	Y/N	…….

Total Score of Risks …./10

Risk score: 9-10 = Very high; 6-8 = High; 3-5 = Medium; 0-3 = Low

III Results and Recommendations:

The following important points of risk were noted: (list nos. 1-10)

Signature of Health Inspector/Assistant:

Comments: