Bachelor Thesis
VVRL01

The Relevance of the Sodium Hypochlorite Solution Certeza as a Domestic Water Disinfecatant in Maputo.

A Minor Field Study

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Preface

This study is a result of a Minor Field Study financed by SIDA (Swedish International Development Cooperation Agency). The MFS scholarship is a programme that makes it possible for Swedish students to acquire experience of working in developing countries. The programme includes an eight week field study in a developing country that can be part of a Bachelor or a Master degree. The study should concern problems and issues connected to the development of the country.

The study is also a part of the cooperation between the Department of Water Resources Engineering at Lund Institute of Technology (LTH) and the Eduardo Mondlane University (UEM) in Maputo.

First of all we would like to thank Clemêncio Nhantumbo, our local supervisor. This thesis would not have been possible if it was not for him. We are very thankful for all the time and energy he has dedicated on making the study possible. Not only has he been a big help during the research but also with practicalities. Although Sofia Kac speaks Portuguese, which is the official language, some of the interviews would not have been possible if it weren't for Clemêncios knowledge of the local languages spoken in the rural areas around Maputo.

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Last but not least, thank you to all the kind people in Maputo who let us use some of their valuable water for research, and to those people giving a few minutes of their day to take part in our interviews.

Stockholm 26th of May 2014

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Abstract

The quality of piped drinking water in Maputo is generally poor and it affects many people, in particular the poor living in areas with inadequate or insufficient water distribution systems.

In Mozambique, the chemical disinfectant, Certeza (containing diluted sodium hypochlorite), is used to treat domestic water at the consumers' end. It is well known that chlorine products used for disinfection of water with high amounts of organic matter can produce disinfection by-products (DBP) that can lead to future health risks for consumers. However, it should be noted that the health risks caused by DBPs are very small compared to drinking unsafe water. Nevertheless, it is important that DBP levels are monitored and taken into account while considering disinfection measures of treating water for drinking purposes.

This study serves to find out if Certeza should be used as a disinfectant for domestic water treatment in Maputo. Analyses of pH, turbidity, nitrates, nitrites, ammonia, organic matter and coliforms were carried out in five different areas, including city central, suburbs and rural areas, to obtain a representative sample of the water quality.

In parallel to the analyses 75 interviews were carried out during April to May 2014 to assess whether the users believed their water was safe to drink or not. This provided the opportunity to find out if people treat water domestically and, if so, at what quantities Certeza is used.

Water distributed by FIPAG had generally high levels of organic matter and also high levels of total coliforms. Ground water presented lower levels of organic matter, but variable levels of faecal coliforms. Water collected in the rural area showed to have the highest levels of organic matter and variable levels of faecal coliforms.

The results from the interviews presented that 75% did not feel safe drinking the water, but still only 40 % treats their water. Out of these 40 % only 20 % used Certeza for domestic water treatment.

Concluding, Certeza or any other sodium hypochlorite product is not suitable for all kind of water sources. Water with high levels of organic matter and bacteria are the problematic resources. Certeza should be used in areas where there is a risk of contaminated water, but it ought to be discussed whether it should be promoted for private domestic use, especially without informing about the possible consequences.

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1. Introduction

Mozambique is one of the fastest developing countries in Africa, more and more people are moving in to the cities. Infrastructural development is not following the same pace, which is shown in all aspects of infrastructure, not the least when it comes to sanitation and drinking water. 25 % of Maputo's inhabitants have access to clean drinking water, and 56 % is the average in the entire country.

Due to the poor conditions of the available drinking water in Mozambique and spread of diarrhoea and cholera an American NGO (Non Governmental Organization) called PSI developed a disinfectant product in 2004 called Certeza, consisting of sodium hypochlorite. This product has since then been distributed in 150 ml bottles all over Mozambique, either donated at hospitals or NGOs or sold cheap for 15 MT, which is about the same price of an apple.

It is commonly known that the reaction between chlorine and organic material result in DBPs. These by products are known as cancer genic. Depending on the amount of organic matter in the water source it might not be recommendable to use chlorine based disinfectants.

Objectives:

The purpose of the study is to investigate the water quality in Maputo and decide if chlorine products should be used as a disinfectant for household water treatment in different areas of the province. Along with this it will also be researched if people feel that the water provided is safe to drink or not, if they treat their water domestically and if so, in what quantities is Certeza used.

Limitations:

In order to fulfil the objective with a limited time and budget frame, fieldwork was concentrated in five different areas in Maputo. Fieldwork was carried out during 10 weeks from Mars until Ma 2014. Chemical analyses were restricted to the equipment and abilities at MISAU.

2. Background

2.1 Description of the Study Area

Mozambique is located on the southeastern coast of Africa. It has boarders to South Africa and Swaziland in the south, Zimbabwe to the west and Malawi and Tanzania in the north, which is shown in Figure 1. The official language is Portuguese.

In 1975 Mozambique reached independence after 10 years of war with its colonial power Portugal. The independence was followed by a 16 years long civil war and in the year of 1992 peace was finally reached.
Due to decades of war Mozambique was in 1992 near bankruptcy. Since then the country has grown at a rate of almost 10 %, which is seen as a success story. Still it is one of the poorest countries in the world and also one of the most corrupted, the poverty rate in Mozambique is 50 %.

As a result of the civil war many people moved in to the cities in search for employment, healthcare and education. The former urban areas created by the Portuguese were not built for the amount of people that migrated to the cities, this leading to the construction of many informal settlements around the cities, called suburbs or "suburbios" in Portuguese.

The constitution in 1990 and the Land Law written in 1997 affirms that settlers that have lived at the same piece of land for 10 years or more have the right to stay there. Nevertheless, these informal areas have no kind of central management, which makes it difficult to organize municipal services like collection of solid waste and proper sanitation and therefore lead to high risk areas for waterborne diseases. (UN-HABITAT, 2010)

Figure 1: Mozambique's location (Google maps, 2014).

Maputo

Maputo is the capital as well as the biggest city in Mozambique with 1,3 million inhabitants. The city is located by the coast in the southern part of the country. (UN-HABITAT, 2010)

The city of Maputo consists of a smaller urbanized central area with a relatively functioning infrastructure; electricity, telephones and water supply to the buildings are working but not splendid. It occurs that the water supply shuts down in the middle of the day and will only come back the following day. The drainage system however is not dimensioned for the big rains during rainy season resulting in big floods. (UN-HABITAT, 2010)

Surrounding the small central area are the many peripheral neighbourhoods, also referred to as slums and suburbs. As a result of un-planned settlements there is no infrastructure how so ever in these areas. (UN-HABITAT, 2010)

Although poverty is reducing nationally in Mozambique, Maputo is not following the same trend. Many impoverished people are migrating from rural areas to the city, increasing the amount of informal settlements. The population growth in Maputo is 3,5 %, compared to the 1,70 % in Stockholm (Länsstyrelsen, 2013). In 2010 UN-habitat estimated that 70 % of the population of Maputo lived in slums. As earlier mentioned the lack of solid waste management and sanitation in these areas is vast and with a growing migration the problem is getting worse. (UN-HABITAT, 2010)

2.2 Water and Sanitation in Mozambique

After sixteen years of civil war the water system in Mozambique was completely deteriorated in 1992 when the war finally got to an end. In 1998 a framework called the Delegated Management Framework (DMF) was inaugurated by the government, an institutional reform with the objective to better water supply services in the bigger cities. Two autonomous public bodies were created to perform the actions needed to full fill the framework FIPAG and CRA (Conselho de Regulação do Abastecimento de Água). FIPAG, Water Supply and Investment Fund as an asset management agency and CRA, Water Regulatory Council an independent regulator.

As a result of the new governments vision to promote decentralized economical services FIPAG leased their pipes to other investors. In 1999 a 15 year contract was signed with Aguas de Mozambique, funded by a French company and has since then change main investors a couple of times. The end of the lease will be in November 2014. (Triche, T, Beete, N, Martins, F, 2009) Though the lease is affective until the end of November this year, FIPAG has already started to take over some of the pipelines.

Figure 2 below is a map over the different operators involved in the water distribution of Mozambique.

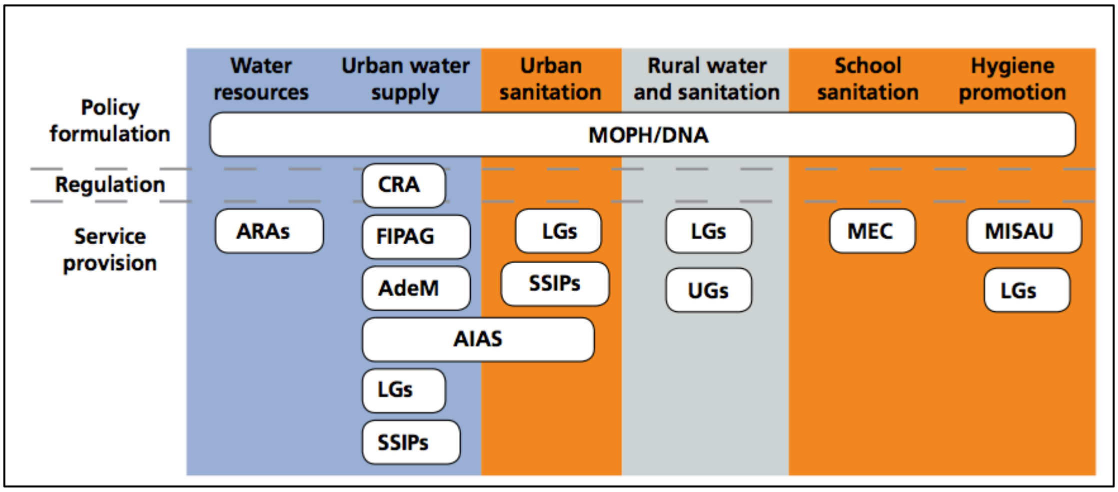

Figure 2: Map over water distributing actors in Mozambique. (WSP, 2011)

AIAS: Water and Sanitation Management Unit. Recently-created asset holder withing DNA for water supply and sanitation system in secondary towns outside the FIPAG remit.
AdeM Mozambique Water Utility. Lease holder for the Maputo water supply system.
ARAs: Regional Water Management Units: Five regional agencies for bulk water provision and large dam management.
CRA: Water Regulatory Agency. National water supply regulator.
DNA: National Directorate of Water. Policy lead on water supply, sanitation, and water resources management. Some services provision in smaller cities and towns.
FIPAG: Asset-holder and operatior of major city water supplies.
LGs: Local Governments. Include provincial, municipal and district authorities.
MOPH: Ministry of Public Works and Housing. Institutional home of DNA.
MEC: Ministry of Education and Culture. Provides and maintains school sanitation infrastructure.
MISAU: Ministry of Health. Undertakes national and local hygiene promotion efforts.
SSIPs: Small-Scale Independent Providers. Currently supplying a high percentage of water users, producing latrine slabs, and providing pit emptying services, primarily in urban areas.
UGs: User Groups. Operate and maintain village water and sanitation infrastructure.

Since 1999 the urban water access in Mozambique has increased a lot and in 2010, UN-Habitat estimated that 78 % had access to clean water compared to the 56 % ten years earlier. However the rural areas have not had the same development and the population with access to clean water is only 24 % in these areas.

The main natural water sources are surface water from rivers and lakes, and underground water from springs and boreholes.

Nationally only 4 % of the urban population have access to sewerage. Though the government is aware of the water and sanitation problems and have addressed that it is a priority, the shortage of safe water, storage and sanitation is great. (UN-HABITAT, 2010)

In 2011 they started to discuss to have a municipally based management arrangement in the urban and peri-urban areas. The absence of financial resources and staffed institutional home for urban sanitation has resulted in very little development in this sector. (WSP, 2011)

Maputo

In the central area of Maputo the majority of the drinking water is provided by FIPAG.

When it comes to water supply in the suburbs some drink water distributed by FIPAG while others buy their water from private distributers who provide groundwater from drilled holes. These private distributers can be whoever had enough money to drill a borehole and then sell water to their neighbours. There are also bigger private distributers.

It is widely known that FIPAGs water systems are not always pressured therefore some people only have running water a few hours a day. In addition to this it is a necessity for everyone to find ways to storage water that will last for the rest of the day. Buildings in the central parts of Maputo have big black plastic tanks, while people in poorer areas have their different ways of storing water. Some have plastic containers while other have corroded metal basins.

In the poorer areas where FIPAG is distributing water the canalization is extremely poor. In one of the peripheral suburbs called Chamanculo there were passages filled with water originated from the FIPAG water pipes, which is presented in Figure 3. Along with the pipes only delivering water from 05.00 in the morning until midday, the result is infiltration of bacteria and organic material into the water pipes.

Figure 3: Distribution system in Chamanculo.

The sanitation in Maputo is a bit better than the rest of the country, comparing to the 4 % nation-wide, 20 % of the households in Maputo are connected to a sewerage system. In addition to this only 10 % of the sewerage of Maputo is treated, the rest goes untreated in to the sea.

Solid waste management in urban and peri-urban areas is the municipalities' responsibility. However it is not working as it should and communities that pay a monthly fee for the solid waste collection still have to find other ways to manage their waste. (UN-HABITAT, 2010) Everywhere in Maputo plastic bags, crushed glass from bottles etc. are spread on the streets and grounds.

2.3 Water Sources and Quality Parameters

There are several parameters that are important when measuring the quality of drinking water. Even if the water looks clean it does not have to be that way. Some parameters used to measure water quality are turbidity, pH, alkalinity, organic matter, nitrates, nitrites, ammonia nitrogen and the amount of pathogens. Depending on the water source different parameters are measured and the guideline values do also differ sometimes.

Different Water Sources

Figure 4 present different types of water sources. The main water sources in Mozambique are superficial surface water from rivers and lakes, and subterranean water from springs and boreholes.

Groundwater from deep and confined aquifers is usually safe from microbiologic and chemical contamination. However, shallow and unconfined aquifers can get contaminated by for example nitrates and pathogens due to agricultural practices. Poor sewerage and sanitation can also be a reason to contaminated groundwater. (WHO, 2011)

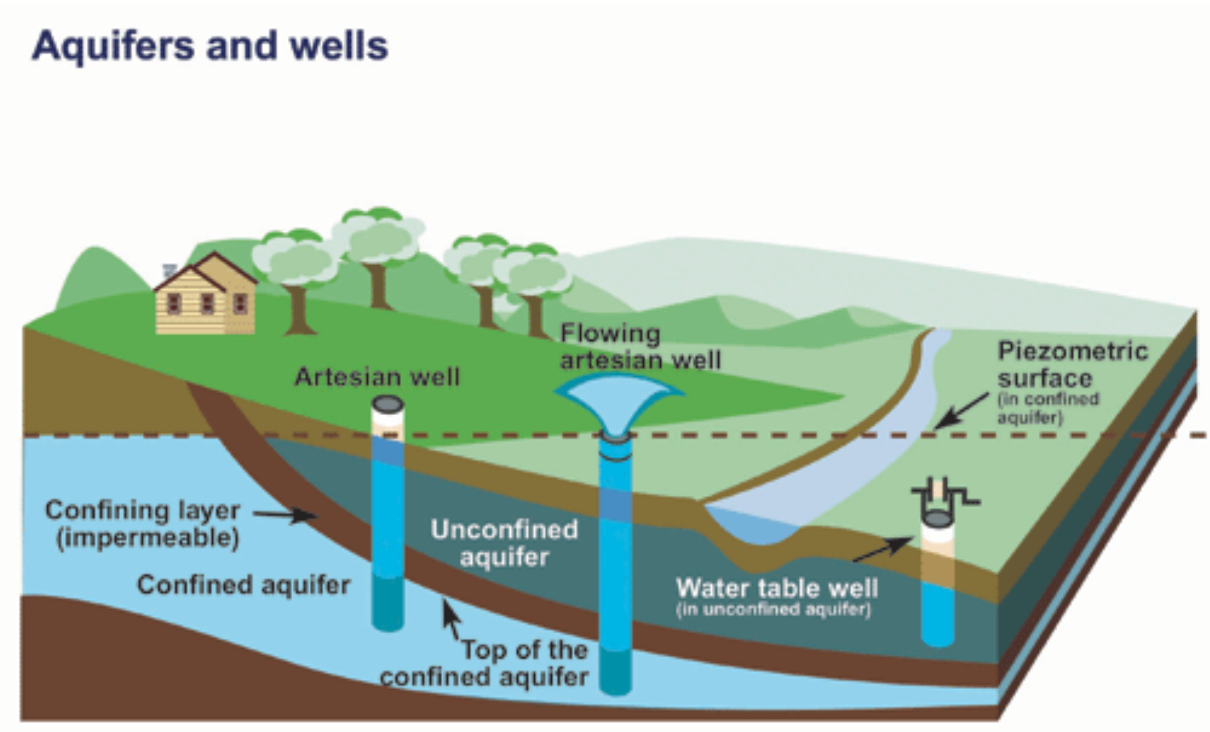

Figure 4: Natural Water Sources (EC, 2013)

Quality parameters

Total Coliforms

The total coliform group includes faecal and environmental species occurring in both sewage and natural waters. Some of these bacteria come from faeces of humans and animals, however many coliforms are able to multiply in water and soil environments so total coliforms are not a good indicator for pathogens in the water. However total coliforms can survive in water distribution systems, especially in presence of biofilms, making it a good indicator in the purpose of monitoring if the pipes are clean. (WHO, 2011)

Faecal Coliforms, Pathogens and Diarrhoea

A pathogen is an infectious agent, a microorganism that causes a disease its host. It can be a virus, bacteria, fungus, prion or protozoan .The host can be an animal, a plant, a fungus or even another microorganism.

In general terms, the greatest microbial risks are associated with ingestion of water that is contaminated with faeces from humans or animals. Faeces can be sources of pathogenic bacteria, viruses' protozoa and helminths. Faecal pathogens are the principal concern in setting health-based targets for microbial safety. (WHO, 2011)

Cholera is a diarrhoea illness caused by a pathogen called *Vibrio Cholera* and causes infection of the intestine. Often the infection is mild, but sometimes the symptoms can be severe. Symptoms are watery diarrhoea, vomiting, and leg cramps leading to rapid loss of fluids, which then leads to dehydration and chock. Without treatment, death can occur within hours.

Cholera is transmitted through contaminated water and food. It is rare to get cholera from direct contact with a contaminated person. The disease is usually spread through the faeces of a contaminated person. Therefore cholera can spread very rapidly in areas with poor water treatment and no sewage systems. (CDC, 2013)

Turbidity

Turbidity is a measurement of the relative clarity in water. Material that causes water to be turbid includes clay, silt and finely divided inorganic and organic matter, algae, organic compounds, plankton and other microscopic organisms.

The turbidity levels increase during the rain period due to partials from surrounding land that washes in to the rivers. When high levels of turbidity are found in drinking water there are often high risks that humans get gastrointestinal diseases. The reason to this is that turbidity can provide food and shelter for pathogens. If turbidity is not removed pathogens can grow bigger in number and lead to water borne diseases (USGS, 2013). One method that is used to decrease turbidity is usage of coagulants. Coagulants are added to water to combine the dirt particles so that they get heavier and sink to the bottom during sedimentation (EPA, 2012).

pH-levels

The waters pH-level is an important parameter that says a lot about the quality of water. It can determine the solubility and biological availability, meaning that aquatic life and heavy metals can be identified (USGS, 2014). The pH-level is also an important parameter when chlorine products are used to treat water, which is explained in section 2.5, Water Treatment.

Organic Matter

Organic matter is a parameter that determines the amount of organic compounds in the water. Organic compounds can be remains of dead organism such as plants and animals (USGS, 2013). Organic matter in water can provide food for pathogens, which can lead to growth and therefore lead to water born disease. There are different ways to measure organic matters in water. This study will measure the amount of Chemical oxygen demand COD, which will be converted to total organic carbon TOC.

Nitrates, Nitrites and Ammonia Nitrogen.

Ammonia, nitrates and nitrites are nitrogen-oxygen chemicals, which can both be inorganic or organic compounds. These substances are used a lot as fertilizers and can sometimes be found in water resources. It is also possible that these substances will come from sewage and erosion of natural deposits. High level of the substances can lead to serious health issues. (EPA, 2014)

2.4 Water Quality Guidelines

Water restrictions and guidelines are individual for every country. Developed countries have much more technology and options than the developing countries, Mozambique for instance. In this report the decision has been made that the guidelines of interest are those that MISAU, the health ministry, observes. Both WHO and Livsmedelsverket have a bigger range of water guidelines than MISAU's guidelines, which are presented below in Table 1.

	Max level of content	
Parameters	Well or hole	Distribution system
Total Residual Chlorine		0,2-0,5
pH	6,5-8,5	6,5-9
Conductivity [microsecond/cm]	50-2000	2500
Turbidity [NTU]	0,5-5	0,5-5
Colour	Nun	nun
Nitrates [mg/l NO3]	50	50
Nitrites [mg/l NO2]	3	0,5
Cloretos [mg/l Cl-]	250	250
Ammonia [mg/l NH4]	1,5	1,5
Faecal Coliforms [amount of colonies/ 100ml]	10	<1
Total coliforms [amount of colonies/ 100ml]	Do not test	<1

Table 1: Regulation on the quality of water for human consumption, Ministerial Decree nr 180/240.

WHO Comments About the Parameters

pH

There are no health-based guidelines for pH as the levels found in drinking water are not of concern. However pH has a big importance in water quality parameters concerning water disinfection. pH should be around 6,5-9,5. (WHO, 2011)

Turbidity

For effective disinfection the turbidity should not be more than 1 NTU, though preferably much lower than that. However in rural areas where it is hard to achieve 1 NTU, 5 NTU can be accepted. (WHO, 2011)

Ammonia, nitrate nitrite

There is no health-based guideline values for ammonia as the concentration in drinking water is significantly lower than what is of concern. Nevertheless there have been proposals for threshold levels for taste and odour. For water with pH over 7 the ammonia value in the aspect of odour should not be more than 1,5 mg/l and 35 mg/l when it comes to taste (WHO, 2011)

Nitrates have a restriction value of 50 mg/l while Nitrites only have 3 mg/l. (WHO, 2011).

Colour

Ideally water should have no colour. Colour indicates presence of coloured organic matter, which is associated with humus fractions of soil. If water is coloured it should always be investigated, as it might be the first indicator for water contamination.

Colour is valued in TCU, True Colour Units. Most people can detect colours above 15 TCU, therefore water with TCU lower than 15 is usually accepted by consumers. There is however no health based guideline values. (WHO, 2011)

Total Coliforms

Total coliform bacteria are an organism indicator. By testing total coliforms information like faecal pollution, effectiveness of disinfection and cleanliness of the distribution system can be collected. The total coliform group includes faecal and environmental species and occurs in both sewage and natural waters. Some of these bacteria come from faeces of humans and animals, however many coliforms are able to multiply in water and soil environment. In addition to this total coliforms are not a good indicator for pathogens in the water. Nevertheless total coliforms can survive in water distribution systems, especially in presence of biofilms, making it a good indicator for the purpose of finding biofilms.

Faecal Coliforms

There should be no faecal coliforms in drinking water.

Organic matter

The TOC levels are recommended not to exceed the value of 3mg/l (Khademikia et al, 2013).

Comparing MISAU, WHO and Livsmedelsverket

Among the parameters observed by MISAU, some are not of greater value for this study. Therefore only useful parameters will be compared in Table 2.

Parameters	MISAU	WHO	Livsmedelsverket
pH	6,5-8,5	6,5-9,5	7,5-9 (10,5 max)
Turbidity [NTU]	0,5-5	1 – 5	1,5
Nitrates [mg/l]	50	50	50
Nitrites [mg/l]	3	3	0,5
Ammonium [mg/l]	1,5	No Value	0,5
TOC [mg/l]	No Value	3	Depends
THMs [µg/l]	No Value	100	50-100
Faecal Coliforms [amount of colonies/ 100ml]	10/100		
Total Coliforms [amount of colonies/ 100ml]	<1/ 100		

Table 2: Comparison between drinking water guideline values (WHO, 2011)(SLVFS 2001:30)(MISAU 2014)

2.5 Water treatment

There are several methods for water treatment and they differ from country to country depending on the treatment plant technology. Understandably the technology is less advanced in developing countries. Along with this, many people in these countries live in rural areas where water is not treated at all before consumed.

Chlorination

Chlorination is an effective and cheap way to disinfect water sources. It is used all over the world in both modern and simple treatment plants. Chlorination is a chemical method, which uses various types of chlorine such as chlorine gas, sodium hypochlorite solution or calcium hypochlorite. (SDWF, n.d)

Chlorine added to water will result in hypochlorous acid (HOCl) and hypochlorite ion (OCl^-). These products are disinfecting compounds.

$$A\ form\ of\ Chlorine + H_2O \rightarrow HOCl + OCl^-$$

Of these two disinfecting compounds hypochlorous acid is the most effective one. The amount of the different compounds is dependent on the pH level in the water. Lower level of pH will result in more hypochlorous and higher levels will result in more hypochlorite. (Cfour, 2003)

The combination of these compounds are called “free chlorine” and has a high oxidation potential, which means that the compounds are determined to react with other compounds. This makes free chlorine a more effective disinfectant than other forms of chorine. Free chlorine first reaction is oxidation with all the ammonia nitrogen compounds that are present in the water, which will result in chloramines. This chlorine form is not as effective disinfecting as free chlorine. The amount of chlorine required to react with all the ammonia nitrogen is called chlorine demand. It can also be explained as the amount of chlorine that depends of the impurities of the water. The amount of chlorine added over the chlorine demand will remain as free chlorine and its purpose is to maintain the water quality throughout the distribution system, called residual chlorine. (CDC, n.d)

Different chlorination techniques

There are three different techniques of chlorination, including breakpoint-, marginal- and super-chlorination/de-chlorination.

Breakpoint chlorination is a technique where you add chlorine and it oxidizes with all the ammonia nitrogen, chlorine demand, and leaves remaining chlorine (free chlorine) to maintain the water quality.

Super-chlorination/de-chlorination is a technique where a large dose of chlorine is added to disinfect water followed by reducing the amount of free chlorine residual. Reducing the amount of chlorine is important to prevent taste issues. This technique is used when the bacteria levels are variable and when the contact time is short.

Marginal chlorination is a technique used when the water quality is good, which means that added chlorine will result in free chlorine residual and therefore little chlorine demand is required. (WHO, 2011)

Treatment factors

The amount of chlorine that is used and the contact time for disinfecting water are parameters that are relevant for chlorination. The relationship between these factors can be explained with a CT level. CT is a combination of concentration C and contact time T, which is the time from when chlorine is added until it is used. The treated water quality and the process time for the treatment will decide the amount of chlorine required. (Cfour, 2003)

Chlorination can be done any time throughout the water treatment. Its main purpose is to eliminate pathogens in the water, which can give water borne diseases.

Pre-chlorination is when chlorine is added immediately when the water enters the treatment facility. Its purpose is to eliminate algae, other forms of aquatic life from water, remove taste, odour and control the biological growth throughout the treatment process. The chlorine will oxidize with any iron, manganese and hydrogen sulphide and will be removed by sedimentation (where solids are removed by gravity settling) and filtration.

Disinfection can also be done after sedimentation and before the filtration. The chlorine will remove irons, manganese, taste, odours, algae and colour from the water and also control the biological growth.

At the water treatment plants it is most common to add chlorine in the final step of the process. The chlorines main task is to disinfect the water and maintain the chlorine residuals that will remain in the water when it travels through the distribution system. Chlorinating filtered water is more economical because it requires a lower level of CT. Since the water has been through the process of sedimentation and filtration a lot of unwanted organisms have been removed. This means that less chlorine and shorter contact time is required and therefore more economical. (SDWF, n.d)

To support and maintain the water quality through the distribution system re-chlorination can be used within the system to maintain the chlorine residual (WHO, 2011).

Correlation between chlorination and disinfection by products

Chlorine as a disinfectant can be problematic when chlorine reacts with organic compounds producing DBPs, disinfection by-products (OEM, 2000). The most common DBPs are trihalomethanes (THMs) and halocetic acids (HAAs). High levels of these products can cause health problems such as cancer and adverse pregnancy outcomes. (DEC, 2013)

According to WHO, DBPs are common by-products from disinfection with chlorine in waters with organic substance. In the western parts of the globe there are regulations of how much DBPs the drinking water should contain (CA.GOV, 2013). In these countries educated personal add the correct amount of chlorine to maintain the DBP at an accepted level in public waters. In Mozambique on the other hand, people can buy Certeza at their local shop, meaning that it is up to the consumer to use Certeza according to the instructions. It can also be problematic if consumers use Certeza in water with high amounts of organic matter; the chance of DBPs formatting in the water is higher leading to health risk.

It is also important to mention that the health risks caused from DBPs are very small comparing to the endangerment of drinking water that was not disinfected, which is mentioned by WHO as Figure 5 presents (Cfour, 2003). Nevertheless, it is important that DBPs levels are monitored and taken into account while considering disinfection measures of treating water for drinking purposes.

Disinfection should not be compromised in attempting to control disinfection by-products.

Figure 5: Directly copied from WHO Water Quality Guidelines 2011.

The basic strategies according to WHO that can be adopted for reducing the concentrations of DBPs are:

- Changing the process conditions (including removal of precursor compounds prior to application);
- Using a different chemical disinfectant with a lower propensity to produce by-products with the source water;
- Using non-chemical disinfection;
- Removing DBPs prior to distribution. (WHO, 2011)

However there is not a unison opinion about the correlation between organic matter, chlorine and THMs. In 2012 a study was made in fifteen rural water treatment plants in Khuzestan, a province in Southwestern Iran concerning the correlation between trihalomethanes (THMs) levels and TOC, pH, temperature, chlorination dose and free chlorine residue. The result of this study showed correlation between THMs and all parameters except TOC. (Ahmadi et al, 2012)
A different study concerning TOC as a reliable indicator for THMs and HAA5 formation showed that there is no linear correlation between TOC and THMs. Nevertheless it was possible to see that by removing TOC from the water before adding the chlorine disinfectant the concentration of THMs in the treated water decreased. (Consonery et al, 2004)

The pH level of water treated by chlorine has an influence on the amount of THMs formed. Lower levels will decreases the formation of THMs and higher the opposite. The explanation to this is that the reaction to create THMs depends on the concentration of HClO. Like mentioned before lower pH leads to higher concentration of HClO and therefore less formation of THMs. (Ahmadi et al, 2012)

Other water treatment

Ozonation

Ozon is a powerful oxidant that can be used in many ways throughout the water treatment. To create ozon gas (O_3) dry air or oxygen is passed through a high voltage electric field. The gas is directly added to the water treatment. Ozonation is mostly used with a following treatment such as biological filtration or granular activated carbon (GAC), to remove biodegradable organics, followed by chlorine residual, as ozone does not provide a disinfectant residual. (WHO, 2011)

Smaller scale applications

UV radiation is a common and effective method used to disinfect water in smaller scale treatments. UV radiation is a physical process rather than a chemical disinfectant, which eliminates the work to take away any products that can be harm for consumers (EPA, 1999).

There are a number of methods used for domestic water treatment such as boiling and chemical treatment. Chemical treatments use substances like bromine, iodine and chlorine. Chemical treatments often produce by-products that can be harmful for long term consumers depending on the water quality (WHO, 2011).

Chemical Product used in Mozambique

In Mozambique people use Certeza for domestic water treatment. Certeza is solution that contains diluted sodium hypochlorite. Diluted sodium hypochlorite is a chlorine product used for water treatment in smaller scales. It was launched in Mozambique in 2004 by Population Services International (PSI). The solution is used but in what quantity is hard to say. Certeza can be bought in 150ml bottles, which is enough for a family of five for one month. The product has been promoted a lot through mass media and community theatres (J. Wheeler, Sohail Agha, 2013).

However as mentioned before the efficiency of chlorine solution it is dependent on the quality of the water. Water that contains organic matters when treated with chlorine will result in DBPs, which are a danger for people's health.

3. Method

The method used in the study is divided into 2 parts. The first part is to analyse the water quality in areas around Maputo. The second part is to find out how people living in Maputo consume water and if they treat water before consumption.

3.1 Analysis of water quality

The main purpose of this part of the study is to decide if chlorine can be used for domestic water treatment by analysing the water in different areas in Maputo. The parameters chosen for analysing in this study were pH, turbidity, nitrates, nitrites, ammonia nitrogen, bacteria and organic matter. MISAU has been able to provide results for all of the parameters except organic matters, since it is not something they normally analyse. To analyse organic matters a COD monitoring was preformed. COD monitoring is not the most accurate method to analyse organic matter but because of the studies budget and of the limited equipment provided this method was chosen.

COD monitoring

COD monitoring is a method used to analyse organic matter in water. The method consists of indirect titration and will determined the concentration of the organic substance expressed as mg/l oxygen need for oxidation. Later on to convert COD to TOC, the relationship below was used (Chioetto n.d).

TOC levels between 0-10mg/l:

COD / TOC = 0,47

TOC levels between 0-20mg/l:

COD / TOC = 0,67

Because there is no determined relationship between TOC and DBP it is hard to discuss when chlorine should be used or not depending on the TOC levels.

Collecting samples

Water has been collected from distribution systems with treated water, ground water and surface water. The different types of water collected in the areas depended on what resource people used for drinking water.

For chemical analyses plastic bottles were used to collect water samples. For the microbiologic analyses, coliform tests, glass bottle were used from MISAU. Water from the distribution system that had been treated with chlorine had a solution present in the glass bottles to maintain the residual chlorine in the samples.

Samples were collected twice with two weeks apart at each resource. Depending on the resource different methods were used. When collecting water from pumped sources the water had to flow for three minutes before the samples were collected. In the other sources where there was no flow, a water bottle was let down into the water and filled. The first round of collected sample analyses were done on pH-levels, turbidity, nitrates, nitrites, ammonia nitrogen and organic compounds. The second round of collected samples all the above analyses were done and also bacterial analyses was performed. This was done on all the samples, which were collected two times from the sample resource.

Depending on the water source, MISAU chooses different bacterial tests. Total Coliforms tests are for treated water from FIPAG and Faecal Coliform tests are done on the other sources.

During the second round two new resources were observed and also taken into be analysed for the same parameters as in the first collection.

3.2 Interviews

Quantitative Interviews

When water samples were collected in the different areas interviews were held, presented in Figure 6, with fifteen residents in each neighbourhood, resulting in a total of 75 answers. Questions had been prepared so that they could be answered with multiple choices from a – e. The questionnaire was formed in a way so that an overview of the overall opinion about the water quality could be gathered as well as how many people were using the chlorine product Certeza. Along with these overview questions it was also interesting to see how the users handled the substance, as there are some important factors to have in mind when using sodium hypochlorite. For example the contact time, the amount of Certeza used for what amount of water and if the bottle was up to date as sodium hypochlorite loses its effect after a year in storage.

To be able to draw conclusions age, occupation and sex was thought to be of interest. Occupation was divided in to seven different categories:

1.Domestic; women taking care of the household and their children.

2. Student

3. Office

4. Store/company; work in a store/ at a company, owns a store or a company

5. Handy work; carpenters, cooks, constructors, tailors etc.

6. Academic; completed some kind of higher level education

7. Agriculture; the women who work with planting and selling vegetables

To get as representative answers as possible the first interviews were made to both men and women of different ages. After these few interviews it was notable that it is mostly women that take care of the water in the household, as well as all the other household chores. Therefore the decision was made that it would be better to ask women in front of men. However some men were still asked, though in smaller scale. For the exact questions see appendix 1.

Figure 6: Interview in Chamanculo.

Qualitative Interviews

Beside the quantitate interviews in the chosen research areas, more qualitative and informal interviews were held to get a larger overview of the usage of Certeza not only in Maputo, but also in other parts of Mozambique.

3.3 Research areas

In Maputo the water distribution differs a lot from area to area. To get a proper picture of the water situation in Maputo five locations were chosen, one in the central parts, three different suburban areas (peri-urban) and also one spot in a rural part of Maputo.

To decide the areas where we would collect water samples a meeting was held at MISAU. During this meeting they also informed that in Maputo they do not perform test on organic matter and therefore there is no register of the organic matter in the water around Maputo.

Below are the descriptions of the five different chosen areas.

1. Central Maputo (Avenida Karl Marx)

Avenida Karl Marx, presented in Figure 7, is part of the lower middle class area in central Maputo. Water in this area is distributed by FIPAG. Water collected from Avenida Karl Marx is tap water from the student residential of Eduardo Mondlane University. FIPAG do not manage to have pressured pipes during the whole day, therefore a thousand litre water container is used to storage water for the rest of the day. This container was said to be cleaned once a year.

Figure 7: A building in Central Maputo.

2. Lixeira de Hulene (suburb)

In this area Maputos largest waste damp is located, presented in Figure 8. Waste from all over Maputo is dumped here. When the waste decomposes nitrates and nitrites are formed and the heavy rains during the rainy season results in that the nitrates and nitrites infiltrates through the soil and down to the ground water. This area is chosen to see if the waste affects the quality in nearby water sources.

Figure 8: Wast damp in Hulene.

Hulene is a peri-urban area and could in many ways be considered a slum. The streets are not planned but at least the most houses are made out of concrete and not out of tin. Water consumed in Hulene can come from the distribution system provided by FIPAG and also from confined ground water. Water was collected from both of these sources presented in Figure 9.

Figure 9: Collecting samples. Groundwater (left) and distributed water from FIPAG (right) in Hulene.

3. Laulane (suburb)

Laulane is a suburb of Maputo. Compared to the other two suburbs Hulene and Chamanculo, Laulane has more urban planning. The streets are wider and have a planned structure, which is presented in Figure 10. As well as the streets, the location of the houses seems to have a planned structure.

Figure 10: Laulane.

Water distributed to this area is either from FIPAG or private distributers providing untreated confined groundwater.

Water samples collected in this area was done from both of these resources presented in Figure 11.

Figure 11: Collecting samples. Grounds water (right) and distributed water from FIPAG (left) in Laulane.

4. Chamanculo (suburb)

Chamanculo is the third peri-urban area we investigated. Out of the three Chamanculo is the poorest and most disorganized, it fits well into the description of a slum. The streets are narrow and unstraight, there is no kind of urban planning, which is presented in Figure 12. In some places there are nicer painted concrete houses with patios, but the majority are made out of tin and pop up here and there. Some of the houses we entered here did not even have water. They bought water from a neighbour.

Figure 12: Chamanculo.

Water is distributed to Chamanculo by FIPAG, but as in many other places in Maputo there is no more running water after lunch. People living in these areas normally fill containers with the amount water they need for the day.

Water collected in Chamanculo was water from the distribution system provided by FIPAG presented in Figure 13.

Figure 13: Collecting samples. Treated water from FIPAG in Chamanculo.

5. Pessene (rural)

Pessene is a rural area in the Maputo region, which is presented in Figure 14 and Figure 15. People live very simple and in most cases work with agriculture, or in the "machamba" as they call it here. People have their own piece of land where they cultivate different kind of vegetables and crops that they either eat or sell. The water distribution system is extremely poor. Most people do not have running water and get water from different alternative water sources. There are some wells but people also collect water from whatever place there is water. Some people have to walk far to collect water.

Figure 14: Typical house in Pessene (left), marchland (right).

Figure 15: Pessene market/station.

In Pessene there are confined and unconfined groundwater wells, and FIPAG is also distributing treated water to this area. If the confined groundwater wells (CGW) dry up, presented in Figure 17, people use the unconfined water wells (UCGW), presented in Figure 16. People who live too far from these wells pick up water from the marchland presented in Figure 16.

Figure 16: Collecting samples. Marchland (left), unconfined groundwater well (right).

Figure 17: Collecting samples. Confined groundwater well (left), treated water from FIPAG (right).

4. Results

Quantitative Interviews

A total of 75 people answered the quantitative questionnaire. It is interesting to see the correlation between the laboratory results of the water quality together with the perception of the people consuming it, therefore each neighbourhood answers will be followed by the laboratory results. The answers of most relevance have been selected to be presented in charts below. For exact results for each question see appendix 2.

The pie charts represent the answers for question three and question seven.

3. Do you feel safe drinking the water?

7. What method do you use to treat your water?

Laboratory Results

The results of the water analyses are presented in the following tables. Each table presents the analysed parameters for each water resource from the different areas in Maputo. Water samples collected from the distribution system in Hulene is unfortunately missing the bacterial result since a problem occurred at MISAU and will not be presented in the report.

The weather differed from the first and second time that samples were collected which might be a factor that could affect the results. During the first collection it had been raining a lot compared to the second time, which was drier.

The bacterial analyses that were done differ depending on what water that has be analysed. For water resources from the distribution system total coliforms analyses were performed and for ground water resource faecal coliforms were analysed. Therefore the levels of bacteria in the different resource cannot strictly be compared to each other.

4.1 Central Maputo

Interviews

Of the interviewed there were 27% men and 73 % women. The average age of the interviewed was 35 years and the occupation was academics, people working in stores and offices.

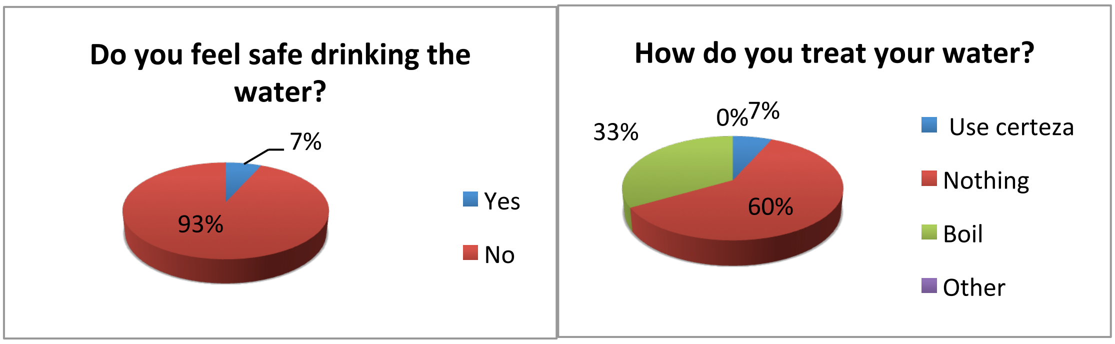

Figure 18: Interview results from Central Maputo.

When asked what water source they had, many who had FIPAG answered Aguas de Mozambique, however the water supply has now been taken over by FIPAG and in the end of this year 2014 Aguas de Mozambique will not be supplying water anymore.

Figure 18 shows that 60 % answered that they do not use anything to treat their water, it includes those who buy bottled mineral water. It also shows that 7 % uses Certeza.

Water analyses

Table 3 below presents the result from samples collected from central city in Maputo.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
8/4 2014	DS-FIPAG	7.68	10	<0.5	<0.03	0.42	6.81	
30/4 2014	DS-FIPAG	7.53	7.8	<0.5	<0.03	<0.04	7.19	>100/100

Table 3: Water analyses of distrubution system from central Maputo.

Despite that this water is distributed by FIPAG and should follow the restrictions from MISAU guidelines there are deficiencies. The water analyses showed high levels of turbidity, TOC and total coliforms. Water analyses of distribution system from central Maputo

4.2 Hulene

Interviews

Of the interviewed there were 20% men and 80 % women. The average age of the interviewed was 39 years and the occupation was mainly handy work and domestics.

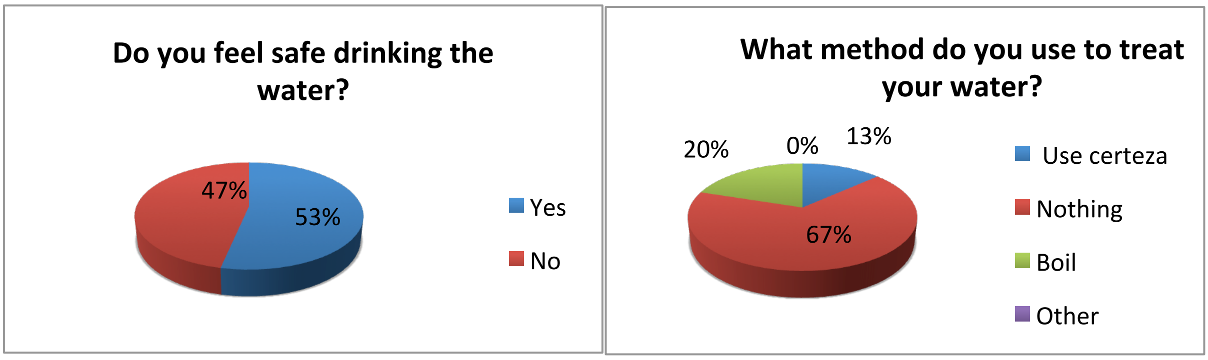

Figure 19: Interview results from Hulene.

Figure 19 shows that 67 % answered that they do not use anything to treat their water, it includes those who buy bottled mineral water. It also shows that 13 % uses Certeza.

Water analyses

Table 4 and Table 5 below presents the result from samples collected from Hulene.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
9/4 2014	GW	6.65	0.6	25.71	<0.03	<0.04	2.38	
28/4 2014	GW	7.76	4.3	<0.5	<0.03	<0.04	6.34	<1/100

Table 4: Water analyses of groundwater from Hulene.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)
9/4 2014	DS-FIPAG	7.3	2.4	<0.5	<0.03	<0.04	6.89
28/4 2014	DS-FIPAG	6.21	0.8	79.13	<0.03	<0.04	3.57

Table 5: Water analyses of distributed system from Hulene.

The results show that the hypothesis about the ground water in Hulene having high concentration of nitrates and nitrites due to the waste damp was not confirmed. However water distributed from FIPAG showed high levels of nitrate and also TOC.

4.3 Laulane

Interviews

Of the interviewed there were 60% men and 40 % women. The average age of the interviewed was 35 years and the occupation was mainly handy work but also some academics

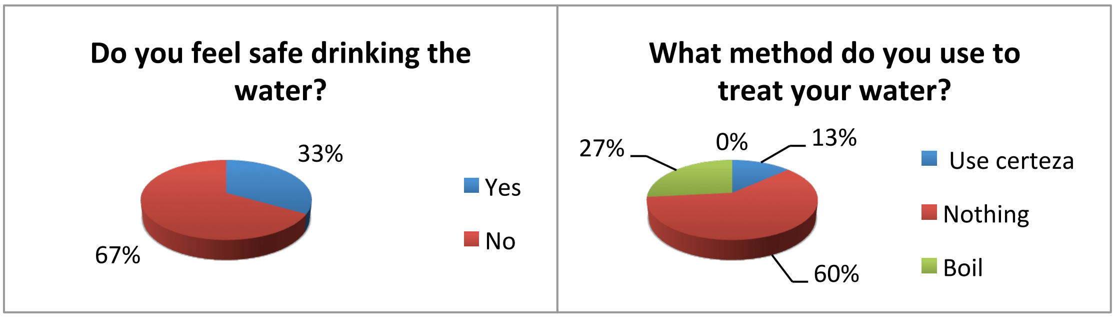

Figure 20: Interview results from Laulane.

Figure 20 shows that 60 % answered that they do not use anything to treat their water, it includes those who buy bottled mineral water. It also shows that 13 % uses Certeza.

Water analyses

Table 6 and Table 7 below presents the result from samples collected from Laulane.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
9/4 2014	GW	7.31	0.6	24.17	<0.03	<0.04	2.68	
28/4 2014	GW	7.43	0.6	88.47	<0.03	<0.04	1.79	80 /100

Table 6: Water analyses of groundwater from Laulane.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
9/4 2014	DS-FIPAG	6.95	0.7	<0.5	<0.03	<0.04	6.47	
28/4 2014	DS-FIPAG	7.48	7	<0.5	<0.03	<0.04	6.30	6 /100

Table 7: Water analyses of distributed system from Lulane.

Ground water analyse from Laulane shows to have high levels of nitrates and faecal coliforms, but TOC levels are under WHOs limit 3 mg/l. Distributed water shows only high levels of TOC.

4.4 Chamanculo

Interviews

Of the interviewed there were 47% men and 53 % women. The average age of the interviewed was 42 years and the occupation was mainly handy work.

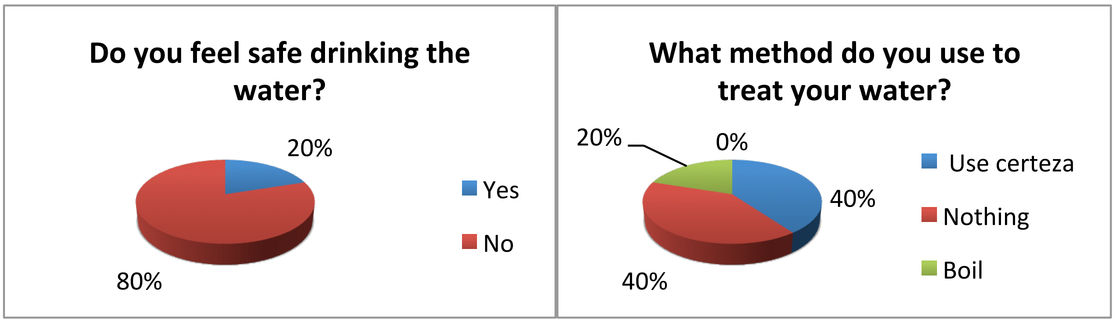

Figure 21: Inteview results from Chamanculo.

Figure 21 shows that 40 % answered that they do not use anything to treat their water, it includes those who buy bottled mineral water. It also shows that 40 % uses Certeza.

Water analyses

Table 8 below presents the result from samples collected from Chamanculo.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
9/4 2014	DS-FIPAG	7.77	5	<0.5	<0.03	<0.04	6.51	
28/4 2014	DS-FIPAG	7.33	7	<0.5	<0.03	<0.04	6.51	48 /100

Table 8: Water analyses of distributed water from Chamanculo.

Water analyse from Chamanculo shows high levels of TOC and total coliforms.

4.5 Pessene

Interviews

Of the interviewed there were 27% men and 73 % women. The average age of the interviewed was 38 years and the occupation was mainly handy work and agriculture.

In Pessene many people answered d on question six. Question six queries why you do not treat your water and answer d is “other”. The “other” in the case of Pessene is mostly lack of access to the product.

Some who answered “other” on question seven concerning what kind of treatment they use. In this area it mostly meant that they used a sodium hypochlorite powder that the hospitals had provided.

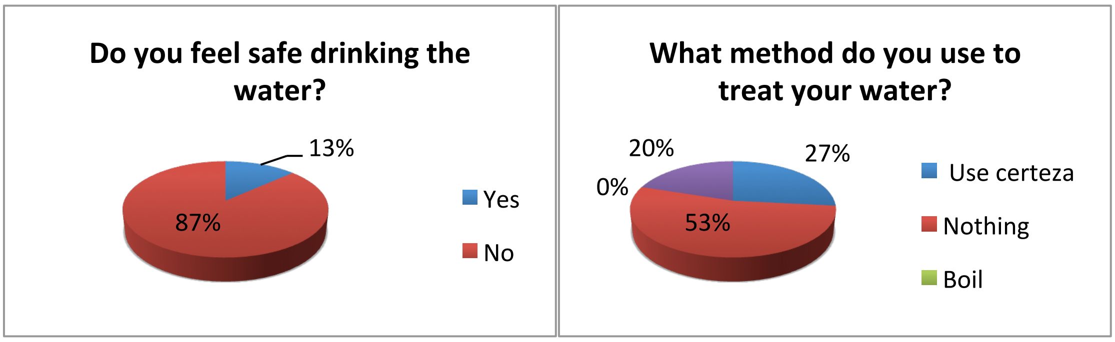

Figure 22: Interview results of Pessene.

Figure 22 shows that 53 % answered that they do not use anything to treat their water, it includes those who buy bottled mineral water. It also shows that 27 % uses Certeza.

Water analyses

Table 9 and Table 10 below presents the result from samples collected from surface water (SW) and unconfined ground water (UCGW) in Pessene.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
10/4 2014	SW	7.19	2	<0.5	0.23	<0.04	9.15	
29/4 2014	SW	6.93	4.5	<0.5	<0.03	<0.04	9.28	<1/100

Table 9: Water analyses from the marchland.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)	Bacteria (colony/ml)
11/4 2014	UCGW	5.04	30	13.5	0.21	2.04	20.12	
29/4 2014	UCGW	5.59	14	38.23	<0.03	0.32	24.78	>100/100

Table 10: Water analyses of unconfined groundwater well from Pessene.

The surface water well had high levels of TOC but low faecal coliforms. The unconfined ground water resource has the highest level of turbidity and TOC analysed in the study and faecal coliforms are also very high.

Table 11 and Table 12 below present the result from samples collected from confined ground water well (CGW) and from distributed water. These samples were only collected once and no bacterial analyses were done on these samples.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)
29/4 2014	CGW-Well	6.7	8.4	<0.5	<0.03	<0.04	10.51

Table 11: Water analyses from a confined groundwater well from Pessene.

Date	Source	pH	Turbidity NTU	Nitrates (mg/l)	Nitrites (mg/l)	Ammonia (mg/l)	TOC (mg/l)
29/4 2014	DS-FIPAG	6.95	9	<0.5	<0.03	<0.04	7.83

Table 12: Water analyses of distrubution system from Pessene.

Water from the ground water well and distributed water shows high levels of turbidity and TOC.

Comments about the Quantitative Interviews

As the charts above show, there is a significant amount of people that do not trust the drinking water. However the amount of people treating the water is remarkably low. Question six queries why the interviewed do not use any kind of treatment though he/she before answered that he/she did not trust the water. The most common answer to this question was the price and no time.

Many of the people who did use Certeza but not frequently, chose to use it at times when the water was more turbid than usual.

Figure 23 below presents the results of the total 75 interviews.

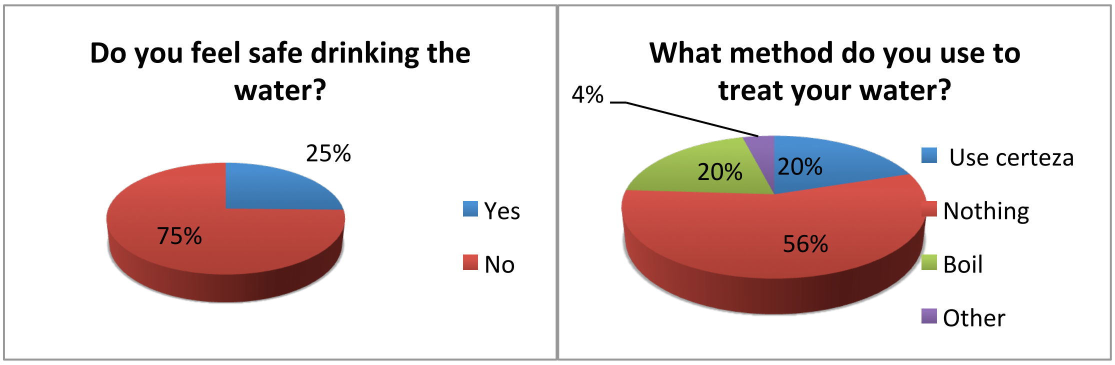

Figure 23: Interview results in total.

Comments about the Laboratory Results

The analyses done of different areas in Maputo present that water distributed from FIPAG has general high levels of TOC and also total coliforms, which is presented in Table 13. Water from ground water resources tends to have lower levels of TOC.

Location Source	**TOC (mg/l)**	**Total Coliforms (colony/ml)**	**Faecal Coliforms (colony/ml)**
Central Maputo DS	7	High	
Hulene DS	5.2	-	-
Laulane DS	6.4	High	
Chamanculo DS	6.5	High	
Pessene DS	7.8	-	-
Hulene GW	4.4		Low
Laulane GW	2.2		High
Pessene SW	9.2		Low
Pessene UCGW	22.5		High
Pessene CGW- well	10.5	-	-

Table 13: Overview of TOC and coliform levels.

Correlation between Turbidity and TOC

This study shows a slight linear correlation between turbidity and TOC, presented in Figure 24. But as the least square is only 0,55 it is not safe to say that high turbidity means high TOC. High turbidity can indicate elevated amounts of TOC, but water with low turbidity can also show high TOC levels.

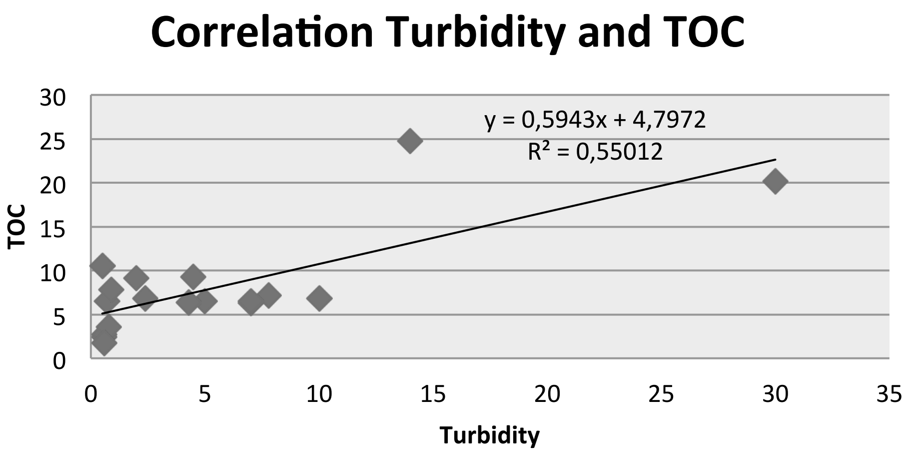

Figure 24: Correlation Turbidity and TOC.

Qualitative interviews

Along with the interviews in the chosen research areas around Maputo there where interviews and conversations held with people around Mozambique as well as in Maputo about their views and usage of Certeza.

In the town of Tofo in the province of Inhambane, located 460 km north of Maputo a conversation with two 25 year old men were held. They stated that they used to use Certeza a lot but lately they had not been able to get a hold of it. They believed that due to the use of Certeza their bodies had been accustomed to water free of pathogens and as a result of the absence of Certeza they now got sick because of the contaminated water.

Presented in Figure 25 two men outside a big superstore were observed adding 15 bottles of Certeza into a 1000 liter water storage. The water distributer was FIPAG, meaning that it had already been treated and contained residual chlorine when reaching the storage.

Figure 25: Certeza added to already treated water outside a supermarket.

5. Discussion

The interviews revealed that Certeza was the most commonly known chlorine based domestic water treatment product and the majority knew about it due to information and commercials on the TV and radio. However, being the most commonly known does not mean that it is the most commonly used. According to the interviews 75 % stated that they did not feel safe drinking the water, but still only 40 % did treat their water. Out of these 40 % it was evenly divided who chose to boil and who chose to use Certeza, meaning that only a total of 20 % of the 75 interviewed used the product.

When asked why they did not treat their water the most frequent answer was that they did not have the time or that it was too expensive except in Pessene where access was the problem.

From the laboratory results it shows that the amount of organic matter differs significantly from the different water sources in Maputo. In the areas where both water from the distribution system and ground water were collected, groundwater showed lower levels of TOC. Why this occurs can depend on different factors. A problem that has been observed in this study is the depraved state of the distribution system, such as leakage and unpressured pipes, leading to particles infiltrating into the system, including organic matters and bacteria.

Water distributed to the central parts of Maputo unexpectedly showed to have a higher level of TOC than all the peri-urban areas we investigated and the amount of total coliforms was also high. After having seen the conditions of the leaking water pipes in Chamanculo the result was surprising. However, the condition of the pipes transporting water to the central parts of Maputo have not been observed, therefore it is difficult to know if the high total coliform result has to do with infiltration. Nevertheless the pipe system in central Maputo is old and it is possible that the high levels of bacteria are due to biofilms in the pipes. Another reason could be that the big black water storage tank connected to the building has not been cleaned for a long time. To have a more exact result of the FIPAG water, either more buildings should have been tested or samples should have been collected directly from the pipes and not after it had been stored in the tank.

In the rural area Pessene, it was no surprise that the unconfined groundwater showed high levels of both TOC and high levels of bacteria. However it was surprising that the marchland had high TOC levels and still the faecal coliforms were below the WHO guideline.

Nevertheless MISAU only test total coliforms in the treated water system but test faecal coliforms in water from bore holes. Due to this, it is difficult to compare the amount of bacteria from groundwater sources and water from the distribution system. In addition to this, there is no information about faecal bacteria in the conventional distribution system, which is peculiar.

The hypothesis concerning high levels of nitrates, nitrites and ammonia in the ground water in Hulene due to the waste damp was not confirmed. The ground water showed better results than the water from the distribution system. An explanation could be that the ground water is from the confined aquifer, while the distribution system pipes are more exposed to infiltration when they brake, as they are located higher up in the ground, closer to the waste dump.

In the study there was a slight correlation between turbidity and TOC, yet it does not give the certainty to state that Certeza should not be used in water with high turbidity.

Nitrates, Nitrites, Ammonium and the weather show no correlation with the quantity of TOC in the collected samples.

As we can see the TOC levels in many areas are high, and in some even extremely high. No studies were found that showed a linear correlation between TOC, chlorination and THMs, nonetheless higher content of TOC show higher content of THMs.

In Laulane the ground water contained a high number of faecal coliforms colonies and the TOC level was low, meaning that Certeza would be a useful and needed option for this kind of water. However the water from the marchland in the rural area Pessene, where the TOC levels were high and the bacteria content was low, Certeza would not be a good alternative for disinfection.

6. Conclusion

This research has shown that Certeza or any other sodium hypochlorite product is not suitable for all kind of water sources. Water with high levels of TOC and bacteria are the problematic resources. According to WHO "Disinfection should not be compromised in attempting to control disinfection by-products". However, if the bacteria level is low and the TOC level high, consumers will be exposed to unnecessary levels of DBPs if sodium hypochlorite solutions are added, leading to a future health risk. Therefore it might be discussed if PSI, which is supposed to be a helping organization, should have the right to promote their product through mass media. Certeza should be used in areas where there is a risk of contaminated water, but however it should be promoted for private domestic use, especially without informing about the possible consequences is questionable.

Furthermore, Mozambique must improve the overall water treatment and sanitation, but to keep people safe from water contamination in the near future a better disinfection product for private use should be presented.

7. Errors and improvements

COD monitoring that was used to analyse the amount of TOC is a poor method compared to latest and more precise technics. The COD monitoring method relies on titration, which relies on your sight and fast reactions. As there were two people doing the tests, which could have made a different in the results. Nevertheless COD monitoring was helpful as an indicator of the TOC levels in the different water resources in Maputo.

For safer results, one more round of tests should have been done. However most of the parameters differ depending on the weather and conditions, meaning that it is not peculiar that the laboratory results for the same source sometime varies a lot. For a more exact study, the sources should be tested more times and during a longer period.

In this report it was decided to not check for residual chlorine in the treated water system. As it did show high levels of total coliforms, it would have been interesting to know the levels of residual chlorine, as it seems that they must be too low, letting the total coliform levels be so elevated.

A fundamental error in the study was forgetting to measure temperature. Temperature is something that always should be measured when it comes to water analyses. However, none of the samples were warm enough to catch our attention.

8. References

Ahmadi M, Keyani A, Amiri H, Hasani AH, Sekhavatjoo MS, Takdastan A 2012. ´THMs assessment in Khuzestan rural water treatment plants´, I*nt J Env Health Eng,* vol 1, no 6, p 39-42, viewed 5 May 2014, http://www.ijehe.org/article.asp?issn=2277-9183;year=2012;volume=1;issue=1;spage=52;epage=52;aulast=Ahmadi

CA.GOV, 2013, *Drinking Water Quality Data,* California Department of Public Health, viewed 28 September 2013, http://www.ehib.org/page.jsp?page_key=151#data_dbp

CDC, *Chlorine Residual Testing Fact Sheet*, Centers for Disease Control and Prevention, viewed 14 May 2014,http://www.cdc.gov/safewater/publications_pages/chlorineresidual.pdf

CDC, 2013, *Cholera - Vibrio Cholerae Infection*, Centers for Disease Control and Prevention, viewed 19 May 2014, http://www.cdc.gov/cholera/general/

Cfour, 2003, *Drinking Water Chlorination: A Review of Disinfection Practices and Issues,* Canadian Chlorine Coordinating Committee, viewed 2 May 2014, http://www.cfour.org/wp-content/uploads/2012/03/Disinfection-Practices.pdf

Chioetto M n.d, *Water Monitoring in drinking water: PlantsThe Comparison Between On-Line TOC Analysis and the Permanganate Oxidation Method*, State of the Art, viewed 30 April 2014,

Consonery, P.J, Lusardi, P.J, Kopansky, R, Manning, R.L 2004, *Total Organic Carbon: A Reliable Indicator of TTHM and HAA5 Formation?*, American Water Works Association, Philadelphia, viewed 7 May 2014, http://files.dep.state.pa.us/Water/BSDW/AboutWaterSupply/FPPE/TOC_TTHM_HAA5_Formation.pdf

DEC, 2013. *Trihalomethanes (THMs) facts sheet,* Department of Environment and Conservation, viewed 27 September 2013, http://www.env.gov.nl.ca/env/faq/thm_facts.html#7

EPA,2014, *Basic Information about Nitrate in Drinking Water,* United States Environmental Protection Agency, viewed 5 May 2014, http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm

EPA, 1999. *Wastewater Technology Fact Sheet: Ultraviolet Disinfection*, United States Environmental Protection Agency, viewed 23 April 2014, http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_uv.pdf

EPA, 2012, *Water Treatment Process – Coagulation.* United States Environmental Protection Agency, viewed 28 September 2013, http://water.epa.gov/learn/kids/drinkingwater/coagulation.cfm

Khademikia K, Rafiee Z, Amin M, Poursafa P, Mansourian M, Modaberi A 2013, 'Association of Nitrate, Nitrite, and Total Organic Carbon (TOC) in Drinking Water and Gastrointestinal Disease', Department of Environmental Health Engineering, viewed 15 May 2014, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3649361/

Länsstyrelsen, 2013, *Fortsatt hög befolkningstillväxt i länet,* Länstyrelsen Stockholm, viewed 16 maj 2014, http://www.lansstyrelsen.se/stockholm/Sv/nyheter/2013/Pages/fortsatt-hog-befolkningstillvaxt-i-lanet.aspx

OEM, 2000, *Chlorination disinfection by-products in water and their association with adverse reproductive outcomes,* Occupational and Environmental Medicine, viewed 27 September 2013, http://oem.bmj.com/content/57/2/73.full

SDWFa, *What is chlorination*, Safe Drinking Water Foundation Canada, viewed 14 may 2014 http://www.safewater.org/PDFS/resourcesknowthefacts/WhatisChlorination.pdf

Triche, T, Beete, N, Martins, F, 2009, *Summary of the Case Study Delegated Management of Urban Water Supply Services in Mozambique*, World Bank Africa Region and PPIAF, viewed 25 April 2014, http://siteresources.worldbank.org/MOZAMBIQUEEXTN/Resources/water_supply_EnglSum.pdf

The World Bank 2012, *Country Data*, The World Bank, viewed 14 Maj 2014, http://data.worldbank.org/country

USGS, 201,. *pH-Water properties,* United States Geological Survey, viewed 5 May 2014, http://water.usgs.gov/edu/ph.html

USGS, 2013, *Turbidity*, USGS Water Science School, U.S. Geological Survey, viewed 27 September 2013, http://ga.water.usgs.gov/edu/turbidity.html

UN-HABITAT, 2010, *Mozambique Cities Profile*, UN-HABITAT, viewed 24 April 2014, http://issuu.com/unhabitat/docs/mozambique_cities_profile

WSP, 2011, *Water Supply and Sanitation in Mozambique: Turning Finance into Services for 2015 and Beyond*, Water and Sanitation Program, viewed 28 April 2014, http://www.wsp.org/sites/wsp.org/files/publications/CSO-Mozambique.pdf

Image

EC, 2013, *Groundwater*: *Always on the move*, viewed 20 May 2014, http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=300688DC-1#sub3

Google maps, 2014, *Mozambique*, Viewed 20 May 2014, https://www.google.com/maps/@-19.2515055,28.4081948,5z

Appendix 1. Questionnaire

1. Where do you collect your water?
   1. = Superficial watersource
   2 = Watersystem
   3 = Bottled
   4 = Groundwater

2. Who is your distributer?
   1= FIPAG
   2 = Private
   3= Well
   4= Other

3. Do you feel safe drinking the water?
   1=Yes
   2=No

4. Have you or anyone in your household gotten cholera as a result of drinking the water?

   1=Yes
   2= No
   3= Diarrhea

5. Do you treat your water?
   1=Yes
   2=No

6. If No, why not?
   1= Not needed
   2= Too expensive
   3= No time
   4=Other

7. If yes which method do you use to treat your water?
   1=Chlorine
   2=Boil
   3=Other

8. If boil or other, why not chlorine?
   1=Safer
   2= Don't like the taste
   3= Lazy
   4= I haven't tried it yet, but have thought about it

9. If chlorine, how often do you use chlorine?
   1= every day
   2= 2-3 times a week

3= 2-3 times a month
4= Only during rain season

10. How do you use your chlorine solution?
1= Follow intstructions
2= Do not follow

11. How long do you store your water after adding Certeza?

1=Half a day
2= One day
3= Two days
4= More

12. In what do you store your treated water?
1= plastic
2=metal
3=other

b) 1=60 liter
2=25 liter
3=10 liter
4=Less
5=More

13. How did you get the chlorine solution?
1=Pharmacy
2=Donated
3= Supermarket
4=Market
5= Hospital

14. Where did you hear about it?
1=TV
2=Donated
3=Posters
4=Friend
5= hospital

15. How long have you had your bottle of chloirine?

1=Less than a month
2=1 month
3=3 month
4=more than 6 months

Appendix 2. Questionnaire Results

Central Maputo

Person	date	weather	Age	Sex	Occupation	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15
1	2014-04-09	1	25	2	2	2	1	2	2	1		2	3								
2	2014-04-09	1	50	1	1	2	1	2	3	1		2	6								
3	2014-04-09	1	23	2	4	3		2													
4	2014-04-09	1	52	1	1	2	1	2	2	1		1		2	2	3	1	2	1	1	2
5	2014-04-09	1	27	2	2	2	1	2	2	2	1										
6	2014-05-09	2	32	1	5	3		2	2												
7	2014-05-09	2	49	2	3	2	1	2	2	1		2	5								
8	2014-05-09	2	34	1	6	3		2	2												
9	2014-05-09	2	36	2	3	2	1	2	2	1		2	1								
10	2014-05-09	2	22	2	2	3		2													
11	2014-05-09	2	26	2	5	2	1	1	2	1		2	1								
12	2014-05-09	2	36	2	5	2	1	2	1		2		5								
13	2014-05-09	2	35	2	6	3		2	2												
14	2014-05-09	2	60	1	6	3		2	2												
15	2014-05-09	2	24	1	6	3	1	2	2												

Hulene

Person	date	weather	Age	Sex	Occupation	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15
1	2014-04-09	1	34	1	1	2	1	2	2	1		2	4								
2	2014-04-09	1	63	2	7	2	1	1	2	1		2	5								
3	2014-04-09	1	30	2	5	2	1	2	2	2	1										
4	2014-04-09	1	57	1	7	4	2	2	2	2	1										
5	2014-04-09	1	17	1	2	2	1	1	2	2	1										
6	2014-04-09	1	28	1	2	2	1	2	2	1		2	4								
7	2014-04-28	1	45	1	1	2	1	2	2	2	2										
8	2014-04-28	1	52	2	5	4	2	1	2	2	1										
9	2014-04-28	1	20	1	1	2	1	1	2	2	1										
10	2014-04-28	1	20	1	5	2	1	1	2	2	1										
11	2014-04-28	1	68	1	1	2	1	1	2	2	2										
12	2014-04-28	1	29	1	1	2	1	2	2	1		1		1	1	3	1	2	1	1	1
13	2014-04-28	1	13	1	2	2	1	2	1	2	4										
14	2014-04-28	1	64	1	5	2	1	1	2	2	1										
15	2014-04-28	1	38	1	4	2	1	1	2	1		1		2	2	4	1	4	2	1	2

Laulane

Person	date	weather	Age	Sex	Occupation	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15
1	2014-04-09	1	34	2	6	4	2	1	2	2	1										
2	2014-04-09	1	24	1	1	2	1	1	2	2	1										
3	2014-04-09	1	37	1	1	4	2	1	2	1		2	3								
4	2014-04-09	1	52	1	7	2	1	1	2	2	1										
5	2014-04-09	1	18	2	2	4	2	2	2	1		2	3								
6	2014-04-28	1	25	1	4	2	1	2	1	1		2	2								
7	2014-04-28	2	32	1	1	2	1	2	2	1		2									
8	2014-04-28	2	52	2	5	4	2	2	2	2	2										
9	2014-04-28	2	26	2	5	2	2	2	2	2	1										
10	2014-04-28	2	22	2	5	2	2	2	1	2	3										
11	2014-04-28	2	59	2	5	2	1	2	2	2	2										
12	2014-04-28	2	57	1	7	2	2	1	2	2	1										
13	2014-04-28	2	18	2	2	2	1	2	2	1		1		3	1	4	1	4	3	1	2
14	2014-04-28	2	47	2	5	4	2	2	2	1		1		5	1	4	1	2	3	1	2
15	2014-04-28	2	29	2	6	4	2	2	2	2	3										

Chamanculo

Person	date	weather	Age	Sex	Occupation	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15
1	2014-04-09	1	43	2	5	2	1	2	2	1		2	4								
2	2014-04-09	1	18	1	2	2	1	2	2	2	3										
3	2014-04-09	1	29	2	4	2	1	2	2	2	1										
4	2014-04-09	1	63	1	1	2	1	2	2	2	4										
5	2014-04-09	1	48	2	5	2	1	1	2	1		2	4								
6	2014-04-28	2	45	2	4	2	1	1	2	1	1	1	2	2	1	2	1	1			
7	2014-04-28	2	60	1	7	2	1	2	2	2	2										
8	2014-04-28	2	30	1	1	2	1	2	2	1		1		3	2	3	1	2	3	1	2
9	2014-04-28	2	48	2	5	2	1	2	2	1		1		2	1	2	1	2	3	1	4
10	2014-04-28	2	47	1	4	2	1	2	1	1		1		2	2	3	1	2	3	1	4
11	2014-04-28	2	37	2	5	2	1	2	1	2	2										
12	2014-04-28	2	32	1	4	2	1	2	2	1		2	4								
13	2014-04-28	2	57	2	5	2	1	1	2	2	1										
14	2014-04-28	2	55	1	5	2	1	2	1	1		1		4	1		1	2	3	1	0
15	2014-04-28	2	22	1	1	2	1	2	2	1		1		1	1	2	1	2	2	1	2

Pessene

Person	date	weather	Age	Sex	Occupation	1	2	3	4	5	6	7	8	9	10	11	12a	12b	13	14	15
1	2014-04-29	2	28	1	4	5	5	2	2	2	2										
2	2014-04-29	2	55	1	7	5	5	2	2	2	4										
3	2014-04-29	2	60	1	7	5	5	2	2	2	4										
4	2014-04-29	2	52	1	7	5	5	1	2	4	4										
5	2014-04-29	2	43	1	7	5	5	2	2	2	3										
6	2014-04-29	2	25	2	5	2	1	2	1	2	1										
7	2014-04-29	2	36	1	4	2	1	2	2	2	4										
8	2014-04-29	2	35	1	5	1	3	2	1	1		1		2	1	3	1	2	3	5	2
9	2014-04-29	2	32	2	5	2	1	2	2	2	4										
10	2014-04-29	2	28	1	4	2	1	2	2	2	4										
11	2014-04-29	2	66	2	5	1	3	2	2	1		1		1	1	1	1	2	5	5	2
12	2014-04-29	2	27	1	6	2	1	2	2	1		1		1	1	3	1	2	5	5	
13	2014-04-29	2	36	1	7	1	3	1	2	1		3									
14	2014-04-29	2	25	1	7	4	3	2	2	1		3									
15	2014-04-29	2	25	2	5	5	5	2	1	1		1		3	1	5	1	2	5	1	2

Appendix 3. Water analyses from MISAU

LNHAA
Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 880/14

Proveniência da Amostra: Samuel, Bairro: -, Av./Rua: Karl Max, Nº-

Tipo de Amostra: Agua da Rede
Volume da Amostra: 1,5L

Data de Colheita da Amostra: 08-04-2014
Data de Início da Análise: 09-04-2014

Motivo da Análise: Pedido do cliente
Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,68	-
Turvação	Turbidimétrico MI B12	n	10	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,81	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	0,42	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Os parâmetros assinalados com asterisco são subcontratados.

A Directora do Laboratório

Dra. Maria Nivalda Lázaro
(Técnica Superior de Saúde N1, Bióloga, MPH)
Data:___/___/________

Av. FPLM 2260 - Atrás do Hopital Geral de Mavalane
Fax: 21462714 - Telefone: 21 462715 - Cell.: 82 306 9249
Maputo- Moçambique

Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1200/14

Proveniência da Amostra: Samuel, Bairro: Central, Av./Rua: Karl Max, Nº-

Tipo de Amostra: Agua da Rede

Volume da Amostra: 1,5L

Data de Colheita da Amostra: 30-04-2014

Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente

Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,53	-
Turvação	Turbidimétrico MI B12	n	7,8	NTU
Nitratos	Absorção Molecular MI CO7	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	7,19	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes Totais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Revisão/Edição: 01/A	n	>100	ufc/100mL

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

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Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 906/14

Proveniência da Amostra: Samuel, Bairro: Hulene, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Furo

Data de Colheita da Amostra: 09-04-2014

Motivo da Análise: Pedido do cliente

Volume da Amostra: 1L

Data de Início da Análise: 09-04-2014

Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,65	-
Turvação	Turbidimétrico MI B12	n	0,6	NTU
Nitratos	Absorção Molecular MI CO7	n	25,71	mg/L NO_3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO_2
Matéria orgânica	Volumétrico MI C09	n	2,38	mg/L O_2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH_4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

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Dra. Maria Nivalda Lázaro

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LNHAA
Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1209/14

Proveniência da Amostra: Samuel, Bairro: Hulene, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Poço
Volume da Amostra: 1,5L
Data de Colheita da Amostra: 28-04-2014
Data de Início da Análise: 30-04-2014
Motivo da Análise: Pedido do cliente
Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,76	-
Turvação	Turbidimétrico MI B12	n	430	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI CO9	n	6,34	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes fecais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Edição/Revisão: 01/A	n	<1	ufc/100mL

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

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Maputo- Moçambique

LNHAA

Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 909/14

Proveniência da Amostra: Samuel, Bairro: Hulene, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede

Data de Colheita da Amostra: 09-04-2014

Motivo da Análise: Pedido do cliente

Volume da Amostra: 1,5L

Data de Início da Análise: 09-04-2014

Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,3	-
Turvação	Turbidimétrico MI B12	n	2,4	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,89	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

Dra. Maria Nivalda Lázaro

(Técnica Superior de Saúde N1, Bióloga, MPH)

Data:___/___/________

Av. FPLM 2260 - Atrás do Hopital Geral de Mavalane
Fax: 21462714 - Telefone: 21 462715 - Cell.: 82 306 9249
Maputo- Moçambique

LNHAA

Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 001HU SubCódigo: EHU01 Nº de Registo: 1198/14

Proveniência da Amostra: Escola Força do Povo; Samuel, Bairro: Hulene, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede

Volume da Amostra: 1,5L

Data de Colheita da Amostra: 28-04-2014

Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente

Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,21	-
Turvação	Turbidimétrico MI B12	n	0,8	NTU
Nitratos	Absorção Molecular MI CO7´	n	79,13	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	3,57	(mg O2/L)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

Dra. Maria Nivalda Lázaro

(Técnica Superior de Saúde N1, Bióloga, MPH)

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Laboratório Nacional de Higiene de Alimentos e Águas - MISAU

Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 907/14

Proveniência da Amostra: Samuel, Bairro: Laulane, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Furo
Volume da Amostra: 1,5L
Data de Colheita da Amostra: 09-04-2014
Data de Início da Análise: 09-04-2014
Motivo da Análise: Pedido do cliente
Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,31	-
Turvação	Turbidimétrico MI B12	n	0,6	NTU
Nitratos	Absorção Molecular MI CO7	n	24,17	mg/L NO_3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO_2
Matéria orgânica	Volumétrico MI C09	n	2,68	mg/L O_2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH_4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1212/14

Proveniência da Amostra: Samuel, Bairro: Laulane, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Poço | Volume da Amostra: 1,5L

Data de Colheita da Amostra: 28-04-2014 | Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente | Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,43	-
Turvação	Turbidimétrico MI B12	n	0,6	NTU
Nitratos	Absorção Molecular MI CO7´	n	88,47	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI CO9	n	1,79	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes Totais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Revisão/Edição: 01/A	n	80	ufc/100mL

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 908/14

Proveniência da Amostra: Samuel, Bairro: Laulane, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede
Data de Colheita da Amostra: 09-04-2014
Motivo da Análise: Pedido do cliente

Volume da Amostra: 0,5L
Data de Início da Análise: 09-04-2014
Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,95	-
Turvação	Turbidimétrico MI B12	n	0,7	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,47	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.
AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno
Os resultados referem-se apenas a amostra analisada.
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A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1211/14

Proveniência da Amostra: Samuel, Bairro: Laulane, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede — Volume da Amostra: 1,5L

Data de Colheita da Amostra: 28-04-2014 — Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente — Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,48	-
Turvação	Turbidimétrico MI B12	n	7	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,3	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes Totais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Revisão/Edição: 01/A	n	6	ufc/100mL

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 910/14

Proveniência da Amostra: Samuel, Bairro: Chamanculo, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede

Data de Colheita da Amostra: 09-04-2014

Motivo da Análise: Pedido do cliente

Volume da Amostra: 1,5L

Data de Início da Análise: 10-04-2014

Data de Fim da Análise: 14-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,77	-
Turvação	Turbidimétrico MI B12	n	5	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,51	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

Dra. Maria Nivalda Lázaro

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1210/14

Proveniência da Amostra: Samuel, Bairro: Chamanculo, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede

Volume da Amostra: 1,5L

Data de Colheita da Amostra: 28-04-2014

Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente

Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,33	-
Turvação	Turbidimétrico MI B12	n	7	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	6,51	(mg/L O2)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes Totais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Revisão/Edição: 01/A	n	48	ufc/100mL

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 933/14

Proveniência da Amostra: Samuel; Malivero 01, Bairro: -, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Rio

Data de Colheita da Amostra: 10-04-2014

Motivo da Análise: Pedido do cliente

Volume da Amostra: 1,5L

Data de Início da Análise: 11-04-2014

Data de Fim da Análise: 15-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	7,19	-
Turvação	Turbidimétrico MI B12	n	2	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	0,23	mg/L NO2
Matéria orgânica	Volumetria MI C09	n	9,15	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

Dra. Maria Nivalda Lázaro

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1208/14

Proveniência da Amostra: Samuel; Pessene 01, Bairro: -, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Poço

Volume da Amostra: 1,5L

Data de Colheita da Amostra: 29-04-2014

Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente

Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,93	-
Turvação	Turbidimétrico MI B12	n	4,5	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI CO9	n	9,26	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4
Coliformes fecais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Edição/Revisão: 01/A	n	<1	ufc/100mL

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 934/14

Proveniência da Amostra: Samuel; Malivero 02, Bairro: -, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Rio

Data de Colheita da Amostra: 10-04-2014

Motivo da Análise: Pedido do cliente

Volume da Amostra: 1,5L

Data de Início da Análise: 11-04-2014

Data de Fim da Análise: 15-04-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	5,04	-
Turvação	Turbidimétrico MI B12	n	30	NTU
Nitratos	Absorção Molecular MI CO7´	n	13,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	0,21	mg/L NO2
Matéria orgânica	Volumetria MI C09	n	20,12	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	2,04	mg/L NH4

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

Dra. Maria Nivalda Lázaro

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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1207/14

Proveniência da Amostra: Samuel; Pessene 02, Bairro: -, Av./Rua: -, Nº-

Tipo de Amostra: Agua do Poço

Volume da Amostra: 1,5L

Data de Colheita da Amostra: 29-04-2014

Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente

Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	5,59	-
Turvação	Turbidimétrico MI B12	n	14	NTU
Nitratos	Absorção Molecular MI CO7´	n	38,23	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI CO9	n	24,78	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	0,32	mg/L NH4
Coliformes fecais	Membrana Filtrante MI P/LNHAA/ML 102 2013-07-22 Edição/Revisão: 01/A	n	>100	ufc/100mL

JUÍZO

-

Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

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A Directora do Laboratório

Dra. Maria Nivalda Lázaro
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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1224/14

Proveniência da Amostra: Samuel; Pessene 03, Bairro: -, Av./Rua: , Nº

Tipo de Amostra: Agua do Poço
Volume da Amostra: 1,5L

Data de Colheita da Amostra: 29-04-2014
Data de Início da Análise: 30-04-2014

Motivo da Análise: Pedido do cliente
Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,7	-
Turvação	Turbidimétrico MI B12	n	8,4	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI CO9	n	10,51	mg/L O2
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

Reprodução parcial proibida, excepto quando autorizada pelo Director do Laboratório.

A Directora do Laboratório

Dra. Maria Nivalda Lázaro
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Boletim de Análise de Água

(F/LNHAA/DQ017)

Nº da Ficha: Código: 999 SubCódigo: 999 Nº de Registo: 1199/14

Proveniência da Amostra: Samuel; Pessene, Bairro: -, Av./Rua: -, Nº-

Tipo de Amostra: Agua da Rede
Volume da Amostra: 1,5L
Data de Colheita da Amostra: 29-04-2014
Data de Início da Análise: 30-04-2014
Motivo da Análise: Pedido do cliente
Data de Fim da Análise: 05-05-2014

Parâmetro Analisado	Método	AC	Resultado	Unidade
pH	Potenciométrico MI BO5	n	6,95	-
Turvação	Turbidimétrico MI B12	n	9	NTU
Nitratos	Absorção Molecular MI CO7´	n	<0,5	mg/L NO3
Nitritos	Absorção Molecular MI CO6	n	<0,03	mg/L NO2
Matéria orgânica	Volumétrico MI C09	n	7,83	(mg O2/L)
Amoníaco	Absorção Molecular MI CO5	n	<0,04	mg/L NH4

JUÍZO

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Taxa: ()

Observações: A amostra foi analisada no âmbito de um trabalho de Mestrado.

AC - Acreditado s - Parâmetro acreditado n - Parâmetro não acreditado MI – Método Interno

Os resultados referem-se apenas a amostra analisada.

A Directora do Laboratório

Dra. Maria Nivalda Lázaro
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