

Feasibility study implementation Water4life filters in Mpongwe



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Preface

As a student “Biologisch en Medisch Laboratoriumonderzoek” of the faculty Life Sciences of the Zuyd University, I’ve written this report for the research I’ve conducted in the Mpongwe district (Copperbelt province, Zambia), as commissioned by the foundation Water4life.

The goal of this research is to see if it is feasible to introduce the Water4life Water purifier in Mpongwe.

From the bottom of my heart I would like to thank Mrs Korsten from the GCMF-foundation and Mr Vrinzen from the Water4Life-foundation, for giving me this unique opportunity.

I would also like to thank Ntazana, not only for being one of my best friends during my stay in Zambia, but without his interpreting, my work would have been lots harder.

And last but not least, my thanks go out to Mike Masona for all the help in the laboratory.

Geleen, Oktober 2009

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Summary

Clean, safe drinking water is still something that 1 in every 6 people on the world have no access to. Contaminated water contains various biological agents which can cause diseases. One of these areas where people don't have safe water at their disposal is the Mpongwe district in Zambia.

The foundation Water4life has developed a solution to the problem; a water purifier unit consisting of 2 buckets, with a set of filters in between to clear the water.

To implement such device research had to be conducted in 3 area's:

- How bad is the quality in the Mpongwe district?
- What is the level of knowledge of people on the area of safe drink water?
- What are the possibilities for the production of the filters from Water4life on a local level?

Microbial analysis of water samples showed that the water in the Mpongwe district is heavily contaminated. Even the tapwater is not to be thrusted. However, with the use of the Water4life Gravity unit the water becomes safe to drink.

The people in the Mpongwe district are aware of the quality of the drinking water, and do acknowledge that the water is an important cause for many of the illnesses that do occur. All people asked where enthusiastic about the Water4life Gravity unit.

According to the Mpongwe Business Association there is enough craftsmanship present in Mpongwe to locally produce the "buckets" of the Water4life Gravity unit. According to the MBA, the filtercandels, the hearth of the Water4life Gravity unit, should at first be imported, and in a later stage locally produced as well. The MBA stated that students from the Zuyd University, with the help of GCMF and Water4Life, would be more than welcome to help setting up a business plan.

List of abbreviations

WHO	World health organization
GCMF	Give the Children of Mpongwe a Future
MBA	Mpongwe business association

List of definitions

Pathogens	Microorganisms that have a malignant effect on health
Saline	Solution of 0,9% (m/v) Sodium chloride. Has the same osmotic properties as extracellular fluids in most organisms.
Inorganic	Compounds of mineral origin.
Organic	Compounds of biological origin.
Distillation	Method of separating based on differences in their volatilities in a boiling liquid mixture.
Filtration	Filtration is a process which is used for the separation of solids from fluids by interposing a medium through which only the fluid can pass.
Disinfection	Treatment with antimicrobial agents, that are applied to non-living objects to destroy microorganisms.
Rural areas	Large and isolated areas of a country, often with low population density.

I Introduction

Clean, safe drinking water is one of the most basic needs for man. Unfortunately there are still large parts of the world where potable water is scarce. According to data published by the WHO 1 in every 6 people on earth does not have access to safe drinking water^[1].

Water can be polluted in 2 ways:

- Inorganic pollution. For example pollution consisting of metals.
- Organic pollution. In most cases present in the form of large quantities of bacteria, molds and other pathogens.

Inorganic pollution does occur a lot in the surroundings of heavy industrialized areas and garbage dumps. This type of pollution is difficult to remove, and this kind of water should normally be avoided.

Organic pollution occurs naturally in surface water and groundwater that is located just beneath the surface. This type of pollution occurs naturally all over the world.

Organic pollution can be removed from water with a broad scala of techniques, for example UV-radiation, distillation, microfiltration, chemical disinfection or a combination of previous mentioned and other techniques.

Unfortunately a lot of these techniques are not available for a lot of people, especially people in developing countries. Causes can be that the infrastructure is not suitable, or that people just don't have enough money.

A solution for this problem are the waterfilters from the foundation Water4life. These filters will clean the water with a combination of microfiltration and chemical disinfection. By these means the number of bacteria in the water is reduced by 99.99%. ^[2] These filter systems are relatively cheap to produce, en can be used at the most remote locations.

One of the areas where people are not able to access safe water is the Mpongwe district in Zambia. The goal for this research assignment is , with the collaboration of the foundation Give the Children of Mpongwe a Future (GCMF), to investigate if the water filters from Water4life can be a solution to the problem in this area. The ultimate goal is to improve the quality of water, and thereby improving the quality of live. To achieve this goal, a few questions need to be asked:

How bad is the quality in the Mpongwe district?

Not everywhere in the whole district shall the water quality be as bad. Perhaps in the urban areas the water is quite safe to drink.

What is the level of knowledge of people on the area of safe drink water?

If people don't see the importance of safe drinking water, a lot of improvements have to be made on education before a solution as the water filters from Water4Life can be implemented. Research needs to be conducted to the attitude of the people towards improvement of water quality.

What are the possibilities for the production of the filters from Water4life on a local level?

In the most preferable scenario the filters can be produced in Mpongwe, or somewhere else in Zambia. In this way a lot of jobs can be created, and the people or dependable no more on a foreign foundation.

2 Theory

2.1 Zambia

Zambia is a republic in southern Africa. With +/- 750.000 square kilometers it is 18 times as big as for example the Netherlands. However, only 12 million people live in Zambia. The neighboring countries are Congo, Tanzania, Malawi, Mozambique, Zimbabwe, Angola and Botswana.^[3]

Zambia has been an English colony until 1964. English is still the official language. This is due to the fact that there are more than 70 languages spoken by the native Zambian people, so English was a more neutral choice for a language. However, in the Copperbelt province the language Bemba has the role of lingua franca. Despite the fact that everyone speaks and understands English to an certain extent in the more urban areas, the use of Bemba is appreciated by the local population.

The Zambian culture differs on a lot of points from our western culture. It is very hard to describe this in a few words, but to give a brief summary it is good to say that patience is a very important skill. For example, it is not exceptionally that people show up late for appointments. Even simple things as doing some groceries is something that easily takes up half a day. Also asking a quick question is very difficult, people always will have a chat with you before they help you any further.

Also, Christianity plays a huge role in the everyday life of the Zambians. On Sunday (or Saturday for Seventh-day Adventists) preferably no labor is conducted, instead people go to church to celebrate their believe. If one wishes to be accepted in a small community it deserves recommendation to show up in church, especially the first Sunday of their stay.

The Zambian infrastructure is not very alike the one in western countries. The roads aren't always paved with asphalt. Even main roads sometimes are not easily accessible due to large craters in the mud-covered road.

Busses have the tendency not to drive on fixed times, but will depart only if all seats are taken.

Also, electricity isn't always reliable. Blackouts every now and then are not totally uncommon. End when there is electricity, the voltage can have any value between 200 and 250 volt.

Even the tap water can't be trusted. There are only few places in Zambia where you can drink the water safely. Besides, in most part of the country running water is only available during certain times of the day.

In a large part of the country, especially the rural areas, tap water isn't available at all. In the best case people can obtain their water from a borehole, but there are also a lot of people who have to obtain their water from streams and wells.

2.2 Mpongwe

The Mpongwe district is a rural area in the Copperbelt province in Zambia. The similarly named place of Mpongwe is the biggest city in the district, and is situated 70 km south of Luanshya. Most people in the district live together with a few to tens of people in small villages. They bear the for us most common things like electricity, fuel and running water. These are the key areas for the feasibility study for the implementation of the water4life filters.

The foundation “Geef de kinderen van Mpongwe een toekomst” (in English “Give the children of mpongwe a future” or GCMF) is based in Mpongwe. The foundation is a personal initiative from Ton Korsten-Korenromp, teacher at the Zuyd University faculty Verpleegkunde. The foundations core activity is, by means of education, giving the children of Mpongwe a better future. Through the years the foundation has broadened its activities, and today it’s supporting many different projects on different topics, like education, health care, economic development and sanitation. Also the help of the foundation is of immense value for this study.

2.3 Water4life

Water4life has started as a project with DSM Geleen (the Netherlands). At the moment Water4life is an independent foundation with the main goal of developing products which can be used by people in developing countries to obtain safe drinking water. One of the core values to achieve this goal are obtaining high quality at a low cost price. Maybe en even more important value is to aim for local production, thus creating employment and reaching a higher level of sustainability.

One of the most successful products so far is the Water4life Gravity Unit. The usage and maintenance of this product is very simple (see appendix III). In short, this system consists of 2 buckets placed on top of each other. In the upper bucket the untreated water can be poured. The water will then flow through a filter in the lower bucket where it will be clean and drinkable. The lower bucket is equipped with a tap that can be used to obtain the water. (see image 2.3.1)



Image 2.3.1 The Water4life Gravity Unit

Before the water is allowed to flow in the lower bucket, it has to pass 2 or 3 physical barriers (see image 2.3.2).



Image 2.3.2 Rendition of the Water4life filtercandels.

The first barrier consists of a ceramic filter that will retain a large fraction of all bacteria and almost all protozoa and helminthes.

The second barrier consists of a colloidal which is impregnated throughout the ceramic filter. Colloidal silver is known for binding to the cell wall of pathogens, and thereby disabling their oxygen metabolism. This causes the pathogens to suffocate.

The third, optional, barrier consists of activated carbon, a substance known for its property to bind chlorine, iron and several flavors and fragrances. Although the capacity of the activated carbon is insufficient to retain heavy chlorine and iron contamination, it does improve the smell and taste of the water.

In the Water4life Gravity Unit filtercandels from different manufacturers are used. The ones used during this study are manufactured by the Indian company Rajaniklal. Despite the lack of the third barrier, consisting of activated carbon, these filters still succeed in retaining the required 99,99% of bacteria.^[2]

2.4 Effects of unsafe water on human health

In large parts of the world people still lack access to safe clean drinking water. This has a gigantic effect on the health of billions of people. In 2006, the world lost a total of 1.490.126.000 disability adjusted life years (DALYs) from various diseases and conditions. About 61.966.000 of the lost DALYs resulted from diarrhoeal diseases. An estimated 37.5% of the diarrhoea-related DALYs was lost in African alone. ^[4]

Diarrhea commonly results from gastroenteritis caused by viral infections, parasites or bacterial toxins. ^[5] Biological agents responsible for diarrhea can enter the body in various ways, for example through contaminated drinking water.

Acute diarrhea is a common cause of death in developing countries and the second most common cause of infant deaths worldwide. The loss of fluids through diarrhea can cause severe dehydration which is one cause of death in diarrhea sufferers. A study with partial results released in October 2009 suggests diarrhea is now estimated to cause 3 times more deaths than previously thought, at 1.1 million annually for people aged 5 and over, up from 300,000 assumed in a 2002 study. ^[4]

Cholera is one of the causes of diarrhoea. The biological agent that causes cholera is *Vibrio cholerae*. The bacterial agent is associated with conditions that force populations to live under conditions of inadequate housing, inadequate excreta disposal systems, lack of potable water, floods, unhygienic human behavioural practices, poverty, civil unrest leading to internal displacement of people, and unhygienic food production, distribution and handling systems. ^[6]

Schistosomiasis is yet another disease one can acquire from unsafe water. Schistosomiasis is caused by several species of the genus *Schistosoma*, hence the name. These helminthes enter the human body and are the cause for the parasitic disease Schistosomiasis. Although fatality rate is low, some serious damage can be inflicted on the internal organs, and children can even cause impairment of growth.

Polluted water is often also infected with *E. coli* 0157:H7. This serotype (one of hundreds) naturally occurs in human faeces. It produces powerful toxins which causes severe illnesses. This serotype of *E.coli* often is a key indicator that the drinking water is also contaminated with other biological agents. Since this serotype naturally occurs in human faeces, presence of it in water indicates bad hygiene. ^[7]

Above mentioned are only some examples of the various biological agents which can be present in drinking water. Therefore it is necessary to treat water before human consumption.

3 Material en methods

3.1 Visits to the villages

To investigate if people are really willing to use a product like the Water4life gravity unit it is important to reach out to the target audience. This was achieved visiting the villages in the more rural areas, and question people about their knowledge of potable water, the way they practice hygiene and if they are willing to use an product like the Water4life Gravity unit.

Unfortunately, people in these areas do not always speak fluently like in the urban areas. Therefore communication had to go through an interpreter. In all the villages that where visited water samples have been taken, which were analysed in the laboratory of the Mpongwe Mission hospital. An improvised cool box has been used to inhibit microbial growth in the sample tubes.

The villages that have been visited are all located within 10 kilometres from the center of Mpongwe town.

3.2 Water analyses

The analysis of the drinking water started with the sample taking. Giving the fact that transportation of the water and possible processing steps are all factors that affect the quality of the water, a sample was taken from the water that is ready for consumption. Furthermore, it is of grave importance that the samples were kept as cold as possible to slow down metabolic functions of the micro organisms (to prevent cell division) before the actual analysis took place.

The actual analysis has took place in the Mpongwe Mission hospital. The analysis was performed by incubating culture media plates with different dilutions of the water samples. Unfortunately this method is only suitable to give an indication of the level of contamination. More advanced analysis techniques where not possible due to the limitations of the presence of laboratory equipment. However, the amount of bacteria in the water samples is a good indication for the organic pollution of the drinking water. For a complete analysis protocol, see appendix II.

To determine whether the Water4life Gravity unit worked as it should have, a sample of a larger quantity (+/- 10 liter) has been taken. This sample was filtrated with the use of the Water4life Gravity unit before the actual analysis will take place. Not for all the villages this was possible because the source of the water can't be too far outside the village, and transportation could also be a limiting factor due to the large quantity.

3.3 Questionnaires

During the visits the villages the most important source of information were the people themselves. By asking the right questions a quite complete image of the situation can be obtained. It is of grave importance to get insight in the following categories:

Demographics

The size and composition of the community are an important factor. Also the presence of animals and the association with them is a very important factor.

Water supply

Of course it is important to know where people get their water and under what circumstances.

Level of knowledge

A key factor in this study is to investigate if people know about the importance of safe and clean drinking water.

Illness

It is also important to know if there are a lot of illnesses in the villages, and if people think it is due to the water quality.

Hygiene

The level of hygiene that is practiced is of great influence on the distribution of pathogens.

Willingness to adapt

It is also of great importance to know if people are interested at all in the improvement of the water quality, and what they are willing to do about that.

For the complete questionnaire see appendix III.

4 Results

The results are based on the outcome of the questionnaires held in the villages and the microbial analysis of the water samples. The complete list of answers given to the questionnaires can be found in appendix IV. The complete list of results from the microbial analysis of the water samples is presented in appendix V.

4.1 Summary answers questionnaire visits to the villages

This data is compiled out of 17 visits to villages throughout the Mpongwe District.

Water supply

Where do people get their water from?

15 villages get their water from a well in or near their village.	(88%)
1 village get their water from a borehole.	(6%)
1 village get their water from a stream.	(6%)

How long does it take to get water?

In 13 villages it takes less than 5 minutes.	(76%)
In 3 villages it takes between 5-30 minutes.	(17%)
In 1 village it takes 30 minutes or longer.	(6%)

In what container is the water taken back home?

In 15 villages plastic jerry cans are used.	(88%)
In 4 villages metal buckets are used.	(24%)
In 1 village plastic bottles are used.	(6%)

Will the water be processed before it will be consumed?

In 10 villages chlorine is (sometimes) used.	(59%)
In 6 villages the water will be used straight at all times.	(35%)
In 1 villages the water will be boiled before use.	(6%)

Who is responsible for the water supply?

In 12 villages everyone is equally responsible for getting water.	(71%)
In 3 villages this is a task of the elders.	(18%)
In 2 villages this is a task of the children.	(12%)

Level of knowledge

Do the children attend school?

All children in the villages who have reached the appropriate age attend school. 100%

Does the school provide education on water safety?

The school provides education on water safety in 5th, 6th and 7th grade. (age 11-15)

In 7 villages people are aware of this. (41%)

In 9 villages people are not aware of this. (53%)

In 1 village no children resided. (6%)

Are there other forms of education on the subject?

No there are not. All people in the villages are aware of this fact. 100%

Illness

Are people often sick? (diarrhea, malaria)

In 13 villages people said they do get sick often (> 2 times a year). (76%)

In 4 villages people claimed they don't get sick often (< 2 times a year). (24%)

Do they think they are sick because of the water?

In 11 villages the people did think water is an important cause. (65%)

In 6 villages the people did not think water is an important cause. (35%)

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

In 17 villages people have reacted positive to the concept. 100%

How many time are they willing to spend on such an apparatus?

In 17 villages people stated they don't mind about the waiting time. 100%

What is the maximum amount of money they are willing to spend on water safety?

In 12 villages the people insisted on first seeing the device. (71%)

In 5 villages people responded positive to a price of about 150.000 K (+/- \$27). (29%)

From these results it is clear that there is a big market for the water4life water purifier, since all people asked replied very positive. A large part of the people asked also sees the importance of safe drinking water, and acknowledges the consequences of drinking the water they are using now.

4.2 Results analysis water samples

4.2.1 Villages

The analysis of the water samples taken in the villages showed that the quality of the drinking water in all of the villages was below the WHO requirements.

Village	Bacteria present in water sample (per litre)
Village #1 – Musomba village	2,53E+07
Village #2 – Lese village	1,27E+05
Village #3 – Chiefteness palace	8,50E+04
Village #4 – Malulamba village	1,65E+05
Village #5 – Manshansha village	2,06E+05
Village #6 – Malembwe village	2,26E+05
Village #7 – Chipante village	2,71E+05
Village #8 – Kekombela village (1)	1,51E+05
Village #9 – Kekombela village (2)	8,30E+06
Village #10 – Mpenda village (1)	2,42E+05
Village #11 – Mpenda village (2)	6,20E+06
Village #12 – Kalasala village	2,87E+05
Village #14 – Kekombela village (3)	1,05E+07
Village #15 – Sweete village	1,94E+05
Village #16 – Kabuba farm	3,00E+06
Village #17 – Chisakulo village	8,80E+04

Table 4.2.1.1 Overview results analysis water samples taken in the villages.

4.2.2 Mpongwe tap water

The quality of the tap water in Mpongwe was slightly better than the quality of the water in the villages, but it still doesn't meet WHO requirements. Sample 1 was taken in the GCMF guesthouse. Sample 2 was taken in a house in Mpongwe.

Mpongwe tap water	Bacteria present in water sample (per litre)
Sample 1	2,45E+04
Sample 2	3,50E+04

Table 4.2.2.1 Overview results analysis water samples taken from the tap.

4.2.3 Water4life water purifier

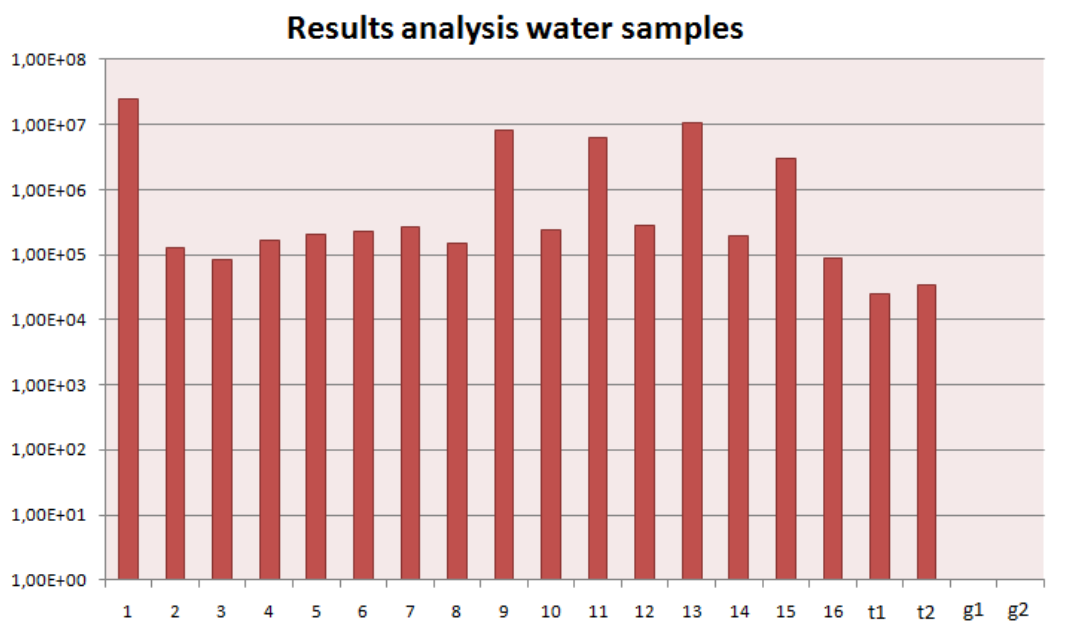
Not a single bacterium was found in the water after the Water4life water purifier was used. Before the water was filtered the device was cleaned, according to the manual (see appendix I). Sample 1 was prepared while using the water from Musomba village. Sample 2 was prepared while using the sample from Kekombela village (3). During the filtration process the device was still used for providing potable water, using the tap from the lower subunit.

Water4life water purifier	Bacteria present in water sample (per litre)
Sample 1	0,00E+00
Sample 2	0,00E+00

Table 4.2.2.1 Overview results analysis water samples taken from the Water4life water purifier

4.2.4 Overview results analysis water samples

Below is a overview of all results so a clear comparison can be made. Note that the y-axis is divided logarithmically.



Legend

Village

1	Musomba village	8	Kekombola village (1)	16	Kabuba farm
2	Lese village	9	Kekombola village (2)	17	Chisakulo village
3	Chiefteness palace	10	Mpenda village (1)	t1	Tapwater 1
4	Malulamba village	11	Mpenda village (2)	t2	Tapwater 2
5	Manshansha village	12	Kalasala village	g1	Water 4 Life Gravity unit 1
6	Malembwe village	14	Kekombola village (3)	g2	Water 4 Life Gravity unit 2
7	Chipante village	15	Sweete village		

5 Discussion

Not every figure in this report is as accurate as it would have been if this research was conducted in a developed country. Due to some limiting conditions, some improvisation was needed to cope with challenging problems.

One of those problems was that it was not possible to refrigerate the water samples taken in the villages before the microbial analysis would start. This is necessary to prevent the bacteria from multiplying in the sample collection tube. The problem was somehow solved by making a “refrigerator” out of a plastic bag (coated with tin foil). For the cooling properties sachets containing a 40%(v/v) ethanol solution (which were sold on the Mpongwe market for human consumption) were cooled in a freezer and placed in the bag. At the end of the working day the temperature in the “refrigerator” had still not exceeded 10° C. Although at this temperature microbial growth is not completely inhibited, the results are more accurate.

Another problem is the fact that the Mpongwe Mission Hospital (where all laboratory work has been conducted) didn't have enough Petri dishes in stock. For that reason the 2 strongest dilutions have been omitted, and also the usual triple analysis's had to be cut back to 2 analysis's per dilution per sample.

Yet another problem in the laboratory was the fact that due to the high temperatures (caused by the climate and the laboratory equipment) the agar didn't solidify within the usual 20 minutes. Some added cooling in the form of icepacks speeded up the process, but the plates needed to be treated carefully afterwards to prevent them from cracking.

Unfortunately no characterization of pathogens was possible with the available means. The conducted experiments with nutrient agar only showed bacterial contamination. Although neither viruses, helminths or moulds were tested for, determination of bacterial contamination is a good indicator for the real microbiological contamination.

Of course, the use of questionnaires is always a bit tricky. People always tend to bend the truth a bit to tell you the answer you are most likely wanting to hear. However, as long as one judges the results critically, questionnaires are a very fast, efficient and powerful research tool. The results are in line with the views and opinions of many professionals spoken to during the research.

6 Conclusion

The results clearly show that the amount of bacteria in the drinking water of all the villages exceeds the WHO requirements with even up to a factor 100.000 and even more. Drinking this kind of water is can be a serious health threat to children, the elderly, people with an compromised immune system, and even healthy people.

Thanks to the still improving education system people are coming more aware of the dangers of drinking untreated water from a well or stream. A large part of the people already use chlorine to disinfect their drinking water, or at least during the rainy season. The problem is that chlorine is not always available and quite expensive. Besides, if not handled properly it is ineffective, and some pathogens are resistant. But the fact that people are using such measures is a key indicator that lots of people are aware of the dangers of unsafe drinking water.

During the questionnaire it turned out that all people spoken to where very enthusiastic about the concept of the Water4life water purifier. The people who did wanted to discuss which amount of money they would be willing to spent all replied that a target price of approximately \$25,- would be acceptable.

If the Water4life water purifier will be produced in Zambia there is a good market, since there is a grave need for a device that can do such a task. People are also willing to use such a device because they know it really improves their health situation.

According to the Mpongwe Business Association (in short MBA) there is enough craftsmanship present in Mpongwe to locally produce the “buckets” of the Water4life Gravity unit. According to the MBA, the filtercandels, the hearth of the Water4life Gravity unit, should at first be imported, and in a later stage locally produced as well. The MBA stated that students from the Zuyd University, with the help of GCMF and Water4Life, would be more than welcome to help setting up a business plan.

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Directions for use

Before first use:

1. If you use new candles, don't use the first 5 litres for drinking water. The water can contain black carbon particles.

Daily use:

2. Place the top bucket on the lower bucket.
3. Remove the lid.
4. Pour the untreated water into the top bucket.
5. Close the lid and wait for a few hours for the water to trickle through the filter candle into the bottom bucket.
6. Then open the tap and collect the water.

Cleaning:

When the flow rate is very low, the filter candles need to be cleaned:

7. Use some water and a piece of cloth to rub the dirt of the candles. Never use soap or other detergents.

Replacing candles:

The lifetime of the candles ends when the surface becomes uneven and difficult to clean. This is after approximately 6 months.

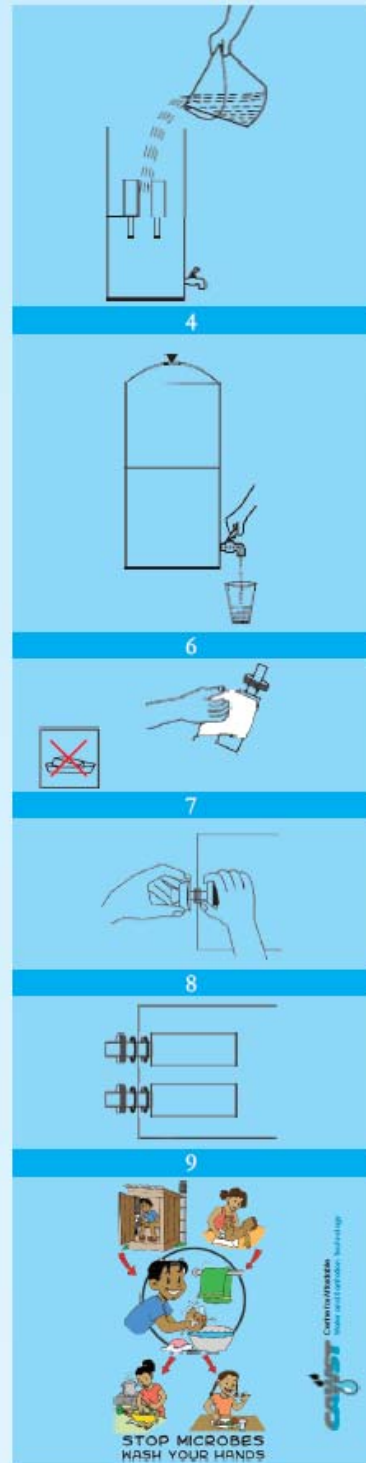
8. Hold the plastic base of the candle and turn the nut on the opposite side of the bucket.
9. Place the new candles in the bucket and hold the plastic base of the candle. Place on the interior and the exterior side of the bucket a rubber ring. Tighten the nuts on the opposite side of the bucket.

Do's & Don'ts

- Use the tap of the water purifier.
- Clean the purifier only when it's dirty or there is no flow.
- Leave the top-unit always on the bottom unit (to prevent re-contamination of the clean water).
- Store clean water covered and away from sunlight.
- Don't touch the clean water in the bottom unit.
- Don't clean the unit and candles every day.
- Don't use soap or other detergent for cleaning the candles.

General hygiene tips

- Separate the animals from the water and food.
- Put rubbish in the dustbin.
- Use a latrine or toilet.
- Don't defecate in or near water.
- Wash your hands after using the toilet with soap.
- Wash your hands after cleaning or changing the baby.
- Wash your hands before eating and food preparing with soap.



Appendix II – Water Analyses Protocol

Requirements

- Sterile sample bottles
- Autoclave
- Culture media (Nutrient Agar)
- Waterbath
- Water4life gravity unit
- Incubator
- Distilled water
- Saline

Sample taking

Take a sample of +/- 50 ml. Keep on ice if possible or otherwise as cool as possible. In any case start with the analysis within 12 hours. If the Water4life Gravity unit needs to be tested a sample of +/- 10 l is required.

Sample processing

If the bacteriological contamination of the drinking water needs to be tested, no sample processing is requirement.

If the effectiveness of the Water4life gravity unit needs to be determined, the sample has to be processed by standard procedure (see appendix I). Clean the filter system before use.

Analyses preparation

Preparation Nutrient Agar

- Weigh in 38 g Nutrient Agar
- Dissolve in 1000 ml distilled water
- Bring over to a round-bottom flask
- Seal the flask by placing a tuft of cotton wool in the neck of the flask. Cover the neck with some tin foil.
- Sterilize the flask in a pressure cooker for 15 minutes at 121°C
- Let the flask cool down in a water bath to 65°C.

Analyses

- A) Make a dilution series by doing the following:
- Fill test tube A with at least 4 ml sample.
 - Pipit 0.1 ml from the contents of tube A to tube B, and add 9.9 ml saline.
 - Pipit 0.1 ml from the contents of tube B to tube C, and add 9.9 ml saline.
- B) Pipit 1 ml of each tube in the centre of a sterile culture plate.
- C) Pour approximately 15 ml nutrient agar in the culture plates.
- D) Repeat this experiment three times.
- E) Place the culture media in an incubator for 24 h at 37°C.
- F) Count the formed colonies on the culture media plates en calculate back to the original dilution.

NOTE: only plates which have produced more then 30 and less than 300 colonies can be considered statistical relevant.

Appendix III – Questionnaire visits to the villages

Following is the questionnaire as it will be used during the visits to the villages. Some of the questions can be brought under in several categories.

Demographics

How many people are living in the villages?

How many women and men?

How many children?

How many people have a paid job?

Water supply

Where do people get their water from? (if possible see for yourself)

How long does it take to get water?

In what container is the water taken back home?

Will the water be processed before it will be consumed? (for example boiling, chlorinating, filtrating)

Who is responsible for the water supply?

Level of knowledge

Do the children attend school? (how many)

Does the school provide education on water safety?

Are there other forms of education on the subject?

Illness

Are people often sick? (diarrhea, malaria)

Do they think they are sick because of the water?

Hygiene

How many animals are there in the villages?

Are animals allowed to walk around freely?

Do people wash hands, and if yes how often?

Do people wash themselves, and if yes how often?

Do the people look clean and tidy? (not to be asked)

Willingness to adapt

(First tell about the Water4life gravity unit)

Are people willing to use such an product?

How many time are they willing to spend on such an apparatus?

What is the maximum amount of money they are willing to spend on water safety?

Appendix IV - Answers questionnaire visits to the villages

Village #1 – Musomba village

Demographics

How many people are living in the villages?

There are approximately 30 people living in the village.

How many women and men?

The population of the village consists of 18 males and 12 females.

How many children (not yet reached the age of 18)?

12 children are living in the village.

How many people have a paid job?

6 people have a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 15 meters deep and has a concrete housing. When not in use the well is covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can

Will the water be processed before it will be consumed?

The water is not processed before being used.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All 12 children attend school

Does the school provide education on water safety?

The school provides education on water safety in 5th, 6th and 7th grade. (age 11-15)

Are there other forms of education on the subject?

No

Illness

Are people often sick? (diarrhea, malaria)

Sometimes, although malaria mostly occurs during the rainy season.

Do they think they are sick because of the water?

Yes, the people do acknowledge that diseases could be prevented with safe drinking water.

Hygiene

How many animals are there in the villages?

Approximately 16 chickens and one dog.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before each contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath multiple times a week.

Do the people look clean and tidy?

The people looked clean, but their clothes where in some cases worn-off.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people where very enthusiastic about the concept.

How many time are they willing to spend on such an apparatus?

Waiting times of up to six hours where no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers first wanted to hear a price so they could discuss. After suggesting a price of 150.000 K (aprox. \$27) they reacted positively.

Village #2 – Lese village

Demographics

How many people are living in the villages?

There are approximately 40 people living in the village.

How many women and men?

The population of the village consists of 20 males and 20 females.

How many children (not yet reached the age of 18)?

25 children are living in the village.

How many people have a paid job?

5 people have a paid job.

Water supply

Where do people get their water from?

From a well in the center of the village. The well is approximately 20 meters deep and has a concrete housing. When not in use the well is not being covered.

In the summertime the well dries up, and the villagers have to get their water from the stream. This happens a few weeks a year.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers usually use chlorine, although they sometimes drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All 25 children attend school (except for 4 who haven't reached the age of 4)

Does the school provide education on water safety?

The school provides education on water safety in 5th, 6th and 7th grade. (age 11-15)

Are there other forms of education on the subject?

No

Illness

Are people often sick? (diarrhea, malaria)

According to the villagers only malaria is a serious health issue, especially during the rainy season.

Do they think they are sick because of the water?

Yes, the people do acknowledge that diseases could be prevented with safe drinking water. Therefore they are using chlorine to treat the water most of the time.

Hygiene

How many animals are there in the villages?

Approximately 20 chickens, 5 ducks and one dog.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before each contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath once a day.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were very enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times of up to six hours were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers stated they could easily afford because in the long run they would save money because they don't have to use chlorine anymore.

Village #3 – Chiefteness palace

Demographics

How many people are living in the villages?

There are approximately 35 people living in the village.

How many women and men?

The population of the village consists of 20 males and 15 females.

How many children (not yet reached the age of 18)?

11 children are living in the village.

How many people have a paid job?

11 people have a paid job.

Water supply

Where do people get their water from?

From a well in the center of the village. The well is approximately 10 meters deep and has got a housing consisting of an old car tire. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerrycan, or sometimes plastic bottles.

Will the water be processed before it will be consumed?

The villagers sometimes use chlorine, although they also drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All 11 children attend school (except for 2 who haven't reached the age of 4)

Does the school provide education on water safety?

The school provides education on water safety in 5th, 6th and 7th grade. (age 11-15)

Are there other forms of education on the subject?

No

Illness

Are people often sick? (diarrhea, malaria)

Sometimes, but not very often. Especially children are the ones getting sick.

Do they think they are sick because of the water?

No, the villagers think it has only something to do with the season, since they get rarely sick outside the rainy season.

Hygiene

How many animals are there in the villages?

Approximately 15 chickens.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before each contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath once a day and sometimes even more often.

Do the people look clean and tidy?

The people looked clean and tidy. Some were even wearing cosmetics.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times of up to six hours were no problem, since the lower subunit can contain enough water to use during the waiting period. Also they mentioned that they can use chlorine-treated water in the waiting time.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device in operation, and knowing a price before they decide if they want to buy one.

Village #4 – Malulamba village

Demographics

How many people are living in the villages?

There are approximately 22 people living in the village.

How many women and men?

The population of the village consists of 5 males and 17 females.

How many children (not yet reached the age of 18)?

10 children (3 boys and 7 girls) are living in the village.

How many people have a paid job?

1 person have a paid job.

Water supply

Where do people get their water from?

From a well on the edge of the village. The well is approximately 8 meters deep and has got a housing consisting of a pvc tube. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerrycan.

Will the water be processed before it will be consumed?

The villagers drink the water straight at all times.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

4 children attend school, the others are too young

Does the school provide education on water safety?

The people in the village don't know.

Are there other forms of education on the subject?

No

Illness

Are people often sick? (diarrhea, malaria)

Sometimes, but not very often..

Do they think they are sick because of the water?

Yes, the villagers acknowledge that the quality of the water is bad for their health.

Hygiene

How many animals are there in the villages?

1 dog, and several chickens from the neighboring villages.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath once a day.

Do the people look clean and tidy?

The people looked clean and tidy. Some of the clothes the kids wore were a bit worn-off.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times of up to two hours were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers said cynically they paid at most 500 K (€0,007) if they haven't seen the device. Besides, they want the person to sell to state a price, and not the other way around.

Village #5 – Manshansha village

Demographics

How many people are living in the villages?

There are approximately 42 people living in the village.

How many women and men?

The population of the village consists of 18 males and 24 females.

How many children (not yet reached the age of 18)?

8 children (3 boys and 7 girls) are living in the village.

How many people have a paid job?

3 people have a paid job.

Water supply

Where do people get their water from?

From a well just outside of the village. The well is approximately 12 meters deep and has got a housing consisting of a pvc tube. When not in use the well is being covered with a sheet of plate metal with a filled jerry can on top to provide weight.

How long does it take to get water?

Less than 1 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers add chlorine to the water before drinking.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All children attend school.

Does the school provide education on water safety?

Yes, in grade 5.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Not very often.

Do they think they are sick because of the water?

No, the villagers don't acknowledge that the quality of the water is bad for their health, because they use chlorine

Hygiene

How many animals are there in the villages?

Several chickens, nobody knows how many exact.

Are animals allowed to walk around freely?

Yes they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before contact with food.

Do people wash themselves, and if yes how often?

Yes all the people take a bath once a day.

Do the people look clean and tidy?

The people looked clean and tidy, despite the fact that their clothes looked worn-off and dirty.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, the people were quite enthusiastic about the concept. They see the advantage of the purifier over the use of chlorine (which is quite expensive and gives a bad taste to the water).

How many times are they willing to spend on such an apparatus?

Waiting times were no problem at all, as long as the purifier is able to meet the daily requirements of safe water.

What is the maximum amount of money they are willing to spend on water safety?

The villagers really insisted on seeing the purifier before they stated a price. Besides, they want the person to sell to state a price, and not the other way around.

Village #6 – Malembwe village

Demographics

How many people are living in the villages?

There are approximately 16 people living in the village.

How many women and men?

The population of the village consists of 9 males and 7 females.

How many children (not yet reached the age of 18)?

11 children are living in the village.

How many people have a paid job?

3 people have a paid job.

Water supply

Where do people get their water from?

From a borehole a few kilometers from of the village. For bathing and washing the people use a well on the edge of the village. The well is approximately 15 meters deep and has got a concrete housing. When not in use the well is being covered with a hatch.

NOTE: a sample from the water the villagers collected from the borehole is collected for analysis.

How long does it take to get water?

30 minutes for drinking water and less than a minute for “grey” water.

In what container is the water taken back home?

In metal buckets.

Will the water be processed before it will be consumed?

The villagers drink the water straight at all times, although they always drink from the borehole.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water from the well. It is the task of the children to get the water from the borehole.

Level of knowledge

Do the children attend school?

All of the children attend school.

Does the school provide education on water safety?

The people in the village say only private schools (which their children don't attend) provide with education on the subject.

Are there other forms of education on the subject?

No

Illness

Are people often sick? (diarrhea, malaria)

Yes, often malaria in the rain season. Very rarely diarrhea.

Do they think they are sick because of the water?

No, the villagers don't acknowledge that the quality of the water is bad for their health, because they take their water from a borehole.

Hygiene

How many animals are there in the villages?

2 dogs, 1 cat, and 1 chicken. Other chickens recently died due to a disease.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Not everyone washes hands as adequate as they should.

Do people wash themselves, and if yes how often?

Yes most people take a bath once a day, otherwise every 2 or 3 days.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, the people were quite enthusiastic about the concept, because it would save a lot of time they know spend on collecting water from the borehole.

How many times are they willing to spend on such an apparatus?

Even if it would take the whole night it wasn't a problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #7 – Chipante village

Demographics

How many people are living in the villages?

There are approximately 28 people living in the village.

How many women and men?

The population of the village consists of 16 males and 12 females.

How many children (not yet reached the age of 18)?

7 children are living in the village.

How many people have a paid job?

No one has a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 15 meters deep and has got a housing consisting of a old car tire. When not in use the well is covered loosely with the wheel cap that originally was used with the tire.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers normally use chlorine. If there is no chlorine available they sometimes drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All 7 children attend school.

Does the school provide education on water safety?

The people in the village think no education is given on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season.

Do they think they are sick because of the water?

Yes, the villagers acknowledge that the quality of the water is bad for their health.

Hygiene

How many animals are there in the villages?

Lots of chickens, nobody knows how much exactly.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Yes, each time before contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath every 2 days.

Do the people look clean and tidy?

The people looked clean and tidy. Some of the clothes the kids wore where a bit worn-off.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people where quite enthusiastic about the concept.

How many time are they willing to spend on such an apparatus?

Waiting times where no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #8 – Kekombela village (1)

Demographics

How many people are living in the villages?

There are 14 people living in the village.

How many women and men?

The population of the village consists of 5 males and 9 females.

How many children (not yet reached the age of 18)?

8 children are living in the village.

How many people have a paid job?

No one has a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 4 meters deep and has got a housing consisting of a metal shaft (+/- 70 cm in diameter). When not in use the well is not covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers don't process the water in any way.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

3 children attend school, the others are too young.

Does the school provide education on water safety?

The people in the village have no idea if any education is given on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria. Children often suffer from diarrhea.

Do they think they are sick because of the water?

The villagers don't know if it is because of the water, but they do it to be the cause.

Hygiene

How many animals are there in the villages?

5 pigs and lots of chickens, nobody knows how much exactly.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses. The pigs are kept in a designated little building.

Do people wash hands, and if yes how often?

Yes, each time before contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath every day. Although it happens sometimes they skip a day.

Do the people look clean and tidy?

The people looked clean and tidy. Some of their clothes were a bit dirty, but that is inevitable with the work they were doing at the moment.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would discuss together.

Village #9 – Kekombela village (2)

Demographics

How many people are living in the villages?

Nearly 200 people are living in the village.

How many women and men?

The population of the village consists of about 50% males and 50% females.

How many children (not yet reached the age of 18)?

Approximately 40 children are living in the village.

How many people have a paid job?

6 people have a paid job.

Water supply

Where do people get their water from?

From a well on the edge of the village. The well is approximately 15 meters deep and has got a housing consisting out of concrete. Around the entry to the well there is an car tire placed (according to the villagers for convenience sake). After use the well is not covered

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

Plastic jerry cans and buckets.

Will the water be processed before it will be consumed?

The villagers normally use chlorine. If there is no chlorine available they sometimes drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water. (with the exception of children below the age of 12)

Level of knowledge

Do the children attend school?

All children attend school, with the exception of the ones who are too young.

Does the school provide education on water safety?

The people in the village know that there is some education given on the subject, but they didn't know what exactly.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. They suffer from diarrhea sometimes throughout the whole year.

Do they think they are sick because of the water?

Yes, the villagers noticed that the ones not using chlorine get sick more often.

Hygiene

How many animals are there in the villages?

Chickens, pigs, goats and ducks. nobody knows about the figures, because it varies each week.

Are animals allowed to walk around freely?

Yes, they are, although they don't come into the houses. Pigs are kept in a pen.

Do people wash hands, and if yes how often?

Not everyone. It depends a bit on the person.

Do people wash themselves, and if yes how often?

Depends. Not everyone bathes each day.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak. When a price of 130.000 Kwacha (+/- \$ 25) was stated they responded that is not much for a device that was described to them, but they really insisted on seeing the device first.

Village #10 – Mpenda village (1)

Demographics

How many people are living in the villages?

There are approximately 25 people living in the village.

How many women and men?

The population of the village consists of 7 males and 18 females.

How many children (not yet reached the age of 18)?

13 children are living in the village.

How many people have a paid job?

1 person has a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 12 meters deep and has got a concrete housing. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers normally use chlorine. If there is no chlorine available they sometimes drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water. (with the exception of the children)

Level of knowledge

Do the children attend school?

All children attend school, except for the ones too young.

Does the school provide education on water safety?

The people say that the school provides education on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Often malaria in the rain season. Children suffer from diarrhea often.

Do they think they are sick because of the water?

No, they think the water is good because of the use of chlorine.

Hygiene

How many animals are there in the villages?

Lots of chickens, 1 pig.

Are animals allowed to walk around freely?

Yes, the chickens are, although they don't come into the houses. The pig is kept in a pen.

Do people wash hands, and if yes how often?

Yes, each time before contact with food.

Do people wash themselves, and if yes how often?

Yes most people take a bath every day.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #11 – Mpenda village (2)

Demographics

How many people are living in the villages?

There are 6 people living in the village.

How many women and men?

The population of the village consists of 4 males and 2 females.

How many children (not yet reached the age of 18)?

3 children are living in the village.

How many people have a paid job?

2 people have a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 6 meters deep. Logs are placed over the entrance to the well, covering +/- 50% of the area. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers normally use chlorine.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water. (with the exception of the children)

Level of knowledge

Do the children attend school?

All children attend school.

Does the school provide education on water safety?

The people know that school provides education on the subject in grade 5.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. Especially the children suffer from diarrhea often.

Do they think they are sick because of the water?

Yes, they are convinced the water is the cause of most of the illnesses.

Hygiene

How many animals are there in the villages?

Lots of chickens, 2 cows.

Are animals allowed to walk around freely?

Yes, the chickens are, although they don't come into the houses. The cows are not allowed to come in the village.

Do people wash hands, and if yes how often?

Some people do, some don't.

Do people wash themselves, and if yes how often?

Some people do, some don't.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #12 – Kalasala village (2)

Demographics

How many people are living in the villages?

There are 50 people living in the village.

How many women and men?

The population of the village consists of 27 males and 23 females.

How many children (not yet reached the age of 18)?

7 children are living in the village.

How many people have a paid job?

1 person has a paid job.

Water supply

Where do people get their water from?

From a well outside the village (+/- 150 metre). The well is approximately 8 meters deep. A bush is starting to grow over the well. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

Some villagers use chlorine, some drink it straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All children attend school, except the ones who are too young.

Does the school provide education on water safety?

The people know that school provides education on the subject in grade 7.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. Especially the children suffer from diarrhea often.

Do they think they are sick because of the water?

The people don't think it is the only cause but they do notice that the ones not using chlorine get sick more often.

Hygiene

How many animals are there in the villages?

At the moment 7 chickens and 10 cows.

Are animals allowed to walk around freely?

Yes, the chickens are, although they don't come into the houses. The pigs are kept in a designated building.

Do people wash hands, and if yes how often?

Some people do, some don't.

Do people wash themselves, and if yes how often?

Some people do, some don't, although 3 times a week is a minimum for most people.

Do the people look clean and tidy?

The people looked clean and tidy, although their clothes looked a bit worn-off.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #13 – Kasweshi village

Demographics

How many people are living in the villages?

There are 9 people living in the village.

How many women and men?

The population of the village consists of 5 males and 4 females.

How many children (not yet reached the age of 18)?

0 children are living in the village.

How many people have a paid job?

0 people have a paid job.

Water supply

Where do people get their water from?

From a stream outside the village.

How long does it take to get water?

When on foot 15 minutes. Sometimes they use bicycles to get water, in that case it only takes 10 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers always use chlorine.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

-

Does the school provide education on water safety?

-

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Yes, the people get often malaria in the rain season. They also often suffer from diarrhea trough out the whole year. Sometimes they even have to vomit after drinking the water.

Do they think they are sick because of the water?

Yes, they are convinced the water is one of the causes for all of the illnesses. They are not sure if it is the main cause.

Hygiene

How many animals are there in the villages?

Lots of chickens, nobody knows how much exactly.

Are animals allowed to walk around freely?

Yes, the chickens are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Some people do, some don't.

Do people wash themselves, and if yes how often?

They do, almost each day.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

After stating a price of 130,000 K (+/- \$25,-) they said it's not much if the purifier works as told.

Village #14 – Kekombela village (3)

Demographics

How many women and men?

The population of the village consists of about 50% males and 50% females.

How many children (not yet reached the age of 18)?

Approximately 40 children are living in the village.

How many people have a paid job?

6 people have a paid job.

Water supply

Where do people get their water from?

From a well just outside the village. The well is approximately 6 meters deep. A rusty metal pipe is placed in the entrance of the well. When not in use the well is not being covered.

How long does it take to get water?

Less than 10 minutes.

In what container is the water taken back home?

A plastic jerry can, and sometimes buckets.

Will the water be processed before it will be consumed?

The villagers drink the water straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All children attend school, except the ones too young.

Does the school provide education on water safety?

The people think that school provides no education on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. Especially the children (but also the other people) suffer from diarrhea often.

Do they think they are sick because of the water?

Yes, they are convinced the water is the cause of most of the illnesses.

Hygiene

How many animals are there in the villages?

Lots of chickens, some pigs and goats.

Are animals allowed to walk around freely?

Yes, all animals are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Some people do, some don't.

Do people wash themselves, and if yes how often?

Some people do, some don't.

Do the people look clean and tidy?

Each day.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #15 – Sweete village

Demographics

How many people are living in the villages?

There are ? people living in the village.

How many women and men?

The population of the village consists of ? males and ? females.

How many children (not yet reached the age of 18)?

? children are living in the village.

How many people have a paid job?

? people have a paid job.

Water supply

Where do people get their water from?

From a well on the edge of the village. The well is approximately 15 meters deep. An old car tire is placed around the entrance of the well. When not in use the well is not being covered.

How long does it take to get water?

About 15 minutes.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers sometimes boil the water first, but if there is not enough charcoal available they drink the water straight.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

All children attend school, except the ones who are too young.

Does the school provide education on water safety?

The people have no idea if the school gives education on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. Especially the children (but also the other people) suffer from diarrhea often.

Do they think they are sick because of the water?

They are convinced the water must have something to do with the illnesses, but they don't know if it is the main cause.

Hygiene

How many animals are there in the villages?

Lots of chickens, some ducks.

Are animals allowed to walk around freely?

Yes, all animals are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Only before eating.

Do people wash themselves, and if yes how often?

Each day.

Do the people look clean and tidy?

Yes, they do.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak.

Village #16 – Kabuba farm

Demographics

How many people are living in the villages?

There are 9 people living in the village.

How many women and men?

The population of the village consists of 2 males and 7 females.

How many children (not yet reached the age of 18)?

6 children are living in the village.

How many people have a paid job?

3 people have a paid job.

Water supply

Where do people get their water from?

From a well on the edge of the village. The well is approximately 8 meters deep. An old car tire is placed around the entrance of the well. When not in use the well is not being covered.

How long does it take to get water?

About 1 minute.

In what container is the water taken back home?

A plastic jerry can.

Will the water be processed before it will be consumed?

The villagers drink the water straight.

Who is responsible for the water supply?

The children are responsible for getting water.

Level of knowledge

Do the children attend school?

All 6 children attend school.

Does the school provide education on water safety?

The people say the school gives no education on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes the children suffer from diarrhea.

Do they think they are sick because of the water?

They don't know for sure.

Hygiene

How many animals are there in the villages?

Lots of chicken and 2 dogs.

Are animals allowed to walk around freely?

Yes, all animals are, although the chickens don't come into the houses. The dogs do.

Do people wash hands, and if yes how often?

Only before eating.

Do people wash themselves, and if yes how often?

Yes, each day.

Do the people look clean and tidy?

Yes, they do.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak. After stating a price of 130,000 K (+/- \$25,-) they said it's not much if the purifier works as told.

Village #17 – Chisakulo village

Demographics

How many people are living in the villages?

There are 45 people living in the village.

How many women and men?

The population of the village consists of 25 males and 20 females.

How many children (not yet reached the age of 18)?

6 children are living in the village.

How many people have a paid job?

5 people have a paid job.

Water supply

Where do people get their water from?

From a well on the edge of the village. The well is approximately 20 meters deep. The well has a concrete housing. When not in use the well is not being covered.

How long does it take to get water?

Less than 5 minutes.

In what container is the water taken back home?

In metal buckets.

Will the water be processed before it will be consumed?

The villagers normally use chlorine.

Who is responsible for the water supply?

Everyone in the village is equally responsible for getting water.

Level of knowledge

Do the children attend school?

4 children attend school. (others too young)

Does the school provide education on water safety?

The people know that school provides education on the subject.

Are there other forms of education on the subject?

No.

Illness

Are people often sick? (diarrhea, malaria)

Sometimes malaria in the rain season. Especially the children (but the other people as well) suffer from diarrhea often.

Do they think they are sick because of the water?

Yes, they are convinced the water is the cause of most of the illnesses.

Hygiene

How many animals are there in the villages?

Lots of chickens.

Are animals allowed to walk around freely?

Yes, the chickens are, although they don't come into the houses.

Do people wash hands, and if yes how often?

Some people do, some don't.

Do people wash themselves, and if yes how often?

Yes each day.

Do the people look clean and tidy?

The people looked clean and tidy.

Willingness to adapt

Are people willing to use such a product like the Water4life gravity unit?

Yes, all people were quite enthusiastic about the concept.

How many times are they willing to spend on such an apparatus?

Waiting times were no problem, since the lower subunit can contain enough water to use during the waiting period.

What is the maximum amount of money they are willing to spend on water safety?

The villagers insisted on seeing the device first and hearing a price, before they would speak. After stating a price of 130,000 K (+/- \$25,-) they said it's not much if the purifier works as told.

Appendix V – Results water analysis

Village #1 – Musomba village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	>300	>300	>300	-	-	-
1E2 x	253	239	268	253,333333	14,50287	25333,33333
1E4 x	<30	<30	<30	-	-	-
1E6 x	<30	<30	<30	-	-	-
1E8 x	<30	<30	<30	-	-	-
negative control	0					
Bacteria present in water sample (per litre)			2,53E+07			

Village #2 – Lese village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	93	145	142	126,666667	29,19475	126,666667
1E2 x	<30	<30	<30	-	-	-
1E4 x	<30	<30	<30	-	-	-
1E6 x	<30	<30	<30	-	-	-
1E8 x	<30	<30	<30	-	-	-
negative control	0					
Bacteria present in water sample (per litre)			1,27E+05			

Village #3 – Chiefteness palace

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	81	91	83	85	5,291503	85
1E2 x	<30	<30	<30	-	-	-
1E4 x	<30	<30	<30	-	-	-
1E6 x	<30	<30	<30	-	-	-
1E8 x	<30	<30	<30	-	-	-
negative control	0					

Bacteria present in water sample (per litre) 8,50E+04

Village #4 – Malulamba village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	178	152	-	165	18,38478	165
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					

Bacteria present in water sample (per litre) 1,65E+05

Village #5 – Manshansha village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	212	200	-	206	8,485281	206
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			2,06E+05			

Village #6 – Malembwe village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	228	223	-	225,5	3,535534	225,5
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			2,26E+05			

Village #7 – Chipante village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	287	254	-	270,5	23,33452	270,5
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			2,71E+05			

Village #8 – Kekombela village (1)

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	172	129	-	150,5	30,40559	150,5
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			1,51E+05			

Village #9 – Kekombela village (2)

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	>300	>300	-			
1E2 x	93	73	-	83	14,14214	8300
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			8,30E+06			

Village #10 – Mpenda village (1)

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	272	212	-	242	42,42641	242
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			2,42E+05			

Village #11 – Mpenda village (2)

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	>300	>300	-			
1E2 x	76	48	-	62	19,79899	6200
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			6,20E+06			

Village #12 – Kalasala village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	288	285	-	286,5	2,12132	286,5
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			2,87E+05			

Village #14 – Kekombela village (3)

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	>300	>300	-			
1E2 x	98	112	-	105	9,899495	10500
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			1,05E+07			

Village #15 – Sweete village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	212	176	-	194	25,45584	194
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			1,94E+05			

Village #16 – Kabuba farm

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	>300	>300	-			
1E2 x	32	28	-	30	2,828427	3000
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			3,00E+06			

Village #17 – Chisakulo village

Dillution	Colonie count (Plate 1)	Colonie count (Plate 2)	Colonie count (Plate 3)	Average	Standard deviation	Average (with correction)
0x	93	83	-	88	7,071068	88
1E2 x	<30	<30	-			
1E4 x	<30	<30	-			
1E6 x	-	-	-			
1E8 x	-	-	-			
negative control	0					
Bacteria present in water sample (per litre)			8,80E+04			