Mzuzu SMART Centre

The impact of Rope Pumps on Household Income in Mzuzu, Malawi

BSc Thesis by Robin Rosendahl

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Water Resource Management Group

WAGENINGEN UNIVERSITY
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How do Rope Pumps Impact Household Income in Mzuzu, Malawi?

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Showing a woman operating a Rope pump in the rural Mzuzu area, Malawi.

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Abstract

The technology of rope and washer pumps is known and in use for over 2000 years, but the appropriation in Africa seems to be limited, even though the potential benefits can be great. Previous research attributes rope pumps with a significant increase in income of up to 50%. The increasing water shortage and erratic supply augment the need for other (new) sources of water supply. This thesis explores some of the impacts that rope pumps have on household income in Mzuzu, Malawi.

With an average income increase of 35% among lower income households, the rope pump presents a serious benefit for the people in Mzuzu. By decreasing water bills, extending agriculture and vending of pumped water, household income is diversified and allows for more financial leeway. A part form direct income improvement, the rope pump aids in health improvement through the supply of clean drinking water and elevated schooling levels.

However the thesis also highlights the necessities for long-term success and the importance of perception and maintenance, which is among the biggest factor of negative conception. The rope pump is no large community pump, rather a low-cost, self-supply technology, which needs to be recognized next to mainstream community pumps. It can be highly beneficial when used and maintained correctly, nonetheless it is still in the promotion phase in Mzuzu.

Keywords: Rope Pump, Household; Malawi**;** self-supply; income; pumps; Mzuzu

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Acronyms

CS	Communal Supply
FAO	Food and Agriculture Organisation of the United Nations
GoM	Government of Malawi
GVH	Group Village Headman
HDI	Human Development Index
IRC	International Water and Sanitation Centre
IWRM	Integrated Water Resource Management
NRWB	Northern Region Water Board
RWSN	Rural Water Supply Network
SS	Self Supply
SSA	Sub-Saharan Africa
UNDP	United Nations Development Program
WHO	World Health Organisation

1. Introduction

1.1. Introduction

As the world seeks a more sustainable future, better water management is one of the challenges we face. Among the poor, water is of vital importance in their livelihood activities; small-scale cropping, livestock rearing and other micro-enterprises (Moriarty et al. 2004). Without water there is no escape from poverty. Mulwafu and Msoso (2005) argue for IWRM (Integrated Water Resource Management) as effective approach to sustainable water management and driver of rural prosperity.

In Malawi, 85% of the population lives in rural areas and is heavily dependent on agriculture. Poverty, water supply and food security are some of the major issues, which Malawi faces. Currently 43,000 ha are under smallholder irrigation with estimates of potential irrigation area of up to 1 million ha (RWSN 2013). Access to clean drinking water in Malawi according to WHO reports lies at 95% (urban) and 84% (rural) (Joint Monitoring Program for Water Supply and Sanitation 2014; GoM 1999). To ensure water of sufficient quality for all needs in Malawi, the government has introduced a national water policy in 2005, which involves the adoption of IWRM principles such as that water is a finite and vulnerable resource (Malawi Government 2007; Mulwafu and Msoso 2005).

According to Harvey and Drouin (2006) rope pumps offer opportunities for sustainable water supply in Africa. Rope pumps are praised by their simple, low-cost technology and local available spare parts (Alberts & Van der Zee 2003). A more technical description is given in Box 1. Besides domestic water use, rope pumps can also supply water for irrigation practices. In the dry season, when limited water is present, farmers rely on additional water sources to prevent harvest reduction and guarantee a stable income through the sales of irrigated crops. Utilization of rope pumps can help towards the cultivation of small-irrigated plots, which can have a further influence on the income generating effect of the rope pump. The Mzuzu SMART Centre therefore promotes the rope Pump in Malawi as a low-cost technology that could become one part of the Mzuzu City water supply strategy in the near future.

1.2. Location

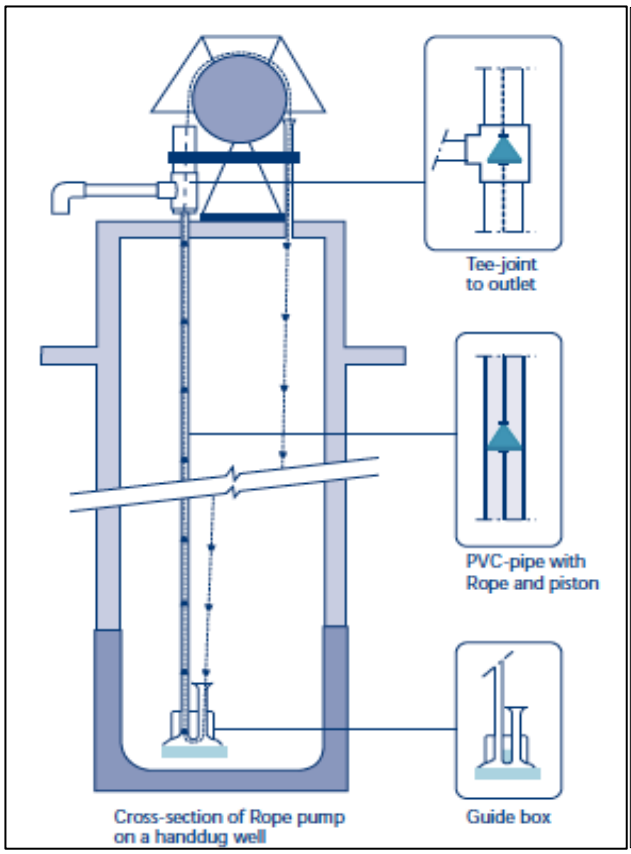
The Republic of Malawi is a landlocked country situated in the southeast of Africa known for its natural beauty and warm, friendly people. With 118,484 km^2 and a population density of 128.km^{-2} it is a rather small African country (FAO 2013; CIA World Factbook 2014). Its economy relies on a small and narrow base with only little industry. The Human Development Index (HDI) ranks it as 174th from 187 countries in the world, making it one of the least developed nations on this earth (UNDP 2014). Next to major export goods like tobacco, tea and sugar; small-scale agriculture is the mainstay of

Malawi. Due to the fact that it is a landlocked country, import goods are heavily priced and often not affordable for low-income households (Peace Corps, 2014).

This study focuses on Mzuzu. With a population of roughly 150.000 in 2012, an agglomeration of over 1.7 million, growing at 4.2% per annum and doubling its size in less than 17 years, Mzuzu is the third largest and fastest growing city in Malawi and capital of the Northern Region (Figure 2) (Populationdata 2014, UN-Habitat 2011).

1.3. The Rope Pump

Although the technology behind the rope pump was invented thousand years ago in the Middle East and China (Alerts 2000), the rope pump as we know it today was mainly developed in Nicaragua. Since the introduction in Nicaragua in 1984, the pump has transformed under several improvements. So was a rubber washer added to the rope that allowed an operating head of 40 meters. The use of smaller diameter pipes and a double crank has further extended the reach depth of the pump to 80 meters. As a result, the pump was now suitable for domestic use besides irrigation purposes. By 1990, the rope pump was a great success, drastically improving rural water supply. Alberts (2004) estimated that the rope pump provides 25% of the Nicaraguan population with water. Since then several tries to introduce the rope pump in African and Asian countries were done. Unfortunately, these tries still lack success rates compared to Nicaragua (Sutton & Gomme 2009).



Box 1. The Rope Pump

The rope pump generally consists of three main parts. The *guide box* at the bottom of a hand dug well or borehole, which is submersed in the groundwater. A *PVC pipe* which guides the *rope* and *washers* (*pistons)* and the top part, consisting of a *pulley wheel with a handle* and a *tee-joint outlet* for the water.

The basic principle is, that when you start turning the wheel, the rope and the pistons enter the guide box and trap water, lifting it upwards to the surface outlet.

The pump can lift water from up to around 40-45 metres depending on the diameter of the pipe used.
Maintenance of the pump is easy, can be done locally by users or Artisans and uses locally

Figure 1 - Cross-section of a Rope Pump in a hand dug well (Source: IRC Centre 2004)

1.3.1. Where is the rope pump applied?

The rope pump is meanwhile established in many Sub-Saharan countries. However the numbers are not very high compared to the coverage of rope pumps in Nicaragua (about 70.000 pumps) but many organisations are trying to bring the rope pump to Africa (Sutton & Gomme 2009).

Countries with the most rope pumps in Sub-Saharan Africa (SSA) are Zimbabwe with more than 4.500, Ethiopia with over 2000 pumps, Ghana with more than 1.600 rope pumps and also in Malawi with approximately over 400 pumps installed in 2009 (Sutton & Gomme 2009). Today the pumps is promoted and used in main countries all over the developing world (Alberts 2004).

1.3.2. Why does it spread better in some places than in others?

The main reasons for the success of the rope pump in namely Nicaragua were its simplicity and low cost in production and maintenance. These factors seem catching however since the introduction in many SSA countries it hasn't spread as much as in Nicaragua or Mexico. The rural water supply in Africa has only increased by 3% in the decade from 1990 up to 2000 (WHO & UNICEF 2000). Often problems lie within distribution system, many NGO at first wanted to stick to their VLOM hand pumps as they were specialized in them. It has become difficult to reach the informal private sector to promote and develop the pump (Alberts 2004). In Mzuzu this is done by training local people in manufacturing the pump and teaching them how to drill a borehole without any electrical gear.

1.3.3. Who benefits and what can it deliver?

The main beneficiaries are the users themselves. The household has through the pump direct access to water, which is also more often cleaner than the water, which was used before. But also the neighbours or the village can benefit depending on the use and allowance of the rope pump.

Furthermore the local private sector can be boosted by people establishing their own store, creating and selling the pumps to the area. This also works for a longer period in time as donors often don't continuously provide funds and materials (Alberts 2004).

1.4. Problem Statement

The rapid increase in population size creates challenges for public water supply and is a threat to health and safety (Wanda et al. 2012). Currently the Northern Region Water Board (NRWB) can supply 14.000 $m^3.d^{-1}$, which supplies 82% of the residents (UN-Habitat 2011). However the supply is unevenly distributed. Especially the informal settlements around town are most affected and often only have little or no access to piped water. These areas depend greatly on water kiosks or often-unprotected sources like hand dug wells, rivers and streams (UN-Habitat 2011).

If no preventive actions are carried out, Mzuzu will face more and more water supply difficulties in the future. In 2020 it is expected that Mzuzu will need up to 70.855 $m^3.d^{-1}$ (UN-Habitat 2011).

Besides domestic water use, rope pumps can also supply water for irrigation practices. In the dry season, when limited water is present, farmers rely on additional water sources to prevent harvest reduction and guarantee a stable income through the sales of irrigated crops.

Utilization of rope pumps can help towards the cultivation of small-irrigated plots, which can have a further influence on the income generating effect of the rope pump.

This low cost technology could thus be a part of the Mzuzu water supply strategy in the near future.

1.5. Research objective and questions

The main research objective is to analyse how rope pumps contribute to (rural) water supply. And moreover to understand how rope pumps impact livelihoods and how they contribute to income generation of a low-income household. Hereby the differences in individual usage of rope pumps versus communal ones need to be also further understood. From this objective, the main research question has been formulated:

How do communal and individual rope pumps impact household income in Mzuzu, Malawi?

With an additional set of five specific research question to support the main question:

- *SRQ1: For what purposes is the rope pump used?*
- *SRQ2: What is the functionality and what influences it?*
- *SRQ3: How is maintenance organized?*
- *SRQ4 How do different actors (households, implementing organisations, community leaders) perceive the working and functionality of the rope pump?*
- *SRQ5 What differences are there between self-supply and community rope pumps?*

1.6. Report structure

This thesis is structured as followed. After the introduction of the study location, the used methodology is elucidated followed by the description of the 'livelihood strategies' framework where its usefulness is explained. In chapter four the gained results are presented followed by an extensive discussion and ending with a conclusion that answers the research questions.

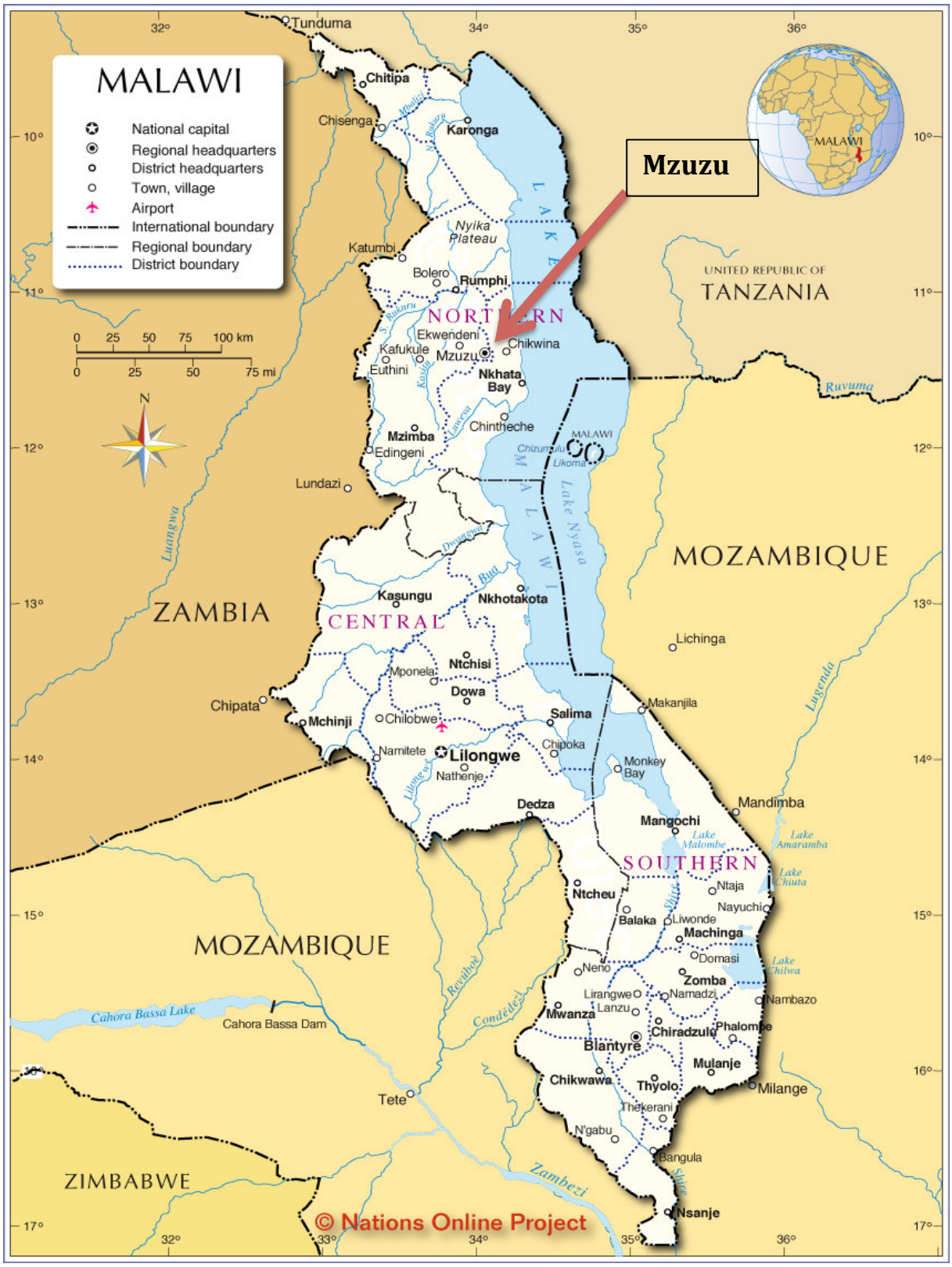


Figure 2 - Map of the Republic of Malawi (Source: Nations Online Project)

2. Methodology

To answer the previous stated research questions and to achieve the research objective, a desk and field study was conducted between February – March 2015. Including 8 weeks of fieldwork. In total 22 installed pumps were visited around Mzuzu City.

All research questions were answered using interviews as data collection method. A literature study on the rope pump was conducted prior to the interviews. Based upon information from several documentation centres including the Mzuzu SMART Centre, Connect International, the Mzuzu Centre of Excellence in Water and Sanitation and the universities of Mzuzu and Wageningen. Subjects covered different types of rope pumps, technical functioning, social and cultural acceptance and experiences with the rope pump in different countries.

Activities during the research period included:

- Literature study
- Observations during workshops from Mzuzu SMART Centre
- Observations on the distribution of rope pumps outside Mzuzu
- Observations of rope pump installation in the field
- Discussion with manufacturing companies
- Interviews with rope pump users

Observations and interviews in the field were held with users of the rope pump: man, woman and children at family and community level, caretakers of different schools, farmers and 'copycat' rope pump producers. Furthermore local informants and affiliates were questioned, as well inhabitants of Mzuzu who do not personally own rope pumps.
Field visits were supported by a translator, named Charles Chawinga. Preparation of the visits was supported by the resource persons: Reinier Veldman and Rochelle Holm.

In total 22 rope pumps around Mzuzu City were visited, including self-supply (individual) and communal rope pumps (Figure 3). A list of the pumps visited is attached in Annex 2. Data was gained through interviews with open-ended questions. This method of interviewing was chosen recommended above other methods as they permit an unlimited of possible answers. Respondents have the opportunity to reply in detail and clarify responses.
Furthermore unanticipated answers can also be found. However, some disadvantages of this method are different degrees of detail in answers, irrelevant information and the comparison of given answers can become difficult. But the gathering of anticipated answers via this method of interviewing exceeds the disadvantages. The interview layout is shown in Annex 1**.** In total, 22 interviews were held with users of rope pumps. An app on a mobile device, named *mWater*, was used to gather and store data. Covering the GPS locations, responses to questions and converted to an Excel spread sheet presenting all data. Data analysis and interpretation is done using these Excel Spread sheets.

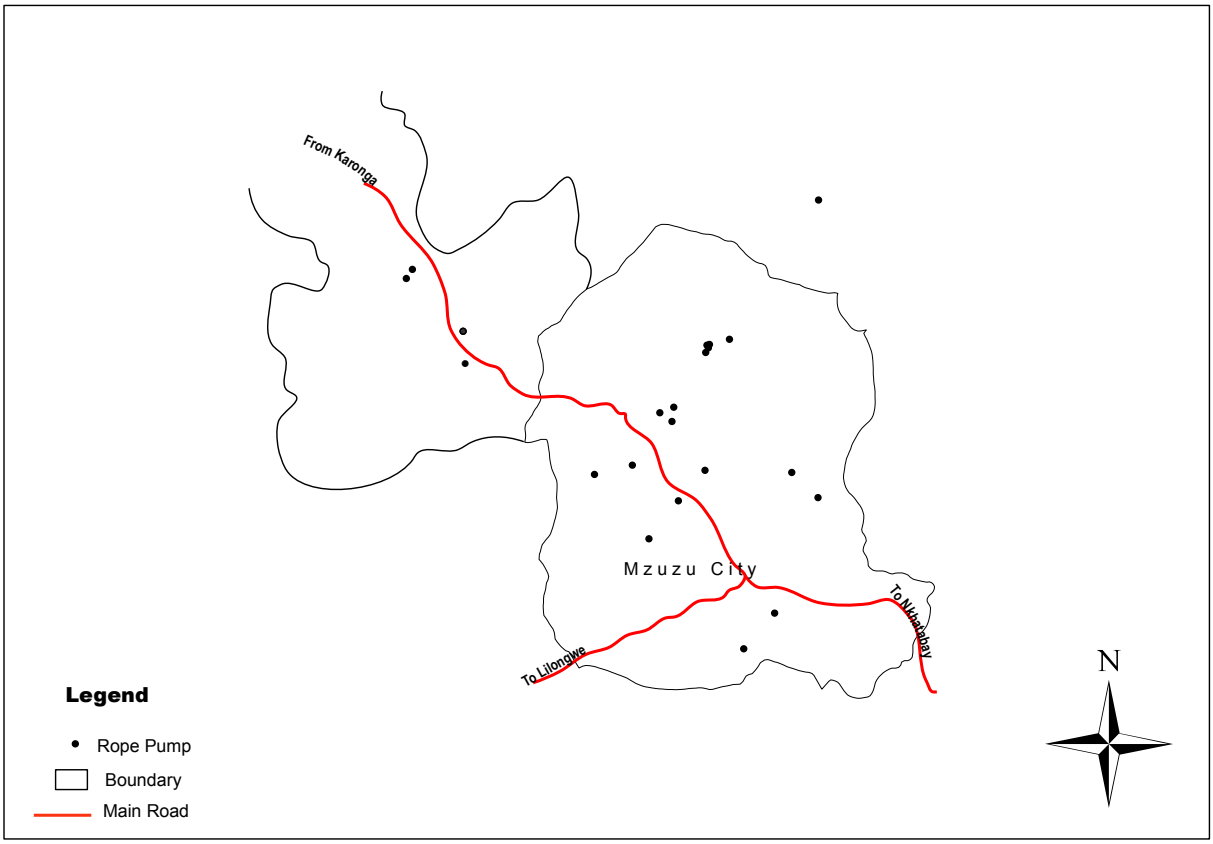


Figure 3 - Rope Pump Locations in Mzuzu. (Source: Author 2015)

Results of the study will be presented to the Mzuzu University (the Centre of Excellence in Water and Sanitation and Mzuzu SMART Centre) as well as to the Wageningen University in the Netherlands.

3. Framework

In this chapter a framework is presented, that was used during the research and in this report.

The conceptual framework of this research is compiled with the theory of 'household strategies' described by Wallace (2002) as "the motivations and agency of actors in society", the theory of household strategies and rural livelihood diversification after Ellis (1998) where Ellis says, that "diversification may occur both as deliberate household strategy or as an involuntary response to crisis" and the strategy of coping with unreliable water supplies by Zérah (2000) where she says, that individual household strategies are important to reach a degree of autonomy from the water supplier.

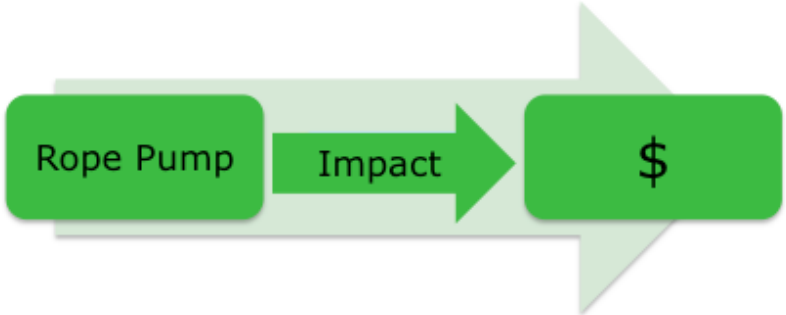


Figure 4 – Conceptual framework for analysis (SOURCE: Author 2015)

First of all, Wallace (2007) mentions, that certain motivation needs to be present for a change in action. These motivations can come from pressures from within the society or from the actor itself in desperate need for a change in its livelihood. In the case of Mzuzu, the rope pump can possibly be seen as a diversification strategy of the household to cope with the possibilities of unreliable water supply or the lack of sufficient water quality.
Bearing this in mind, this research will try to identify the impact the rope has on the household and if it can be seen as a household and/or diversification strategy.

The middle arrow of Figure 4 will be the main focus of this research. This will be accomplished through open-ended interviews giving the interviewee the space to answer with their own opinions. With this data, the five specific research question will be answered to further expose the 'impact arrow'.

An example of a household diversification strategy could be that a household gets a rope pump, after introduction, possible benefits like increased income or increased health and schooling occur. This additional benefit opens up opportunities for other strategies like fertilizer, pesticides or acquiring a bicycle/car and motivates the household to further improve their livelihood.

This approach is useful to determine, structure and analyse the impact of rope pumps on household income in Mzuzu, Malawi.

4. Results

In this chapter the results are presented and visualized. The data is presented per specific research questions. Firstly I will show the rate of functionality and what is important for it. After that, the gained data on maintenance, which is closely linked to the functionality, is presented, followed by the perception of rope pumps. Hereafter the impact on household income is shown and finally some differences of communal and individual (self-supply) rope pumps.

All 22 visited pumps, were installed by trained drillers who are also responsible for the concrete superstructure and the borehole or hand dug hole of the pump.

4.1. Purpose

Three major purposes can be distinguished for what the rope pump is used in Mzuzu. The main goal of the users is to decrease the monthly or quarterly water bill, which needs to be paid to the Northern Region Water Board (NRWB). Many households (82%) have piped water into their dwelling in Mzuzu. By making use of this water supply service monthly costs of over USD 35$ can occur in households with a high water usage. Because the pumped water is free of charge, this most often is the reason for purchasing a rope pump.

Secondly, the pump is used for supplemental irrigation of small gardens and dambos. Which are located in close proximity to the pump. This can on the one hand be done in the dry season to generate the possibility of growing crops the entire year and on the other open up the opportunity for different, water intense crops. This has the benefit of higher food production, which increases food security at household level and reduces monthly costs for food. Thus a general pleasing effect for households.

Thirdly, households with a rope pump can act as private water kiosks by selling the pumped water to neighbours in their community. Herefore often a structure is embedded so that people pay a monthly sum and have free access to the pump rather than paying for every bucket of water, which would need presence of the owner.

4.2. Functionality

From the visited 22 pumps, a total amount of 63% (14 pumps) was working. A major reason for this is that the pumps are taken good care of by their owners or managers. This implies that an effort is made to keep the pump functional for a longer period of time.

With this in mind, it can be said, that certain conditions need to be fulfilled for a successful functioning of the rope pump. **Fehler! Verweisquelle konnte nicht gefunden werden.** shows, the location of all known rope pumps in Mzuzu. It shows that the location to e.g. the main road does not have any effect on the functionality of the pump. Due to the fact that the person who installed the pump, the driller gets notified if a pump is unfixable, by the owner, he has to travel to the pump which could have indicated that he is less willing to do so by further away located pump. Concerning

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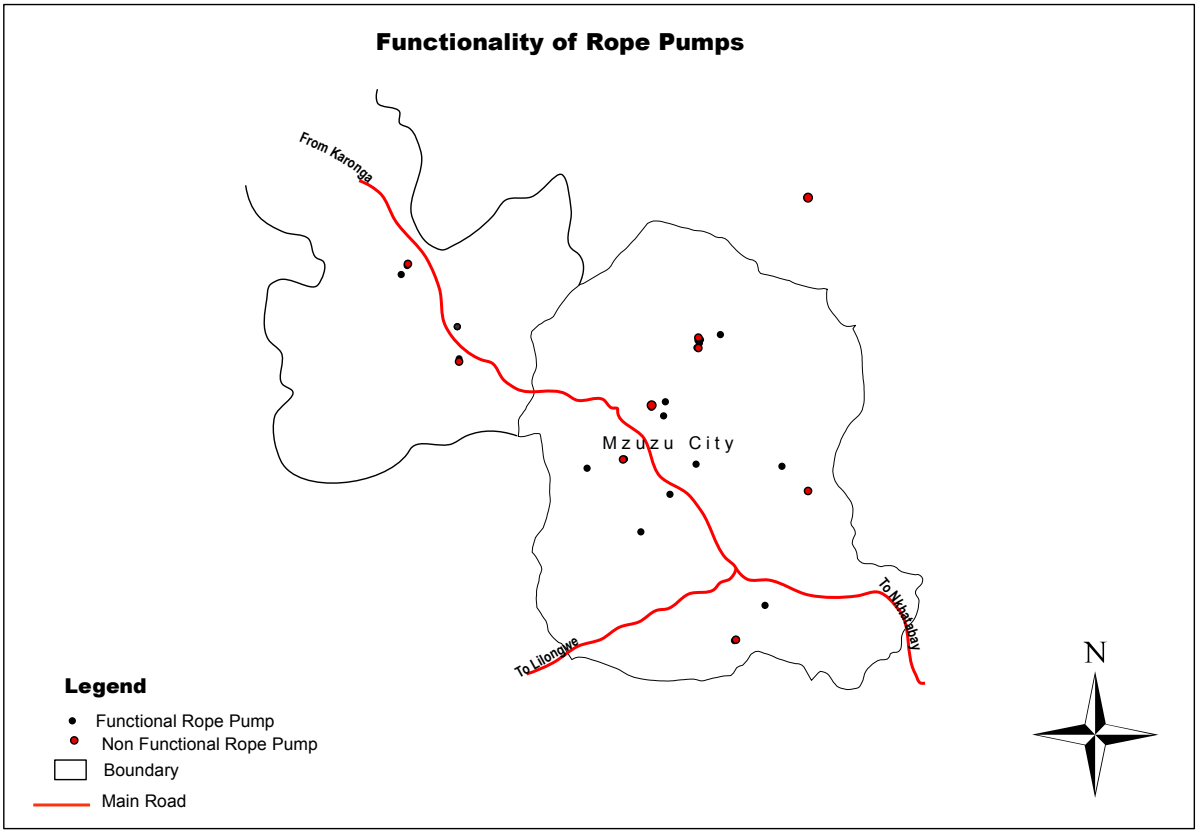

Figure 5 - Functionality of Rope Pumps in the closer Mzuzu area with main roads indicated. (Author, 2015)

piped water into their dwelling. Meaning this could have an impact on the motivation to keep the pump functional, as it is the only source of water for these households.
The main reasons for the nine non-functional rope pumps were due to a snapped rope (66%) or a loose guide box (34%). These issues can be categorized as rather small problems, which are normally easily fixable.

Another finding is, that when installed by the driller, it depends on how well the pump is delivered to the owner. Malfunctioning can occur due to bad installation and a lack of knowledge of maintenance. Furthermore often drillers do not have the time and/or budget to train the owners in maintaining the rope pump. Which would probably increase the functionality rate and the time were the pump is out of order. This leads to the next important aspect of rope pump use maintenance.

4.3. Maintenance

An issue, which plays a big role in sustaining the functionality of the rope pump, is maintenance. The normal sequence when a repair of the rope pump is needed is that the owner contacts the driller. After this the driller should come and repair the pump. The owner is responsible for the payment of the spare parts and the work time of the driller during reparation (personal communication Mzuzu SMART Centre staff). However this didn't seem to work all the time. Drillers had sometimes no intention to repair a broken rope pump.

It was noticed, that where there was a lack or absence of maintenance - meaning the regular taking care of the rope and washers, the handle and other parts of the pump - had a large impact on the overall functioning as well as on the perception of the pump, which is covered in the following chapter. The main reason for not working is, that the rope which tends to snap, caused the dysfunctioning. However, a new rope can be acquired from the driller and/or a local shop. This raises the question why these people don't act quickly and on their own to repair the pump as they say that it gives them a benefit. On the one hand the user doesn't notice to get enough benefit from the rope pump to immediately fix it, on the other hand fixing the rope pump cost time and effort to get the spare part from town and to actually work on it. This is especially the case when the household has access to piped water into their dwelling or close by.

Owners also said, that the rope rump is not suited for larger numbers of users, which lead to a quicker decrease in functionality. This because the wear and tear was drastically increased when more than 100 people use the pump everyday. Even though the pump was still recognized as a benefit the owners were not willing to repair the pump every month when used by larger numbers of users instead of roughly only once a year, when the usage is restricted to one household.

4.4. Perception of Rope Pump

The perception of the rope pump plays a crucial role in the impact on household income. In the following the results of the appreciation are described.

To better understand the perception, I have opted to gather data on what exactly is appreciated about the pump and why. The data was gathered through open-ended questions about the rope pump. Figure 6 shows that the users mostly appreciated the easiness of operation, they describe it as a low effort pump. Comparing this to other common pumps in the area such as the Afridev, Mark 5 or the Canzee pump, the users find the movement during pumping more pleasant with the rope pump.
Furthermore the affordability for individual (self-supply) users is an important point, people do not want to spend too much money on a new or additional water supply if already connected to the water board. Or there simply is no spare capital to invest into a new pump.

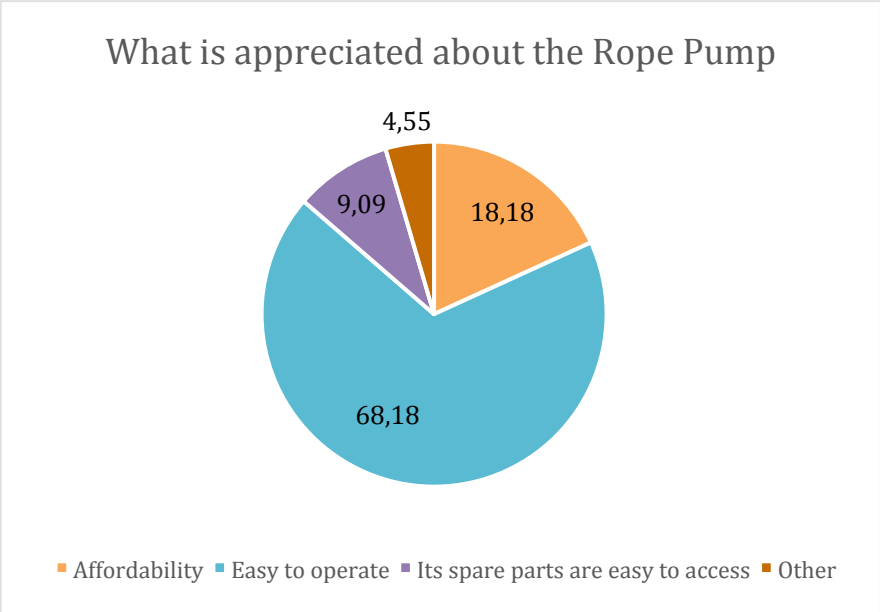

Figure 6 - Perception of Rope Pump by users in Mzuzu, Malawi (Source: Author 2015)

In addition to that people are happy, that the spare parts a locally available. Even though the owners self often don't buy the parts but the repair by the driller can be executed much faster without having to import spare parts from other locations.

These are the main reason why the pump is perceived as positive by 95% of the users and only one owner disagreed to the fact that her pump did not give water, which was a problem of the too low groundwater table. With this high percentage of appreciation, the impact is also influenced.

Box 2. Examples of Rope Pump Usage

A chicken farmer with now more than 6000 chickens used to have a rope pump directly next to his house. In the beginning, this pump was used to supply the workers and the farmer. However, as the quantity of chicken increased, there was also a need for a new water source. This was solved by installing a submersible pump, which could pump up to 6 m^3 per day to feed the chicken and to supply the domestic need. Now, the rope pump is not used anymore and the dug well has dried up possibly due to a decreased water level caused by the submersible pump.

In a small personal garden within a secondary school in Mzuzu a rope pump is used for agricultural practices mainly irrigating the crops and supply the gardener with supplementary water. This decreases the monthly water bill and also eases the work for the gardener. However as the water supply from the NRWB often is intermittent, the pupils of the school come into the garden to use the rope pump for drinking water, washing or other domestic purposes, which ultimately leads to a quicker malfunctioning of the pump than without this extra usage.

4.5. Impact of Rope Pumps on Household Income

The rope pump has a positive effect on household income, especially when the perception is positive, meaning that people are in favour of the pump and see it as an improvement to their livelihood and the pump is maintained well.
There are three effects in terms of monetary value that are related to the rope pump.

- Lower monthly water bill
- Higher food production and safety thus less monthly expenditures
- Selling of water

Firstly, Figure 7 shows that a large amount of monthly cost is invested into food (50%) and electricity/water (41%). The price per cubic meter of water charged by the NRWB is shown in Annex 8.3 and depends on the income of the household. The determination of the three classes traditional, medium and low is unclear. It was mentioned by the interviewees, that they found they price extraordinary high. Nonetheless however the roughly 35% increase in monthly income results from a big decrease in monthly water costs paid to the NRWB. The interviewed users earned about $USD 40 per month without having a rope pump, this figure increased by $USD 15 monthly (Table 1) meaning that one household has on average more than $USD 180 per year at their disposal. A significant increase due to the rope pump.

Table 1 – Average monthly income with and with out the Rope Pump including monthly benefits (all in USD equivalent 29.05.2015) (Source: Author 2015)

Average monthly income without pump (estimated)	Average monthly income with pump (estimated)	Average monthly benefit from the pump (estimated)
40.25	55.40	15.15

Secondly, although the electrical cost are not effected by the rope pump, some households could save on monthly food expenses by growing their own crops or by increasing the irrigated area of their dimba/dambo. This was especially helpful in the dry season, when precipitation is often not sufficient to grow crops.

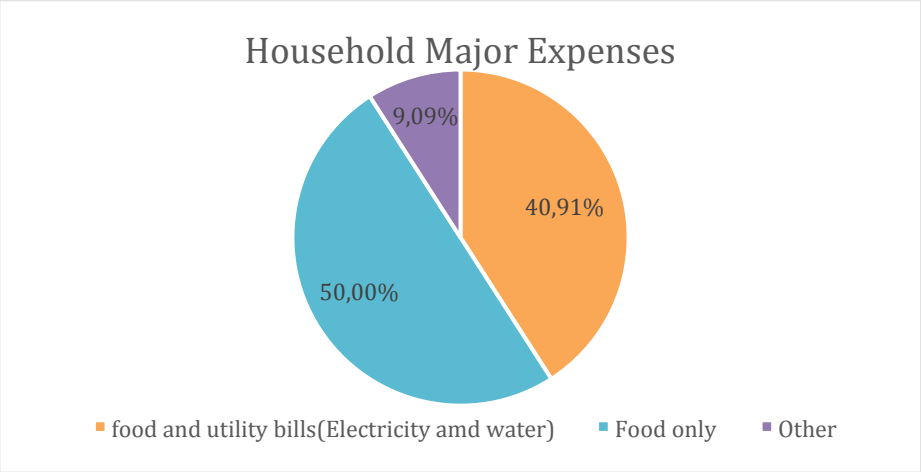

Figure 7 - Major households expenses for Rope Pump users in Mzuzu (Source: Author 2015)

Thirdly, other sources of water supply for people were a water kiosk, a neighbour (attached to the water grid), a river or well and a community pump for which they had to pay a fee expect for the water from the river or well. If the household promoted it well, it could achieve additional earning by selling water either per bucket or as a monthly flatrate.

It can be discussed weather it has an influence on the functioning, maintenance and perception if a household is connected to the water grid of the NRWB. In this study, more than half of the households (57%) had piped water into their dwelling (Table 2).
The study showed, that the perception definitely played a role in the usage and maintenance of the rope pump. This led to an increased usage and had a bigger financial impact. However, as the pumps occasionally break down, people with piped water take on average longer to repair their pump. Moreover, wealthier people also use the pump as an experiment for example for small back garden irrigation but when the materials such as pipes and hoses are not there, the pump is out of use even though it is fully functional.

Table 2 - Piped Water Source Percentage (Source: Author 2015)

Piped water into dwelling:	57%
No direct access to water:	43%

4.6. Difference between self-supply (individual) and communal supply

The main differences between self-supply rope pumps and communal pumps are that people see rope pumps suitable for individual households and not for multiple households within a community. However, only one of the 4 communal pumps was not working at the time of visit.

In Table 3 an overview of the distribution of SS and CS rope pumps is given. The in Box 2 mentioned pump at Mary Mount Secondary School is in this case categorized as a SS rope pump due to its intention as one. It was not planned to supply water to the pupils via this pump.

Table 3 - Type of supply by Rope Pump including functionality – From 22 in total (Source: Author 2015)

Type of supply	Self-supply (individual)	Communal supply	Total
Amount	18	4	22
Functional	11	3	14

5. Discussion of Results

5.1. Reflection on the methodology

In the following, the carried out research is reflected on how the methods used have had an influence on the gained results and in what way.

There are a number of flaws that can be recognised such as:

- The fact that some of the interviews needed to be translated created an extra link in the process and did lead to misinterpretation of the given answers. The answer given by interviewees was often much longer and more detailed than it was translated in a fraction of that time. I rather received a summary of the given answer than the full transcript. By this misunderstanding occurred and I lost important information during the process.
- Due to the inexperience of using interviews as a method, some answers have been over seen due to a too quick question sequence. Often when no answer or sufficient answer came, I went on to the next question possibly preventing me from getting additional information. This also led to not enough information and a lack of answers giving to some of the proposed questions.
- Some of the proposed questions were not specific enough to gather data directly related to the research objective like the ones about household income, which leads to the next point.
- It was difficult to get a grasp, estimation of the (monthly) household income due to the fact that many households had no specific, constant income and often were not aware of exact expenditure for example for food. Moreover some households weren't really willing in giving an adequate answer as they thought it was a very personal matter. Thus the given answers of household income and monthly increases are only estimations and cannot be seen as absolute.
- As there were only 22 pumps in Mzuzu and its surroundings, the pumps can be classified as not very rural. Meaning, that the users of the pump were in many cases not directly dependent on the pumps for water supply as it was not their only source of water available.
- The proposed use of the described conceptual framework, did not fully function in this case. On the one hand, the pumps were not rural thus they cannot be seen as a rural livelihood diversification after Ellis (1998) and on the other hand, the responses were fully deliberate and not involuntary to acquire a rope pump. Meaning, that

5.2. Purpose

The gained data on the purpose of the rope pump has yielded more than three main purposes. However in light of the research objective of this study, the main three (decreased water bill, additional irrigation and water kiosk) are mentioned here because they have the highest impact on the household income of the pump owners. As a large part of the monthly salary goes into the rather expensive water bills and into additional food supply, the rope pump can mean a lot for their users.

The found results are similar to the results found by Belli and Engelhardt (1995) where they evaluated the rope pumps in Nicaragua. In their study, the men mainly mentioned to use the rope pump for agricultural actions and the women and children mainly mentioned to use the water for cooking and drinking.
The main difference between this study and Belli and Engelhardt (1995) is the selling of water to the community thus acting as a water kiosk, which is more reliable than the one from the NRWB and making the pump owners to businessmen.
In the study from Alberts and Van der Zee (2003) also conducted in Nicaragua, the main use of the rope pump next to irrigation is for watering of livestock. In Mzuzu, only six pump users had a small to substantial amount of livestock (varying from one chicken or cow to up to 6000 chicken as explained in Box 2). However in these cases, the rope pump was not used for watering anymore.
Concluding it can be said, that the results gained in Mzuzu in 2015 show similarities made in other research probably due to the nature, that the rope pump has limited abilities when thinking in lager scales.

5.3. Functionality

In order to understand and analyse the impact of rope pumps, one needs to understand how the functionality of these pumps look like and why.
It is very important to keep the pump functional in order to see a benefit in it.

As the Mzuzu SMART Centre is still working and developing on the current rope pump model, there were small changes in design of the found rope pumps, that however had mainly to do with the way of installing and making sure that the pump would be easily repairable and had no impact on the functionality of the pump.

In an advised paper by Holtslag (2014) it is mentioned, that if the rope pump is properly produced, installed and maintained over 90% should be expected to remain functional even after a longer period in time. The very high percentage of expected functionality cannot be matched in Mzuzu. As only 63% of the pumps were working after an introductory period of about two to three years. The results found in Ethiopia however were close to the ones in Mzuzu where only 50% - 67% was still functional during the survey.
Seven out of the nine malfunctioning rope pumps were in my opinion easy repairable as only their rope was snapped, loose or stuck in the guide box. In the other two cases, the water level decreased leaving the guide box dry so there was no chance of lifting water without increasing the depth of the borehole.
The one community rope pump that wasn't functional during the visit was in Area 1B. The group village headman (GVH) said that the pump was already out of usage for a couple of months and no intentions were made to fix it even though he expressed that the pump has a great positive effect on the community. This answer was in contrast to the actions carried out. As none of the households had piped water into their dwelling, they had to get water from a neighbour or fetch it from the river about 500m away. It

remained unclear after interview other members of the community why there was no effort to fix the pump.

5.4. Maintenance

Maintenance is a crucial aspect in the lifetime of a rope pump. If not maintained, at least weekly, breakdowns will occur more often then when regularly maintained.
A positive point about the rope pump is that spare parts are locally made and accessible. This opens up for a quick repair and a high local sustainability.

I think, that during installation, more effort should be made towards teaching the user how to maintain the rope pump and more emphasis needs to be expressed on how important it is to maintain the pump. The visited pumps in Mzuzu had an average age of two to three years, but the owners often said that they don't carry out any maintenance as they think, the pump works for itself. When the bushings don't receive a drop of oil regularly, they will probably eventually break. In comparison, in Nicaragua rope pumps of 20 years old still have the original bushings because they are oiled every week (Holtslag 2014).

In addition, communal pumps that are better taken care of i.e. locked at night or receive regular maintenance have a higher chance of succeeding. Especially when the pumps are rather exposed to people who illicitly use them, often in the dark.

5.5. Perception

Alberts and Van der Zee (2003) found that the rope pump in Nicaragua is seen as highly reliable and when broken down, spare parts are easily accessible. The same is applicable for the rope pumps in Mzuzu. During short courses and workshop where people learned about low cost technologies, I often heard, that people want to buy a rope pump for themselves. 95% of the users seemed to at least be in favour of the rope pump even though experiencing problems.

As mentioned in the introduction, the spread of the rope pump in many SSA countries is slow and not very successful (Sutton & Gomme 2009). It is extremely important to realize, that rope pumps are simple but simple does not necessary mean easy. For this reason the pump producer, driller and the organisation promoting the rope pump need to sell it in a adequate way because bad pumps result in a bad image which ultimately leads to less sales (Holtslag 2014).

5.6. Impact on household income

91% of the monthly costs are invested into food and electricity/water. The rope rump has an affect on both factors meaning, that it has a big impact on the expenditures. With increased water bills and the opportunity to irrigate or increase the agricultural area both expenditures decrease giving the household an additional buffer in the way of

having more money left over at the end of every month. In addition to this money is made on top of this by supplementary services such as selling of water, promoting the pump and sometimes repairing other pumps.

Furthermore there are as well other benefits for their livelihood strategies such as Increased health and time, which results in higher schooling rates. Another benefit is the independence from NRWB.

The visited pumps are all in rather close proximity to a water source, may it be a pump, a neighbour who is connected to the water grid, a river or well. The rope rumps in Mzuzu are not very rural situated one could rather call them semi-rural. For this reason, there is a difference in the essential necessity of the rope pump. If one has no (close) access to any water source, the rope pump would mean potentially much more than it does with in an urban area such as Mzuzu.

Finally, the income increase of about 35% is in correlation with the results found in Nicaragua by Alberts and Van der Zee (2003) where an increase of up to 50% was found. It however, needs to be mentioned, that there are definitely variations in the income of the interviewed rope pump owners. Some of the owners belong to higher income groups with good educational backgrounds for which a slight increase would not be essential. Nonetheless also these groups are positively impacted by the pump and are happy to such.

6. Conclusion

In this chapter, overall conclusions will be drawn from this research.
Whether it succeeded to meet the objective of this research, namely to gain insight in the impact of rope pumps on household income in Mzuzu, Malawi will be elaborated in this chapter.

This research was aimed at answering the following main research question: *How do communal and individual rope pumps impact family's income in Mzuzu, Malawi?* This main research question was divided in to five specific questions:

- *For what purposes is the rope pump used?*
- *What is the functionality and what influences it?*
- *How is maintenance organized?*
- *How do different actors (households, implementing organisations, community leaders) perceive the working and functionality of the rope pump?*
- *What differences are there between self-supply and community rope pumps*

When looking at the first specific question, it can be concluded, that the rope pump is well in use and has found its purpose within the household mainly for exchanging paid piped water, for supplementary irrigation and selling of water.

Looking at the second, third and fourth specific question, it becomes clear that the functioning of the rope pump is strongly related to the maintenance. Pumps that receive a high maintenance are longer functional and have a better perception due to the stable and long functioning. It was obvious, that seeing well build and properly installed, working pumps had an effect on the people noticing the pump. In addition, the perception of the pump was good.

Concerning the fifth specific question, the differences between SS and CS rope pumps are not that big to make a different impact.

Also the differences in households have to be taken into account, is the pump owner wealthy and just experimenting with the pump or is the household rather poor and using the pump as a way to improve their livelihood.
There was no clear line of the acquisition of the pumps. Three of the 22 pumps were donated to the people of, which two are community pumps. These three pumps were mainly meant for promotional services.

Furthermore, the rope pump could be used more efficient, in a marketing and promotion perspective as well as increased irrigation usage. Right no many owners tend to not promote their pump and give away water for free, if this would change, the pump could spread more and the benefits could be even more increased.

Linking the results made to the conceptual framework, it can be said, that the households (actors in society) had a motivation to change their livelihood and thus the rope pump can be seen as a household strategy. Furthermore, as the NRWB provided unreliable water supply to its users, the pump led to a certain degree of autonomy, which was highly appreciated especially in places where the water was essential for daily practices like watering livestock or using it in a restaurant. Both points were thus helpful trying to determine the impact of the rope pump. However the theory of rural livelihood diversification form Ellis (1998) did not help in this process as the conditions made by Ellis were not fulfilled in Mzuzu. The rope pump is not a survival strategy of the people in Mzuzu.

Answering the main research questions, the rope pump does have a positive impact on household income. There are different strategies pursued by the households, to optimize the benefits gained from the rope pump. In total an average amount of up to $USD 15 could be earned monthly making up for an average estimated increase of 35% per month.

There are not so many differences in household livelihood strategies between the pump owners, however the rope pump can be seen as one part of a diversification strategy, that opens up new alternatives in the process of coming out of poverty or sustaining a livelihood an a sufficient manner. It thus has become clear, that the users who procure a rope pump are willing to invest in an additional and/or improved water supply service.

In summary, it can be ascertained that the quality of live has been improved through the rope pump.

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8. Annex

8.1. Annex 1 - Proposed open-ended interview questions for users of rope pumps

Concerning SRQ1 How do different actors (households, implementing organisations, community leaders) perceive the functioning of the rope pump and its possibilities for being put to use differently?

- Do you like rope pumps? If so, what do you like about the rope pump?
- Are you in favour of rope pumps?
- How do you compare rope Pumps and other type of technologies for water supply?
- For what uses do you (or can people) use rope Pumps?

Concerning SRQ2 How do different households organise their livelihoods and their agricultural production and what are relevant differences between these strategies?

- What are your main crops?
- What is the size of your gardens? (in ha)
- How many growing seasons (cycles) do you have each year?
- What are major household expenses?

Concerning SRQ3 How do communities organise the management of common resources and the distribution of responsibilities and benefits, particularly regarding water technologies such as the rope pump?

- Who is in charge of the water management?
- Who is in charge of the rope pump?
- What activities does the person in charge or water management or the rope pump undertake?

Concerning SRQ4 How have rope pumps distributed in the period 2012 - 2015 been operated and maintained in the first 2 years after installation?

- When was your rope pump installed?
- Who does the (current) maintenance?
    - What does the maintenance consist of?
    - When was it maintained for the last time?
    - How often do you have to do maintenance work?
- How many breakdowns has this pump experienced in the last two years? And what types of breakdowns were there?
- How long did it take to repair the pump each time it broke down?
- How do you rate the performance of the pump in the last two years? (1-10)

Concerning SRQ5 In households where water availability was improved through the rope pump, how has this affected household income and by how much?

- How has the rope pump affected your household income?
    - Regarding the household income, has anything changed since the rope pump was installed?
    - Do you earn more or less with a rope pump?
    - In what ways do you earn more or less with a rope pump?
    - Do you see opportunities for further income improvement due to the rope pump?

8.2. Annex 2 - List of Pumps

The list is showing the GPS positions for all 22 visited pumps of this study. The average elevation above msl. is give as Z GPS.

Table 4 – List of Rope Pumps in Mzuzu including their GPS location (SOURCE: Author 2015)

Code Number	X GPS	Y GPS	Z GPS
1	-11,46931700	34,00394800	1278
2	-11,44150590	34,03693020	1312
3	-11,46455460	34,01109790	1272
4	-11,44566890	33,99329840	1277
5	-11,4419570	33,99568000	1260
6	-11,44150700	33,99783100	1253
7	-11,36285529	33,87622384	1211
8	-11,39655435	34,00509712	1276
9	-11,40253900	33,96773200	1325
10	-11,41498718	33,99465739	1278
11	-11,39267555	33,93276105	1258
12	-11,40284400	33,93510000	1307
13	-11,41867300	33,99628200	1291
14	-11,41660298	33,99053146	1272
15	-11,39592200	34,05227200	1357
16	-11,39500116	34,01098141	1278
17	-11,39672719	34,00437376	1302
18	-11,39890376	34,00401629	1305
19	-11,43473262	33,97139881	1263
20	-11,45359962	33,98737756	1269
21	-11,43350903	34,00379891	1238
22	-11,44246092	33,99601158	1256

8.3. Annex 3 – NRWB Water Tariffs

The NRWB has a categorization system for its customers. Meaning, that depending on type (commercial, institutions and individuals) and income (traditional, medium and low) they are charged differently per m^3 (NRWB 2013). Table 5 indicates the discrepancy in charges made.

Table 5 – NRWB Water Tariffs approved since July 2013 (Source: NRWB 2013)

Category	Chare in Malawi Kwacha (MK)		
	Service	Base	Rate per Unit
Institution	2,210.91	1,119.27	384.95
Major Institutions	4,252.47	1,175.76	404.38
Commercials	2,780.21	1,376.38	618.44
Major Commercials	5,387.24	1,606.58	721.85
Individuals (traditional)			
5 - 10 m^3 (per m^3)	355.62	577.42	149.76
More than 10 m^3	355.62	577.42	160.27
Individuals (medium)			
5 - 10 m^3 (per m^3)	621.80	686.66	173.46
More than 10 m^3	621.80	686.66	185.60
Individuals (low)			
5 - 10 m^3 (per m^3)	922.84	764.21	198.25
More than 10 m^3	922.84	764.21	212.12
Communal Water Points			
5 - 10 m^3 (per m^3)		473.48	71.50
More than 10 m^3		473.48	107.28