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Understanding the Handling of Drinking Water in local communities in Kenya

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Abstract

Background: Drinking water has a great impact on people´s health and life expectancy. Waterborne diseases due to unsafe drinking water handling are a major cause of deaths in developing countries. To understand drinking water handling in a rural community in Kenya, several influencing factors need to be considered. For example, water sources, storage, treatment, consumption, sanitation and hygiene. This study was undertaken in a village called Mweiga near Nyeri Town in Central Kenya in order to understand the drinking water practices of a rural community.

Method: The field research was conducted with an observation of the drinking water handling (storage and consumption) on household level. The observation was embedded in a face-to-face interview. Besides the socioeconomic background of the household, the interview investigated the health awareness on waterborne diseases and the occurrence of diarrhoea, cholera, typhoid hepatitis and polio as well as the knowledge about household water treatment. It also explored the sanitary and hygienic conditions of the households. Furthermore, field notes and photographs were taken to complement the findings.

Results: Serious health concerns related to drinking water were recorded in the field research. Especially the number of people drinking untreated water frequently, despite knowing a method of household water treatment was alarming. The observation showed, that the hygienic behaviour of water consumption and storage was insufficient. Additionally, the sanitary conditions were likely to cause waterborne diseases.

Conclusion: The study´s results have illustrated the high need of further health education regarding drinking water handling in Mweiga. Furthermore, there is a high necessity of household water treatment alternatives to water boiling. For rural areas in Kenya, community-based initiatives with empowered community members are needed to prevent diseases and deaths caused by unsafe drinking water.

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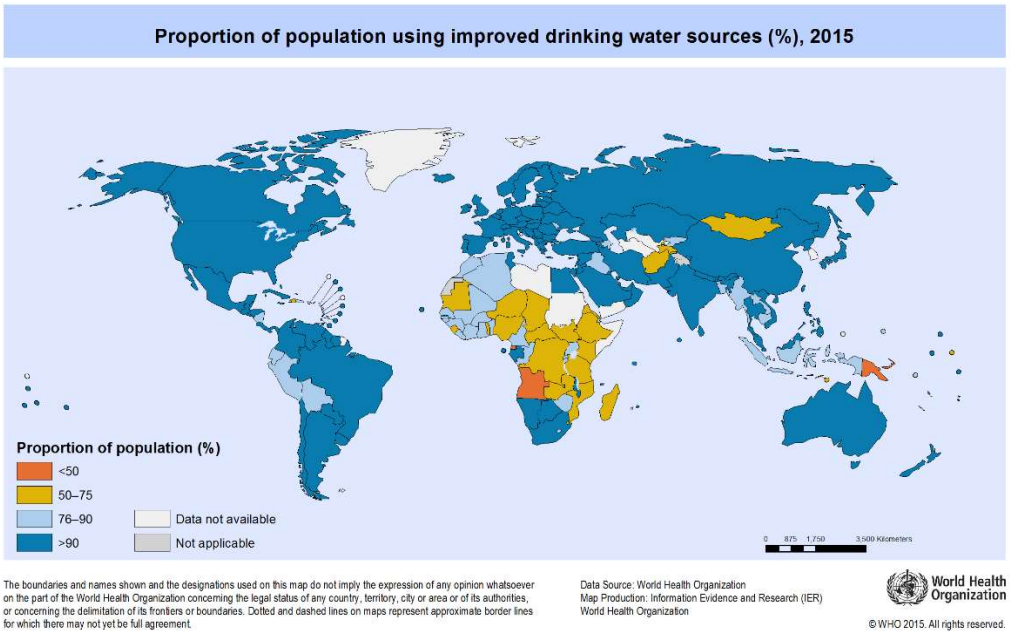
1. Introduction

The access to safe drinking water is essential for life. The United Nations enshrined the right for potable drinking water in their Universal Declaration of Human Rights and it is critical to accomplish the Millennium Development Goals (MDG). In the year 2000, all 189 United Nations member states and at least 22 international organisations committed to help achieve these goals. Each goal had specific targets. One target was to halve the population without sustainable access to safe drinking water and basic sanitation by 2015.

The OECD Development Centre reports that from 1990-2004 ten million people in sub-Saharan Africa annually gained access to safe drinking water. However, the population has grown even faster. So, the absolute number of people with unsafe water has increased by about 60 million people over the same period. In conclusion, sub-Saharan Africa did not reach the drinking water Millennium Development Goals. In terms of sanitation, the situation is similar. The rate of people gaining access to improved sanitation facilities in this area was 7 million annually. To reach the Millennium Development Goal the rate should have been 35 million (Kaufmann, 2007). The scarcity of safe pollutant-free water and the lack of improved sanitation and hygiene are major public health problems. It causes diseases like Typhoid, Cholera, Hepatitis A&E or Poliomyelitis with severe symptoms, for example diarrhoea. To prevent these diseases, there is a high need of better knowledge and awareness about waterborne diseases and Household Water Treatment (HWT). Especially children under five years are vulnerable. Numerous countries particularly in sub-saharan Africa, already face safe drinking water shortage. Poverty, weaknesses in infrastructure, increasing industrialization, fast population growth and climate change are the main origins of this drawback. The fifth International Panel on Climate Change (Hartmann, Tank, Rusticucci, 2013) concluded that climate change is affecting physical and biological systems on every continent and that changes in systems and sectors are consistent with regional temperature trends. Many changes are a result of rising temperatures caused by greenhouse gas emissions. As a consequence, evaporations of water increases as well. That contributes to the water scarcity which is already present in sub-Saharan Africa. These indicators lead to considerable challenges to access improved drinking water sources for rural communities in sub-Saharan Africa including rural Kenya which is the object of investigation in this study. Figure 1 shows a World Map the proportion of population using improved drinking water sources.

Figure 1: Proportion of population using improved drinking water sources (Source: WHO, 2015)



Rainfalls have declined due to climate change as well. US Aid reported that the long rains in central Kenya have declined more than 100 millimeters since the 1970´s. This decrease is linked to the warming of the Indian Ocean and most likely, this development will continue threatening drinking-water safety in rural areas in central Kenya (USAID, 2010). This is an amplifying factor for drinking water safety.

The water quality is mainly threatened by poor infrastructure, poverty, low health consciousness and simply missing knowledge about safe drinking water handling, especially in rural areas.

1.1 Kenya

Kenya is situated in East-Africa, bordered by Tanzania (South), Uganda (West), South-Sudan (North-West), Ethiopia (North), Somalia (North-East) and the Indian Ocean (East). The climate is influenced by the Great Rift Valley, various mountain ranges and a number of volcanos. It includes tropic, highland, arid and semi-arid areas and it is characterized by unreliable rainfall with a vulnerability for droughts and floods due to spatial and temporal variability. About 80% of Kenya are arid or semi-arid lands (ASAL) (Mganga et.al, 2010). The Republic of Kenya has a population of 44 million with an average life expectancy of 61 years. 42% of the population

are under 15 years old. 75 % of the Kenyans are living in rural areas. The World Bank classifies Kenya´s income as low. The Countries Human Development Index was 0.519 in 2012. That was rank 145 out of 187 countries with comparable data. The poverty level is currently decreasing, but it was still 42% in 2012. This drop down has been most remarkable in urban areas, but not in rural regions. In Kenya, only 12% of the rural population has piped household connections comparing to 86.4% of the households in urban areas. Gender disparities are still high, especially in rural areas. There are also disparities between urban and rural areas in drinking water supply. Kenya has also a very fast growing population with a fertility rate of 3.9 birth in 2014 (WHO, 2015).

1.1.1 The Nyeri County in Kenya

The Nyeri County is one of the 47 counties in Kenya. It is located in the Central Region on the south-west flank of Mount Kenya with an area of 3.337 km² and a population of 707.003. The Mount Kenya (5199 m) to the east and the Aberdare Range (3999 m) to the west affect the rainfall in this region. The county experiences equatorial rainfall with long rains from March to May and from October to December.

Figure 2: Location of Nyeri County (Source: Google, 2017)

The rainfall can significantly vary even in small areas because of the special location in the Kenyan Highlands. Rural areas in Kenya are largely cut off from infrastructural services. That causes a lack of sustainable access to basic services. In these areas, the access to safe drinking water is one of the biggest challenges. The coverage of safe water strongly correlates with the

household income and the location and shows the inequality between the rural and the urban areas as well as the rich and the poor. The Human Development Index was 0.5187 in 2009. The county has a poor supply with electricity at 26.3 %. Predominantly, the local people are of the Kikuyu ethnicity. It is not unusual that people in the villages cannot speak or understand the national languages (English and Kiswahili) on a sufficient level. In the rural communities in Nyeri County (Kieni West sub-county) where this study took place, the households usually receive their drinking water from the nearby Honi River (Republic of Kenya, 2013).

1.2 Problem statement

The Kieni West sub-county in Nyeri County in central Kenya has major drinking water issues. Nyeri County is one of the better developed Counties in Kenya. But there are still substantial shortcomings in drinking-water supply. Most of the households in the rural areas in Nyeri County don´t have access to piped water or improved sanitation facilities. People in rural areas in a developing country like Kenya suffer numerous waterborne diseases due to unsafe drinking water and poor sanitation and hygiene. The WHO estimates that 1.7 billion children under five suffer diarrhoea each year. It is second as the cause of deaths in children under five years worldwide only behind pneumonia with approximately 760.000 deaths (WHO, 2016). Diarrhoea is way more prevalent in developing countries and people are more vulnerable due to poorer overall health and nutritional status. The fact that diarrhoea is relatively easy to prevent makes it even a more relevant public health problem. Diseases like typhoid, cholera or polio might be exterminated in more developed countries, but in Kenya it is still a common disease. According to the 2014 Kenya Demographic Health Survey at least 1 in every 19 children born in Kenya are dying before reaching the fifth birthday. Only 63.2% of all diarrhoea causes in central Kenya were treated by a health facility provider. 66.3% in central Kenya are using non improved sanitation (Head et al., 2015). The importance of hand washing with soap to prevent diseases is still not established in many regions. Also, the paramountcy of treating the river water is not as prevalent as it should be. Generally, the awareness of safe water, sanitation and hygiene to prevent diseases is limited. Another issue is the availability of HWT-methods. Many households do not know where to get chlorine or filters to make the water safer to drink. And if they know, the distance to the next shop can be too far to manage. There is also the lack of understanding how to use HWT-methods since Kenya is a multicultural county with 42 tribes and almost as many languages. It is common that people in rural areas do not speak the national languages English or Kiswahili. But descriptions of how to use HWT-

methods are usually in English and Kiswahili. For the poor people, HWT is too expensive as well. The majority of households which are researched in this study are self-sufficient households with nearly no income. These households only get money through selling the field crops they harvest. Then HWT is not number one on the priority list. The people are not aware of waterborne diseases. Other issues for example HIV/AIDS is given more attention. Furthermore, there is a big lack of infrastructural basics. Many problems are sourced in centralized structures. High costs of setting up infrastructure for water security and solid waste management contributes to these shortcomings. Decentralization and less corruption would lead to solving water problems in quality and quantity for the rural population. The high inequalities between urban and rural areas became a major problem (Cherunya, Janezic & Leuchner, 2015).

Summarizing, there are various challenges to secure drinking water problems in Kenya. From policy makers to individuals. If there will be no basic studies which gives policy makers and non-governmental organisations (NGO) a foundation for urgent interventions, the climate change, the high poverty and the fast-rising population will lead to even bigger problems in drinking-water practices in Nyeri County.

1.3 Aims of the Thesis

The main goal of this thesis is to assess and understand how the rural population in Nyeri County (Kieni West sub-county) in Kenya handles their drinking water in their households to prevent water related diseases and assess the awareness of waterborne diseases in the community. Another aim is to detect where the issues lie in HWT for the people living in rural areas in Nyeri County (Kenya). Another goal is to identify how prevalent the most common water related diseases are in the sample and to detect the drinking water sources. In the concept of this thesis, the chapter *conclusion* includes recommendations for actions to improve the quality of drinking water with affordable HWT-methods which are easy to use. Furthermore, recommendations for actions for non-governmental organizations (NGO´s) and community based institutions will be discussed in the following.

The following questions arose during the preparation and writing of the thesis: What is the socioeconomic background of the household? Why is HWT important? How aware are people of safe drinking water practices? How often get people sick from contaminated water? Which

HWT-methods are known and used? Do people know how to use these methods? If knowledge about HWT is present, what hinders people to use HWT-methods?

2. Water Quality Issues in Kenya

The Kenyan waterbodies face increasing quality issues. Human activities lead to the deterioration of river systems. Besides deforestation and biomass burning of the trees, poor agricultural activities next to the riverbed dumping off residues into the water. Inflows of sanitary and industrial wastes as well. Because of low investments, the level of the agricultural sector remains poor. The use of various pesticides and fertilizers is very common in Kenya. These pollutants flow into the rivers with draining storm waters. Rivers also contain loads of sediments because of soil erosion which is polluted by poor farming practices (Ahuja, 2013). Furthermore, Kenyan rivers are microbiological polluted by both animal and human wastes. Cows, goats or chicken live close to the riverbed on the small local farms. The human rural population in Central Kenya often has no access to flush piped sanitary facilities and collects their domestic water from a river. The dwellers in rural Kenya mostly use simple pit latrines. Just a whole in the ground which collects the faeces without use of water. These faeces contaminate groundwater but it can also end up in surface water drainage networks (Kimani-Murage & Ngidnu, 2007). The disuse of improved sanitation facilities and soap for washing hands after excretion favours contamination of the drinking water supplies.

3. Water and Health

All forms of life on Earth depend on water. Human beings are approximately 60 percent water. We cannot not survive without water for more than a few days. Human culture and development is defined by water. Human beings are always in search for water sources and settlements are more successful when water supply is ensured. One has only to look at development along the major river systems on all continents to realize how it affects human development and cultures. On first sight, our planet might appear to have an unlimited reservoir of water. But over 97% of the world´s water is salty, found in the oceans and in inland sand seas and salt water lakes. The rest is freshwater, but two-thirds of the freshwater is locked in the Arctic and Antarctic ice. The water in rivers, lakes, the atmosphere and in the ground which is theoretically consumable for humans or usable for agriculture makes up less than 1% of the world´s water resources. Between these locations, water is constantly in motion. In the so-called hydrologic cycle, which is essential for the health of the planet.

Without these interactions of evaporation, precipitation and runoff back to the oceans no water recharge is possible and the freshwater resources are exhausted quickly. The hydrologic cycle has to be seen from a holistic perspective. One perturbation of one compartment naturally affects the others which threatens the quantity and the quality of freshwater and thus the health of human beings (Frumkin, 2010). This chapter explores these interconnections and how human activities such as water consumption and water treatment influence human health. Furthermore, it will describe the most relevant waterborne pathogens.

Freshwater is divided into surface water and groundwater. Groundwater has been considered a high-quality resource because rainfall and other surface water gets naturally cleaned by physical, chemical and microbiological processes when it percolates in the soil. However, human development leads to more groundwater pollution due to land management practices. Surface water and groundwater under the direct influence of surface water has been considered less favourable for human consumption. But clean groundwater is not always available, so water treatment methods are needed to make surface water safe to drink. However, polluted surface water cannot be used for agricultural, industrial or recreational uses without treatment unconditionally (Frumkin, 2010).

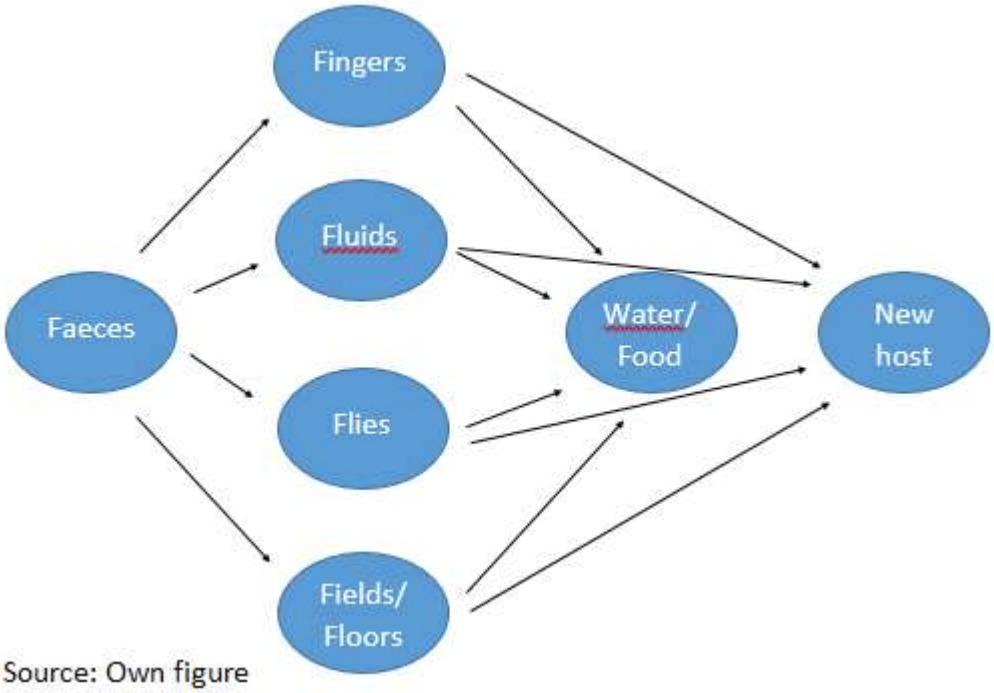
Water scarcity is one of the most critical health threats. When a resource gets exhausted faster than it can be renewed, eventually this resource will be drained. Just as fossil fuels but way less mentioned in the media and less strong in people´s consciousness, freshwater is also a finite resource. Fast growing populations like Kenya place a severe strain on water resources. The republic of Kenya already faces water scarcity, defined as a water supply below 1000 m^3 per person per year. These numbers include all domestic, industrial and agricultural water use (Frumkin, 2010). In a country like Kenya, more than 50% of the water is used for agricultural and livestock matters (FAO, 2010). This reflects the enormous amount of water needed for food security. It is not surprising that agriculture is the greatest contributor to water scarcity. Especially in Kenya, this fact is critical because the Republic´s economy relies on two sectors, tourism and agriculture. At the same time, the country faces the big challenge to secure drinking water supply for the fast-growing population. Although, political implications affect water scarcity because major rivers are often shared by various countries. So, the use of water by one country affects the downstream consumers. The way water moves dramatically

changed due to human activities such as dams, levies and canals. This obviously alters aquatic ecosystems which can directly affect the hydrologic cycle and human health (Frumkin, 2010).

3.1 Waterborne Diseases

The landscapes on Earth are formed and modified by human beings. So, it is not surprising that the water we drink contains both chemical and biological pollutants. These pollutants can be divided in three categories. Bacteria, viruses and parasites. Many waterborne pollutants can infect both humans and animals. As the water is moving through the environment, it often contains small concentrations of waterborne pathogens. However, these pathogens present a considerable public health risk, because many of the pathogens following in this chapter, have extreme low infectious doses and have an enormous environmental persistence. Via the faecal-oral route, waterborne diseases can be transmitted directly from the drinking-water or indirectly through vectors like mosquitos and flies. The faecal-oral route is a transmission of disease when pathogens in faeces pass from one host to another. Over fingers, fluids, flies or floors the pathogens pass on into drinking water or food and then find a new host. Figure 3 shows a model of the faecal-oral route.

Figure 3: Model of the faecal-oral route



Source: Own figure

In rural Kenya, households rely on water supplies that are at a high risk of faecal contamination. Faecal contamination causes waterborne diseases. In the following, this

research work will give an overview about the most relevant waterborne diseases for this study (Bridle, 2014). At first, it will describe the most considerable symptom of waterborne diseases.

3.1.1 Diarrhoea

Diarrhoea is the most grievous symptom of all waterborne diseases in Kenya. Diarrhoea is defined as the passage of three or more liquid stools per day, or simply more than normal for the individual. It is the second leading cause of deaths for children under five years of age and poses an extremely high burden of disease. Diarrhoea "kills more children than AIDS, Malaria and Measles combined" (WHO, 2016). One in ten children die from diarrhoea worldwide annually. In particular, it affects young children in low-or middle-income countries. In 2011, approximately 700.000 deaths of children under five years were due to diarrhoea. The highest risk for children to die from diarrhoea are in the first two years of life. People living with HIV/Aids are on higher risk to die from severe diarrhoea. The burden of mortality is highest in the WHO regions Africa and Southeast Asia. It is estimated that one third of severe diarrhoea episodes is preventable by vaccination, for example against the rotavirus and cholera (Kalyankar et al., 2016). In the year 2010, 10% of all under five causes of death in Kenya were due to diarrhoea (WHO, 2015). In Kenya, 1.725 children under five years had diarrhoea, two weeks preceding the Demographic and Health Survey in 2014 (Kenya National Bureau of Statistics, 2015). The National Bureau of Statistics reported over 20.000 diarrhoea cases in Nyeri County in 2014 (Kenya National Bureau of Statistics, 2015). Children suffering from diarrhoea in their first two years of life are averagely 8cm shorter and have 10 IQ points less by the time they are 7-9 years old. The link of enteric infections and child growth and development makes it a double burden of enteric infections and malnutrition. The link between these factors and obesity later in life makes it even a triple burden. The most important risk factors for diarrhoeal diseases are lacks of exclusive breastfeeding in infants, undernutrition and zinc deficiency (Kalyankar et al., 2016). A study from 2013 showed that there is a relative risk of 4.6 (95% CI 1.8-11.8) to get diarrhoea if the mother provides only partially breastfeeding and 10.2 (95% CI 2.8-39.6) if there is no breastfeeding at all (Fischer Walker et al., 2013). Coherences between unsafe water, poor sanitation and hygiene and diarrhoea have been shown as well. Measles and acute lower-respiratory-tract infections can also cause diarrhoea. It is also discussed that Vitamin A deficiency is a risk factor for diarrhoea (Kalyankar et al., 2016).

The symptom diarrhoea can be classified by the duration as prolonged/acute and persistent diarrhoea. Prolonged/acute with a duration of 1-13 days and persistent with 14 days or more. It can be furtherly classified as prolonged/acute watery diarrhoea which is loose or watery stool at least three or more times a day and prolonged/acute invasive diarrhoea which shows gross blood by history or inspection in the stool less than 14 days of duration, usually accompanied by fever. Diarrhoea can be also divided based on the pathophysiology processes secretory, osmotic and inflammatory diarrhoea. Secretory diarrhoea is an increase of intestinal fluid output which is too much for the gastrointestinal epithelium to reabsorb. The body loses significant water and electrolytes. Osmotic diarrhoea occurs when excessive amounts of solutes are retained in the intestinal lumen. Water will not be absorbed, so diarrhoea is the result. Inflammatory diarrhoea is often a result of barrier disruption by bacteria (for example Salmonella) and rotaviruses. Inflammatory mediators are released and the surfaces of the gastrointestinal tract are not able to absorb water and nutrients. (Kalyankar et al., 2016).

The most frequent causes of diarrhoea in developing countries are infections by bacteria, viruses and parasites. A systematic review of scientific studies between 1991 and 2011 shows that rotavirus, calicivirus, ETEC (Enterotoxigenic Escherichia coli) and EPEC (Enteropathogenic Escherichia coli) are the most common diarrhoeal death causes worldwide (Lanata et al., 2013). A 3-year prospective study about diarrhoeal diseases in four sites in Africa (Kenya, Mozambique, Gambia, Mali) searched out that rotavirus, shigella, ETEC, cryptosporidium and EPEC cause the most attributable cases of severe diarrhoea for children under five years of age (Kotloff et. al, 2013). Seasons have an impact on diarrhoeal diseases in developing countries. Bacterial diseases are peaking in the hot months and viruses occur perennial with peaks in the colder months. In developing countries, gastrointestinal infections are primarily caused by faecal-oral transmission due to unsafe drinking-water, poor handwashing hygiene and unsafe food preparation. The dose which is required for infection depends on the form of diarrhoea. Diseases like shigella, rotavirus or cryptosporidium can be transmitted by person-to-person contact with low infectious dose. High infectious doses are required for example for salmonella, ETEC or EPEC. These diseases are usually transmitted by food or water (Kalyankar et al., 2016).

The most critical threat caused by diarrhoeal diseases is dehydration. It is the main cause of mortality. Early determination is the most critical part of diarrhoea management. The loss of water and electrolytes due to liquid stools, emesis, sweat, urine and breathing has to get replaced. Basaleem and Amin published an assessment of dehydration in their *Handbook: IMCI integrated management of childhood illness* for the WHO in a scale of three. The first stage is early dehydration with no signs or symptoms. Secondly, moderate dehydration with signs of notable thirst, restlessness, irritable behaviour, decreased skin elasticity and sunken eyes. The third stage is a severe dehydration. Symptoms are diminished consciousness, lack of urine output, cool, moist extremities, a rapid pulse, low blood pressure and pale skin in a setting of a clinical shock (Basaleem & Amin, 2011).

Since dehydration is the primary cause of death for patients with diarrhoeal diseases, Oral rehydration solutions (ORS) are considered the cornerstone of diarrhoea treatment. It was developed in the 1960s and 1970s by researchers in South-Asia. It is a simple and cost effective solution containing glucose and electrolytes which can be used for all kinds of diarrhoea and it is suitable for all ages and settings. After treatment with ORS, the body is able to absorb sodium and hence water. The important physiological processes in the gastrointestinal tract stay intact even in the setting of severe diarrhoea. Since the WHO recommended the first ORS in the 1970s there are numerous changes made. Leading to decrease in stool volume of about 25%. It also reduces vomiting by almost 30% and intravenous therapy by more than 30% (Kalyankar et al., 2016). A review by Munos and colleagues has shown that ORS would reduce diarrhoea deaths by 93% (Munos et al., 2010). ORS-treatment should be done in two phases: rehydration and maintenance. In the first phase, clinical rehydration can be achieved in 3-4 hours due to quick fluid replacement. In the maintenance phase, the remaintenance of calories and fluids are achieved with reintroduction of enteral feeding with an age-appropriate diet. Although, ORS has limits. When patients show severe dehydration, there is a need of an intravenous therapy, for example a lactated Ringer´s solution until pulse, perfusion and mental status return to a normal level (Kalyankar et al., 2016).

3.1.2 Rotavirus

Under all diarrheal diseases, the rotaviruses are the most significant cause of death for children under the age of five. It is estimated that about 600.000 children die each year due to a rotavirus infection. That is about 5% of all early childhood deaths worldwide. It is also

estimated that over 90% of these deaths occur in Asia and Africa. More than 100.000 deaths occur in sub-Saharan Africa (McNeal & Bernstein, 2009). The burden of disease varies from continent to continent between 14 and 480 disability-adjusted life years (DALYs), respectively, per 1000 cases (Bridle, 2014). Rotaviruses are transmitted directly from person to person or by the faecal-oral route. The average age of the first infection with a rotavirus is between 6 months and two years. As viruses in general, the rotavirus disease is more common in the colder seasons. The incubation period is between 1-3 days and usually begins abruptly with vomiting, fever and explosive diarrhoea. The disease is self-limited with a duration from 4-8 days. There are two effective vaccines licensed in the world. Studies have shown, that both would be cost-effective as well in low-income countries from the perspective of the society and the health-care system (Giaquinto et al., 2007). The challenge is to implement vaccination programs that both vaccines named Rotatec and Rotarix can really impact the burden of disease in developing countries like Kenya. Dehydration is the primary cause of death in patients with the rotavirus. Most commonly, it is treated with the ORS. (McNeal & Bernstein, 2009).

3.1.3 Cholera

Cholera is another acute diarrhoeal disease. Those who are affected can die within hours if they don´t receive any treatment. The bacterium V. cholerae remains a threat in developing countries. Cholera is transmitted by the faecal oral route. Cholera can be found in any water bodies, especially in the tropics and sub-tropics. The WHO estimated that there are 1.4 to 4.3 million cases, and 28.000 to 142.000 deaths worldwide due to cholera (Gortchev & Ozolins, 2011). East-Africa is an endemic cholera area. In Kenya, there was an outbreak of cholera in December 2014. The outbreak affected 22 of Kenya´s 47 counties with a total of 11.033 suspected or confirmed cases and 178 deaths (George, Rotich, Kigen et al., 2016). The National Bureau of Statistics furtherly reported 3 cholera cases in Nyeri County in 2012 (Kenya National Bureau of Statistics, 2013). Cholera is closely linked to unsafe water and unimproved sanitation facilities. About 80% of all people infected with cholera do not develop any symptoms. But the bacterium is present in their faeces for up to 10 days and are shed back to the environment where it can potentially infect other people. Among the infected who develop symptoms, 80% of them have mild or moderate symptoms. 20% develop severe and watery diarrhoea and dehydration. Patients with mild and moderate symptoms can be treated with ORS. Patients with severe dehydration require intravenous fluids and antibiotics to

diminish the duration of diarrhoea. There are two oral vaccinations recommended by the WHO. Both have shown evidence on effectiveness and feasibility in mass campaigns (WHO, 2017).

3.1.4 Typhoid

The typhoid fever (Salmonella typhi) is another disease threatening lives in Kenya. Unsafe food and drinking-water are important risk factors for the typhoid fever. The incubation period for typhoid fever is 6-10 days depending on the amount of the infectious dose. Typhoid is also transmitted through the faecal oral route. Blood tests are dependable but in developing countries, the unreliable Widal test is often used to diagnose typhoid. Besides fever, the symptoms can be headaches, coughing, diarrhoea or abdominal. These non-specific symptoms often cause diagnostic confusions in developing countries. One sickness results in a lifelong immunity. Predominantly, typhoid fever occurs at a children age under 10 years in Kenya. (Tabu et al., 2012). Antibiotics can be used for treatment. But growing rates of outbreaks with antibiotic resistance makes this disease even harder to control. Percentages vary from 30% in the Democratic Republic of Congo and 70% in Kenya (Nielsen et al., 2012). At present, there are two new vaccinations which are proven effective and licensed for people >2 years old. People are protected from Typhoid for 3 years. This human adapted bacterial disease is very complex and especially in African countries, the knowledge about it is relatively poor because other health issues like HIV/AIDS have higher priorities. Many regions are not capable of laboratory based studies. It is also a confounding factor that non-typhoidal salmonellosis is on the rise in sub -Saharan African countries. However, local surveillance systems remain poor. The actual burden of disease cannot be estimated (Wain et al., 2014). Thus, the National Bureau of Statistics in Kenya reported 34 Typhoid fever cases in Nyeri County in 2012 (Kenya National Bureau of Statistics, 2013).

3.1.5 Hepatitis A & E

Hepatitis A and E belong to different groups. The size and structure of hepatitis A is similar to an enterovirus. Thus, it has its own genus. Epidemics can erupt explosively. The infectious dose of hepatitis A is very small (10-100 infectious particles) and it´s able to persist in a waterbody for a long time. Hepatitis A is transmitted through contaminated food or water or through direct contact with an infected person. The risk of infection is associated with unsafe water, poor sanitation and hygiene, such as dirty hands. The infection proceeds via the intestine over

the bloodstream, eventually infecting the liver. Normally, the incubation period is between 14 and 28 days. In most of the cases the liver is not damaged, especially in young children and lifelong immunity is incurred. Nonetheless, the severity of the disease increases with age and it can cause debilitating symptoms and acute liver failure, which is often fatal. The debilitating symptoms range from mild to severe. Including fever, malaise, loss of appetite, diarrhoea and nausea. Hepatitis A is also associated with dark-coloured urine and a yellowing of the skin and whites of the eyes. Not all patients will have all the symptoms though. According to the WHO, 90% of all children in developing countries have been infected with hepatitis A before the age of ten. Cases of hepatitis A are not easy to distinguish from other types of hepatitis. For a specific diagnose, specialized laboratories are required. There is no specific treatment for hepatitis A. Most important is to avoid unnecessary medication such as paracetamol or medication against vomiting. Patients often recover slow, it may take several weeks/months. Nonetheless, there are several forms of vaccination but none of them is recommended for children under the age of one (Gortchev & Ozolins, 2011).

Hepatitis E is similar to hepatitis A. It also affects the liver and is transmitted via the faecal-oral route due to unsafe water and food practices. The symptoms are also similar but hepatitis E patients can also suffer from itchiness and joint pain. The incubation period of hepatitis E can be longer with up to 6 weeks though and the people suffering from hepatitis E are slightly older. Furthermore, the cases may develop into fulminant hepatitis with acute liver failure which makes the mortality rate unequally higher. Fulminant hepatitis occurs more often during pregnancy. Especially pregnant women in their third trimester are at a higher risk to acute liver failure, fetal loss and mortality. Hepatitis E is found worldwide but the prevalence is higher in South-East Asia and Africa. There is a vaccination on the market, but it is not licensed beyond China (Gortchev & Ozolins, 2011).

3.4.6 Poliomyelitis

Poliomyelitis (polio) is a highly infectious viral disease affecting mainly children under five years. It affects the nervous system and can cause total paralysis within hours. Polio is transmitted from person-to-person or contaminated food or water through the faecal oral route and multiplies in the intestine. Primary symptoms are fever, fatigue, headache, vomiting, stiffness of the neck and pain in the limbs. 1 in 200 infections lead to paralysis, among those who infected 5 to 10% die when their breathing muscles eventually become

immobilized. There is no cure for polio, it can only be prevented. Poliomyelitis cases have decreased by over 90% as a result of high global efforts to eradicate the disease. There are highly effective immunizations on the market (Gortchev & Ozolins, 2011). But in Kenya, there are still polio cases. In May 2013, there was a polio outbreak at the Horn of Africa of the polio virus type 1. So, there are still efforts necessary to build up effective surveillance and immunization systems. In 2017, Kenya has kicked off another polio vaccination campaign (WHO, 2017/a). That shows polio is still a public health problem in Kenya. As long as one child remains infected, children all over the world are at risk. The WHO warns that failures to eradicate polio could lead to a world wide spread within ten years.

4. Household Water Treatment

HWT and safe storage is an important intervention to improve drinking water and prevent waterborne diseases. There is a range of technologies, devices or methods for treating water on a household level. But not only treating the water is essential, the use of closed and clean containers is also an important aspect of household water management. HWT and safe storage – if correctly and consistently used – can significantly improve the microbiological integrity. Access to effective HWT solutions for whom water is a vector for infections can deliver significant health benefits (Clasen, 2009). The HWT-methods which are most relevant in this study are discribed below.

4.1 Boiling

Boiling water is perhaps the oldest method to disinfect drinking water on a household level. It is also one of the most effective methods, if practiced correctly. Boiling is also one of the easiest ways to treat water because there is no extra equipment necessary. It kills or deactivates all classes of waterborne pathogens. Including small components which are too small to get filtered. Heating water to 55 celsius has shown that most pathogens get killed so that the water is safer to consume. While filtering and chemical treatments have challenges with turbidity or certain dissolved constituents, water-boiling can be effectively used over a wide range of physical and chemical characteristics. There are various recommendations for boiling water for disinfection. The WHO simply recommends to heat the water up to a rolling boil as an indication that a disinfection temperature is achieved (Clasen, 2009).

But water-boiling also has disadvantages. First of all, the unavailability or high costs of fuel, gas, wood, charcoal or other biomass for energy supply. In sub-Saharan Africa, 77% of the

population relies on biomass. That makes it an environmentally unsustainable method because these biomasses are limited. To procure these fuels a commitment of time and energy is required, mostly by women or girls. In addition, boiling can contribute to other health hazards. Because many households who are in need to treat their water in the rural slums of Kenya cook indoors in poorly ventilated rooms. Besides these disadvantages, the water is not safe from getting polluted again. As the water cools down, it is vulnerable to recontamination from dirty hands and utensils since it is often stored in bigger quantities and in open tanks (Clasen, 2009).

Despite the disadvantages, water-boiling is the most common way to make water safer to consume. But in 17 countries in sub-Saharan Africa, only 4.9% reported boiling their water compared to 20.4% in Latin America and the Caribbean or 21.2% in South-East (Clasen, 2009).

4.2 Chlorine

Chlorine is another way to treat water on a household level which is often used in Kenya. Bottles in various sizes and compositions can be purchased by many manufacturers. Liquid chlorine or chlorine tablets cause chemical reactions when added to water which deactivates contaminants (Voigt, Jaeger & Knorr, 2013).

It kills bacteria and viruses effectively in water without organic matter and the residual chlorine protects the water from getting contaminated again after treating. It is relatively cheap and very easy to use. Consumers just have to add the right amount of chlorine to the water and shake and stir the container (Voigt, Jaeger & Knorr, 2013).

But there are also a number of limitations and disadvantages with liquid chlorine. It is not effective at killing parasites and retrograding turbidity. Furthermore, the antimicrobial effect highly decreases when organic material is in the water and it forms complex compounds with it which can be hazardous for human health over time. The chlorine compounds also degrade over time so it gets less effective. Many users do not know the dosing quantity and the descriptions how to use the most common chlorine in Kenya are only written in English and Kiswahili. In rural areas in Kenya it is common that people are not able to speak their two national languages. The dosage varies with the water quality as well. Moreover, chlorine fumes and contact with skin are detrimental for health. Many people in rural Kenya do not

like the chemical taste and odour of chlorine treated drinking-water (Voigt, Jaeger & Knorr, 2013).

In Central Kenya, the product named "WaterGuard" established as the most frequently available and used sodium hypochlorite product. The current price of the smallest bottle (150 ml) of WaterGuard is 20 Kenyan Shillings (20 Ksh = 0,176 € in August 2016). One capful is enough to purify 20 litres of water according to the manufacturer. That makes it also a relatively affordable and effective method to treat water on household level.

4.3 Solar disinfection

Solar disinfection (SODIS) is a simple way to treat drinking-water. With solar radiation (UV-A light and temperature) the sunlight destroys pathogenic bacteria and viruses present in the water. The UV-A radiation causes damage to DNA and living cells in the water. It also reacts with oxygen dissolved in the water and produces highly reactive forms of oxygen which also damages the pathogens. Other oxygens which are already contained in the water mediate this process. When the temperature is raised to 75 degrees it causes pasteurization which kills microorganisms. SODIS can be used for small quantities with low turbidity. It is also a very affordable HWT-method because there are no capital costs except plastic bottles. It is independent from energy sources other than sunlight. The treated water is protected from recontamination in the plastic bottles and it significantly reduced causes of diarrhoea. Most commonly, the contaminated water is put into a transparent PET-bottle and exposed to sunlight. The length of exposure can be determined based on the weather (Voigt, Jaeger & Knorr, 2013).

SODIS has also certain disadvantages. First of all, it cannot be used on rainy or cloudy days. It is also not effective with turbid water and the bottles need to be replaced after 4-6 months. The long duration of the treatment which can be up to 48 hours and the small quantity shrinks the effectiveness of this method. Lastly, SODIS does not remove suspended particles and dissolved compounds and it is not effective against chemicals at all (Voigt, Jaeger & Knorr, 2013).

4.4 Flocculation

This is a combination of flocculation and disinfection using chemicals. It is a sachet powdered ferric sulphate (flocculant) and calcium hypochlorite (disinfection). Consumers add the

sachet to the water and stir it for at least five minutes before the solids sink to the bottom of the bucket. The water has to be filtered through a cloth into a second bucket to separate the flocked pollutants from the water. After another 20 minutes the disinfectant has killed microorganisms and made the water safe to drink. Because of these two steps of treatment this method removes bacteria, viruses and parasites. The hypochlorite also safes the water from recontamination. Because of the visual improvement of the water it is usually a highly accepted HWT-method for the users (Voigt, Jaeger & Knorr, 2013).

Disadvantageous is that there are two steps necessary which requires demonstration by public health providers. In addition, there is more equipment (two buckets, cloth, stirring device) required compared to other HTW-methods. This contributes to generally higher costs per litre compared to alternative HWT-methods (Voigt, Jaeger & Knorr, 2013).

4.5 Filtration

Filtration is another option of HWT if it is available. It is a good alternative for secondary and tertiary treatment. There are numerous types of filter membranes which can be used for treating water on household bases which are suitable for filtering mostly ground water, waste water and surface water (Gupta, 2012). The membrane withholds solids and other substances while the water is flowing through the filter. The pores, often coated with silver for bacteriostasis have shown to be effective removing microbes and suspended solids. Filters have to get cleaned regularly, if properly maintained they have a long life. It is important to mention that filtration can be a useful HWT-method depending on the type of water pollutants and other qualities (Voigt, Jaeger & Knorr, 2013).

4.6 Other HWT-Methods

Because of the high need of HWT on the whole planet, the HWT market developed many other technologies to improve drinking-water. A number of technologies have a verifying degree of success or availability in certain areas. Not all of them are common used or known in Central Kenya. There are technologies like adsorption where the water gets treated by adsorbing carbon. Another technology is called reverse osmosis. It is a pressure-driven process where a semipermeable membrane rejects dissolved constituents but allows water to pass through. It is often used for purifying salt water. Furthermore, it is possible to treat water with electrochemical methods such as direct oxidation, indirect oxidation and electro-Fenton which can be used for removing a number of organic pollutants dissolved in water

(Gupta, 2013). Ozonation is also used for disinfecting water. The water gets disinfected by oxidation of bacteria, viruses and chemicals by the ozone which reacts with all kinds of solids in the water. Lastly, silver ions is another method of HWT to mention. Silver nitrate has played an important role in medicine since the nineteenth century. Even in ancient times, water got stored and transported in silver containers to maintain purity. However, the development of silver-resistant pollutants decreased the effectiveness of this HWT-method (Voigt, Jaeger & Knorr, 2013).

These methods are alternatives for water treatment, but are not well known, used or are not applicable in the rural areas of Central Kenya.

5. Sanitation and Hygiene

Sanitation is an important factor of influence for waterborne diseases. To reduce the number of waterborne deaths, countries in sub-Saharan Africa need improvements in access to hygienic sanitation facilities. Poor sanitation is closely linked to transmission of diarrhoea, typhoid, cholera, hepatitis A and polio. In rural Kenya, many people rely on unimproved toilets such as non-flushed pit latrines or don´t even have access to any basic sanitation facility. The WHO estimates that almost one billion people worldwide still defecate in the open, for example in street gutters, behind bushes or into water bodies. At least 10% of the world population consume food irrigated by waste water. Major efforts were made to reduce the number of people relying on unimproved sanitation facilities. But in Africa, this progress remains slow (WHO, 2016/a). The KDHS reports that 66.3% of the rural Kenyan population didn´t have access to an improved toilet in 2014 (Kenya National Bureau of Statistics, 2015). Besides diarrhoea, typhoid, cholera, hepatitis and polio, poor sanitation is a major cause for several tropical diseases. For example, intestinal worms, schistosomiasis and trachoma (WHO, 2016/a).

After defecation, hygienic practices are critical to ensure drinking water cleanness and prevent waterborne diseases. In rural Kenya, people often don´t know about the importance of washing hands with soap to prevent the spread of germs. Efforts need to be made to raise more awareness on hygienic behaviour in the rural population. In the Kenya Demographic Health Survey, over 10.000 rural households were observed. Only 37.5% of the households had a place to wash hands with water and soap. Out of this 37.5%, it is unknown how many

people actually wash their hands ordinary with water and soap (Kenya National Bureau of Statistics, 2015).

6. Methodology

6.1 Introduction

The aim of this study was to contribute to the understanding of drinking water practices and their influences on human health in a rural Kenyan community. To achieve the main goals described in chapter 1.3.1, extensive knowledge had to be gathered. During the literature review, two references emerged as particularly important.

To get an extensive overview of the importance of drinking water, sanitation and hygiene, the "Guidelines of Drinking-water Quality" published by the WHO were essential. The guidelines also provided fact sheets about the common waterborne diseases.

Secondly, the "toolkit for monitoring and evaluating household water treatment and safe storage programmes", also published by the WHO, was the basis for the data collection method.

In the literature review, the scientific papers of Thomas F. Clasen, JD, PhD of the London School of Hygiene & Tropical Medicine were also of great importance and are cited in this bachelor thesis.

The data was collected with an interview and an observation of the drinking water practices of the participants. Field notes and photographs were taken to complement the findings and give deeper inside in the living conditions of the sample. The methods are described in detail in this chapter.

6.2 Study area and challenges of the data collection

All participants in this study were residents of the village of Mweiga, Nyeri County (Kieni-West sub-county) in Kenya. The study took place in this area for several reasons. During a former stay in Mweiga, it has shown that the population frequently consumes unsafe water. Alongside other health issues like HIV/AIDS and Tuberculosis, waterborne diseases did not have a high priority in the health care system and in the community. Nevertheless, waterborne diseases occur frequently, so there is a high need of further knowledge about safe drinking water practices, especially to protect young children under five years old and the most vulnerable people in the community. During this stay, relationships to local

healthcare-givers, local representatives and the rural population were established. That was critical in this special location to interrelate a trustful relationship and obtain a high response and get truthful information from the participants. Because encounters between Europeans and people in rural Kenya still take place in the context of the former colonialization of the country. The local representative was a social worker and was very well known in Mweiga. Therefore, she was very familiar with the household conditions through her long-time work in the field in Mweiga. Furthermore, the local population had a high degree of trust in that person. That was important for the study to get private and potentially shameful information from the participants. Additionally, it simplified the access to the setting. Without the presence of a local, it would have been very questionable whether the sample had been willing to give private information to a stranger and had been willing to be observed in their activities in their private premises. The local representative also functioned as a translator between the interviewer/observant and the target group. That was required because the majority of people in the slums of Mweiga are not able to speak, write or read English on a sufficient level. Furthermore, the assistance of the local representative helped preserving the cultural sensitivity of this ethnographic research in this environment.

All challenges of the data collection are showcased in Table 1.

Table 1: Challenges of data collection

Accessibility	• Location on the countryside of Central Kenya with poor infrastructure • Distance between Nairobi and Mweiga (160 km)
Language	• Lack of English skills in the target group – A Translator was required • Lack of understanding the questions or specific terms– further information was required
Cultural	• Trustfulness between the target group and the interviewer – A local representative was required • Gaining trust on the one hand and keeping emotional distance on the other hand to preserve intersubjectivity
Poverty	• Unavailability of water samples in the households • Sense of shame in the target group
Organization	• Briefing of the translator/local representative to preserve objectivity and ensure truthful statements of the target group • Structured interview with closed questions to ensure a high response and a better understanding
Observation	• Allowance to get a water sample to observe safe collection • Allowance to get access to private rooms of the target group to observe safe storage

It was questionable whether the people in Mweiga would be willing to give personal information to a stranger. However, the sample was remarkably friendly and willing to provide even very private data. All 41 interviews/observations took place in a peaceful and trustful atmosphere. This personal approach resulted in a response rate of 100%.

6.3 Description of the research methods

The cultural characteristics and challenges in this study required a special approach. To get the necessary information and ensure a high response of the sample, a mixed-method research design was chosen. A mixed-method approach is a combination of quantitative and

qualitative research methods. The qualitative part, an observation of the drinking-water practices, was embedded in a structured interview with closed questions which is normally used in quantitative studies. The face-to-face interview had closed questions because the absolute majority of people in the sample were illiterates and not able to speak English on a sufficient level. They only knew their local language which is spoken only by the Kikuyu in Central Kenya. Hence, an unstructured qualitative design with open questions, telephone interviewing, audio-records or focus groups was not applicable in this cohort. Nonetheless, to understand drinking water practices in a rural Kenyan environment it was essential to observe the behaviour of the sample when it comes to their water consumption and storage.

6.3.1 Observation, field notes and photographs

The observation had a micro ethnography character. The observer was immersed in the social setting to observe the drinking water handling of the sample. Regular observations of the drinking water behaviour of members of that setting were made. In the observation, the observer assumed an overt role. The observation was embedded in the interview. Access to the sample was gained through the local representative who was also a key informant in the course of that field work. To keep the effort of this bachelor thesis in scope, the observation was restricted to four observations to see how households in rural communities in Central Kenya consume and store their water. It was a structured observation with pre-defined variables and characteristics. For example: *Was the water collected safely (without touching hands)? Yes or no?*

If there were noticeable drinking water conditions observed in a household, field notes and photographs were taken as well to detect health threats which the interview/observation guide could not assess. Several health risks related to drinking water practices were observed and recorded in the field. Some photographs are presented with the other findings to allow more insight in how the drinking water conditions were in the field. The field notes can be found in the Annexe and they are considered in the findings as well. A copy of the interview/observation guide can be also found in the Annexe.

6.3.2 Interview

The interview/observation guide was developed based on the “Toolkit for monitoring and evaluating Household Water Treatment and safe storage programmes” published by Khusch, Lantagne and Montgomery in 2012 (Khusch, Lantagne, Montgomery, 2012). The toolkit was

used as a working basis. The guide was complemented with other questions/observations and not all the questions from the toollkit were finally in the guide. For greater triangulation, it was also helpful, because the own deliberations were backed by already existing professional material that was already applied successfully in the field. Prior to the actual data collection, a Pre-Test was conducted with people from Mweiga who were not part of the research sample. Additionally, local professionals were consulted to get further opinions. It was helpful for the interviewer/observant to collect some experience of working with the questionnaire and gain a better understanding for the comprehensibility and applicability of the questionnaire. It also identified questions which were likely to get misunderstood from the participants. In ethnographic interview surveys, it is also possible to identify questions that can make the respondents feel uncomfortable. Additionally, the pre-test helped to consider how well the flow of the interview was and whether it was necessary to change the chronology (Bryman, 2015). The chronology was chosen to ensure methodically reasonableness. For example, the question whether the household owns soap for washing hands was placed after the observation where the drinking water handling was observed. That was reasonable because it was not wanted that the participant was reminded of the soap before the participant was asked to show how she/he collects the water from the tank. A smooth flow of the data collection was also considered. Thus, the questions with a higher potential to provoke a sense of shame were embedded or placed at the end of the interview/observation.

6.4 Sampling

The target group was sampled by the snowball sampling approach. Snowball sampling is a technique where a small group of people relevant to the research is sampled at first. And these people purpose other participants with the same characteristics relevant to the study (Bryman, 2015). At first, there was an informal meeting between the interviewer and the local representative. During this meeting the representative was briefed about the research project. She was asked about the drinking water conditions in her community to make sure that the right target group will be approached. Initially, a group of five households was sampled. These participants and the local representative then suggested other participants like neighbours, friends or family members to approach and so on. Basically, going from door to door. The sample was a very homogenous group with similar sociodemographic backgrounds to achieve a high theoretical saturation. Warren recommends a sample size of

minimum 20 respondents for qualitative research (Warren, 2002). In the end, data was collected from 41 households.

6.5 Course of the data collection

The data collection was carried out in a face-to face interview with the observation embedded. After the interview/observation, the field notes and the photographs were taken. The interviews were conducted within four days.

Potential participants were briefed about the nature of the research by the interviewer/observant and the local representative and after a provisional agreement the interview/observation started. The interview/observation guide also included the date, time and the location of the current interview/observation. The actual collection of data began with questions about the socioeconomic background of the household. In the beginning, it was asked about the gender and the age of the respondent to determine gender or age differences in drinking water handling and knowledge about waterborne diseases in the cohort. Besides that, the interviewer asked how many children lived in the household and how many of these children were under five years old. To detect whether better or less educated people with more or less personal properties behave differently and/or know more about the risk factors of drinking water the interview/observation guide contained questions about school education and properties of the household, namely means of transportation and animals.

The next part asked questions about the knowledge of the influence of water on their health. Furthermore, it was sought if the participant knows any water related diseases. After that, the interviewer requested the respondent to provide information about how frequent the common waterborne diseases in the household occurred in the last year preceding the data collection.

The third part entailed the observation within questions about what HWT-methods the household knew and usually used. It was asked if the household could provide a cup of the current drinking water for the interviewer/observant. While the participant collected the water, the observant watched the participant whether the water was collected safely, without touching hands or not and if the participant washed her/his hands before the water collection. Additionally, it was observed whether the water container was clean, closed and out of reach of animals or not and what kind of container was used in this household. Within

the observation, the respondent was asked to inform the research team what source the water the household used at that time was from. Afterwards, the research team wanted to detect how often children and adults drink untreated water and what motives the household has why they treat water. To figure out whether people who received training on HWT behave different or use alternative HWT-methods, it was asked if the respondent ever participated in a training on how to treat drinking water on household level. To get a wider overview over the drinking water practices in the neighbourhood, the participants were asked if they strongly agree, agree, disagree or strongly disagree with the statement that other people they know also treat their water at home. They were also asked to tell how confident they are that they can treat their water with the same range from strongly agree to strongly disagree.

The last part had two questions. First, if the household had soap for washing hands and secondly, what kind of toilet facility the members of the household usually uses. Using soap and improved toilet facilities is critical to hygienic behaviour. The drinking water can get polluted by the unclean hands while fetching the water from the tanks.

The interview/observation aimed to provide detailed information about drinking water practices and how frequent waterborne diseases occur. The questions this interview/observation aims to answer are showcased in Table 2.

Table 2: Table of interview questions (Own figure)

Categories ➡	Criteria ➡	Questions
Demographics	• Gender • Age • Education • Family size • Properties	Are there sociodemographic differences in: • Knowledge about water related diseases? • Occurence of water related diseases? • Use of HWT? • Hygienic behaviour?
Water related diseases	• Health conciousness • Diarrhoea, Cholera, Typhoid, Hepatitis, Polio	• What do households know about water related diseases? • How frequent are the most common water related diseases?
Household Water Treatment	• HWT-Methods • Source • Training	• Which HWT-Methods are known? • What are the sources of drinking water? • Do households use HWT? • Is HWT used consistently? • What influences use of HWT? • How often do children and adults drink untreated water? • Did people got sick despite using HWT? • How confident are households with using HWT?
Hygienic Behaviour	• Soap • Toilet facilities	• Do households use soap for washing hands? • Did people got sick despite using soap for washing hands? • What kind of toilet facilities are used?
Observation	• Sample of drinking water • Container	• Is the water collected safely? • Is the container closed/covered? • Is the container clean? • Is the container out of reach of animals? • What container is used? • Was soap for washing hands used before water collection?

Regarding this project, three weeks were spent in the field in Mweiga. In total, the researcher stayed in Mweiga for three months. For the purposes of self-evaluation, a research diary was kept during the preparation of the interview/observation guide and the data collection.

6.6 Data analysis

6.6.1 Observation, field notes and photographs

The data from the field notes and photographs taken for documentation of observed health hazards caused by drinking water handling were sorted and reviewed chronologically. All initial field notes were worked off at the end of every day of data collection to prevent memory failures. The photographs were attached to their respective field notes at the same day as well.

The data from the observation which were embedded in the interview were analysed with the help of IBM SPSS (Version 22). That was possible, because the observation resulted in findings like *yes* or *no*. For example, *Was the water collected safely (without touching hands)?*

The results were presented in form of texts and major findings were additionally highlighted with graphic illustrations and frequency tables.

6.6.2 Interview

The data of the interview were also entered and analysed with the statistical software IBM SPSS. After the data entry was completed, the data were cleaned and prepared for the analysis. The analysis included calculations of frequencies. For presentation, graphic illustrations were made with SPSS and Microsoft Excel to highlight the most important findings and complement the texts and tables.

7. Results

7.1 Sociodemographic background

The total number of participants is 41, 33 females and 8 males. The participants were from all age groups between 23 and 82 years. In the following table the participants are clustered in six age groups.

Table 3: Age groups of participants (Source: own figure)

		Frequency
Age groups	20-29	6
	30-39	15
	40-49	8
	50-59	5
	60-69	5
	>70	2
	Total	41

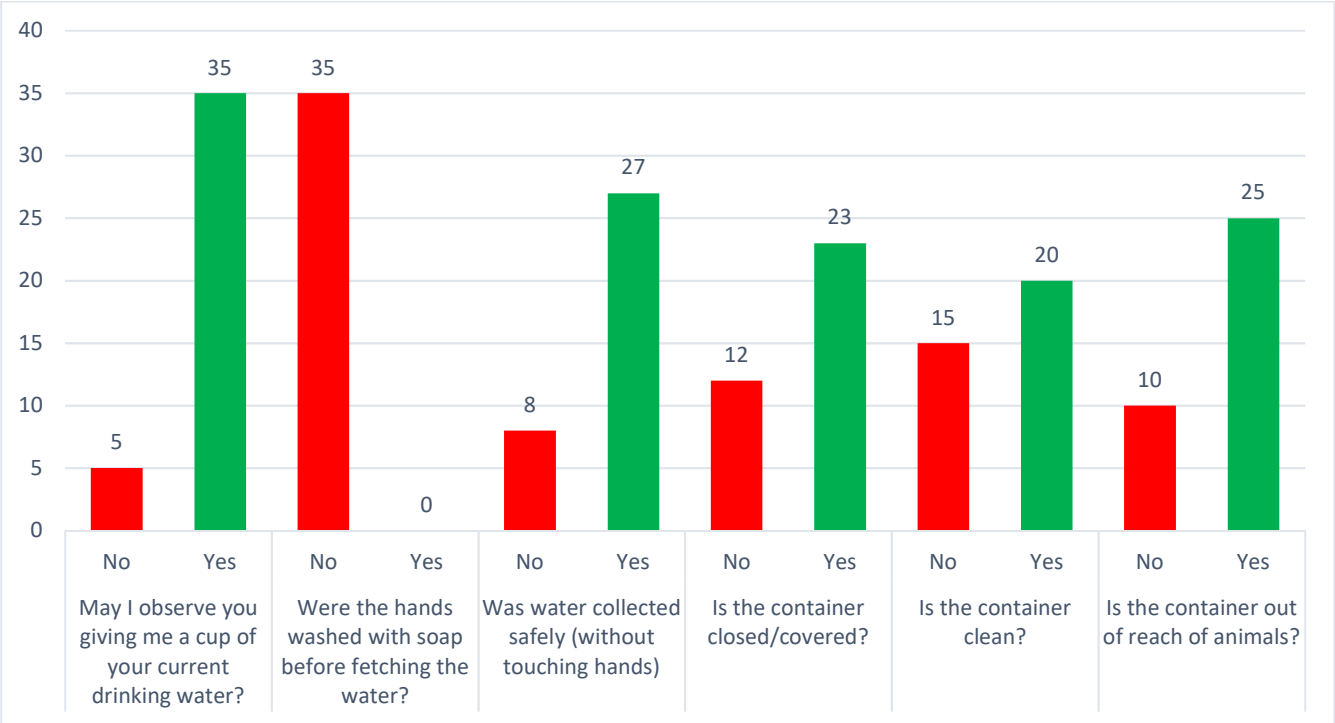
In terms of education, 16 participants finished primary school which is eight years. Six participants completed secondary school. Three have higher education with more than 12 years. Six left school between primary and secondary level. Nine respondents had to leave primary school before graduation and two people never went to school. 36 respondents stated, that the head of the household can read. It is unknown which language they are able to read.

In 36 cases, children were living in the household. 28 children were under five years old at the date of data collection. The welfare of a local Kenyan household can often be measured by the number livestock. Eleven households had more than 10 animals, six households had 6-10 animals and thirteen households held 1-5 animals. Eleven households owned no livestock at all. Thirty-five households were not in possession of an own vehicle. Six houses had a bicycle, a motorcycle or a car.

7.2 Observation

The observation of the drinking water behaviour had the following results.

Figure 4: Observation of drinking water handling (Source: Own figure)



n=41

In 35 of 41 households it was allowed to observe the participant serving a cup of the current drinking water. No participant washed her/his hands with soap before the water was fetched. 8 participants touched the water with their hands while they collected the water from the container. In 12 cases, the container was open so that the water could have been contaminated after filling it. 15 of 35 containers were not categorised clean and 10 containers were reachable for contamination by animals.

Picture 1&2: Open and dirty water containers, reachable for animals

20 of the observed households stored their water in plastic tanks (100 litres). Usually, these containers are closable but it was observed, that not all households make use of it. 5 households used jerry cans, 4 used simple buckets, three used gallon jugs and three households made use of plastic bottles to store drinking water. All 41 participants provided information about their sources of water. 30 respondents stated they get their water from the nearby Honi River. 6 households harvested rainwater, 3 got bought their water from a tanker and 2 participants had piped water in their houses.

7.3 Handling of drinking water

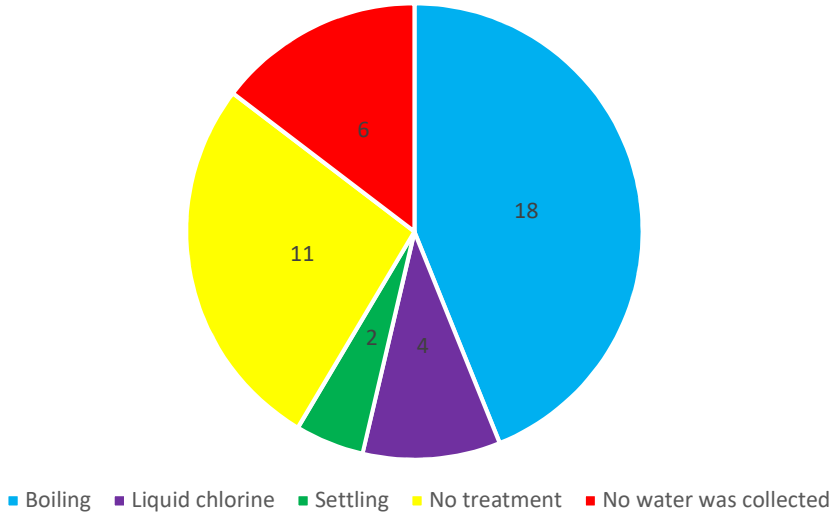
As described in chapter 4, there are numerous ways to treat water on household level. In this study these ten methods were considered:

- Boiling
- Liquid chlorine
- Chlorine tablets
- Flocculant
- Solar disinfection
- Ceramic filter
- Biosand filter
- Membrane filter
- Cloth filter
- Settling

In this sample, boiling has been the best known HWT-method. 38 respondents have known that method. 28 participants have known a second method which was liquid chlorine. Only two people have known more than two HWT-methods. Namely ceramic filter and settling. One participant has not known a HWT-method. Chlorine tablets, flocculants, solar disinfection, biosand filter, membrane filter and cloth filter were not known in this sample.

Of the 35 collected water samples, 11 were completely untreated. 18 respondents boiled the water, 4 household used liquid chlorine and 2 let the water settle before consumption.

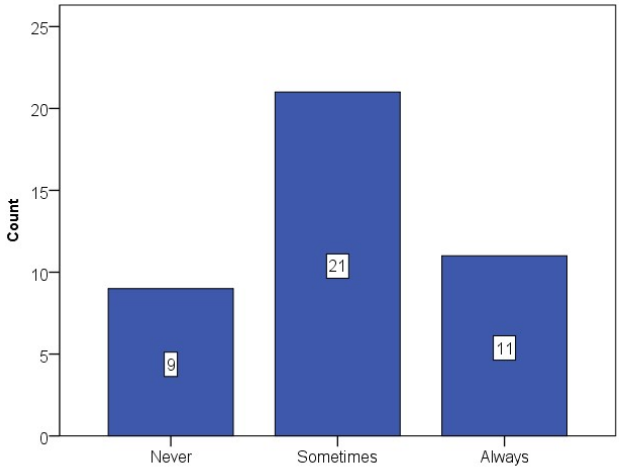
Figure 5: What did you do to make the water safer to drink? (Source: Own figure)



n=41

Participants were also asked how often adults and children drink untreated water.

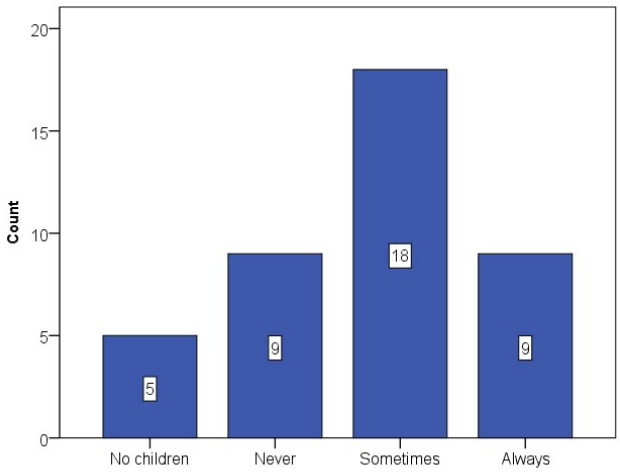
Figure 6: How often do adults drink untreated water? (Source: Own figure)



n=41

21 households have stated that adults sometimes drink untreated water. In 11 households, adults always drink water without treatment. 18 participants have claimed that children sometimes drink untreated water. In 9 households, respondents have affirmed that children always drink unsafe water.

Figure 7: How often do children drink untreated water? (Source: Own figure)



n=41

The sample has given four different reasons why they would use household water treatment. 19 households would treat water because it “kills germs”. 14 participants treat water because it “prevents diseases”, 7 because it “makes water safe” and 1 household stated to use HWT because of the “taste”.

30 of 41 interviewed households never received any kind of training on how to use HWT-methods. The sample has shown strong confidence in their HWT abilities. 35 respondents have “agreed or “strongly agreed” with the statement “I feel confident I can treat my water at home”.

7.4 Hygienic behaviour

38 households have claimed to have soap for washing hands in their household. They were also asked what kind of toilet facility the members of the household have usually used. 39 households have usually used a pit latrine. Only 2 households have had access to an improved toilet facility with flush piped water.

Picture 3: Pit latrine in Mweiga

7.5 Water related diseases

The people in the sample have shown different awareness on the importance of safe drinking water. The sample was asked to estimate the influence of drinking water on their health. 23 respondents mentioned that the influence of water on their health is “not very high”. 11 mentioned it is “high”, 5 households said it is very high and 2 people estimated the influence of water on their health to be “very low”.

As described in chapter 3, there are various water related diseases relevant for this study. The study sample was asked to state the water related diseases they know. Table x shows the frequency of mentioned diseases.

Table 4: Which water related diseases do you know? (Source: Own figure)

		Responses
		N
Diseases	Diarrhoea	16
	Malaria	8
	Dengue-fever	1
	Typhoid	21
	Cholera	19
	Other	8
	None	2

Typhoid (21 times) and Cholera (19 times) and Diarrhoea (16 times) were most frequently mentioned by the respondents. Malaria has been mentioned 8 times and Dengue-fever 1 time. Yellow-fever, Polio and Hepatitis have not been mentioned by any participant. Under "Other" diseases, amoebiasis has been named 8 times by the respondents. Two respondents have not known any water related disease.

It was of importance to detect how frequent the common water related diseases have occurred in the households of the sample. Cholera, Hepatitis and Polio did not occur in the sample preceding two years before the study. Table x shows the occurrence of Diarrhoea and Typhoid in this sample.

Table 5: Occurrence of Diarrhoea and Typhoid (Source: Own figure)

Diarrhoea (2 months preceding the study)	Cases	6
	Number of children under 5	5
	Number of times (max.)	4
	Number of other people	1
	Number of times (max.)	1
Typhoid (2 years preceding the study)	Cases	3
	Number of children under 5	0
	Number of times (max.)	0
	Number of other people	3
	Number of times (max.)	1

Diarrhoea occurred six times in the sample in two months preceding the study. In 5 of the 6 cases, children under five years have been diseased. The maximum number of times has been 4. The respondents reported 1 other case of Diarrhoea. Typhoid occurred 3 times in two years preceding the sample. Only adults or children above the age of four have been diseased.

7.6 Field notes

There were several health risks observed in the field which the interview/observation could not assess. These hazards were documented in the field notes.

It was observed that free ranging animals could rummage around a property. Their faeces could spread around the houses. Not all water containers were inside the house but outside where animals and other people had access to the container. It was also observed that containers might have been closed but the cover was damaged, so that small animals like flies or mosquitos could have gotten access to the water. In one case, the bowl for fetching the water lay loose in the open water tank. The bowl could have been hardly removed without touching the water.

A linguistic barrier for using HWT-methods was also observed. The explanations on how to use a liquid chlorine bottle were only written in English and Kiswahili.

Picture 4: Bowl in open water tank

The complete field notes can be found in the Annexe.

8. Discussion

The aim of this study was to create a profile of a rural community in Kenya regarding the drinking water practices on household level. Economically weak populations are most affected by filthy drinking water. Thus, the research area was selected, as a poor and rural area with a low-level income and a high unemployment rate. Additionally, the acquirement of this area and local social workers was essential for a successful research process in these cultural circumstances.

The researcher was present throughout the field study. The cooperation with the local representative resulted in a 100% response rate. Only six households could not give

permission to observe the drinking water handling. Participation was voluntary after respondents were informed about the objective of the study and assured confidentiality.

One of the strengths of this study was the in-depth knowledge about this special study area. During an internship, three months were spent in Mweiga as part of the bachelor program of the University of Applied Sciences Hamburg. Regarding this bachelor thesis project, the researcher spent another five months in Kenya with several more visits in Mweiga particularly. During this time, the researcher was able to built trust to the local residents.

The mixed-method research approach ensured deeper understanding of the drinking water handling of rural communities in Kenya. The face-to-face interview-guide was reviewed by the mentoring professor at the University of Applied Sciences in Hamburg, Germany. A pilot test was conducted together with the local representative. The local representative demonstrated a high degree of dedication and professionalism under difficult conditions.

The research project was conducted as a fulfilment of the Bachelor of Science (Health Sciences) at the University of Applied Sciences Hamburg. Due to the personally conducted data-collection in a special location, it was beyond the required scope.

8.1 Discussion of methods

First of all, quantitative data usually requires a much bigger sample size. With an increasing sample size, the representativity increases as well. Due to the small sample size in this study, no reliable statements about the population of rural Kenya can be made. Secondly, only a small area has been researched. To get a full overview over drinking water handling in rural Kenya, it is necessary to research all rural areas in all counties of Kenya. The short period of time was also a limiting factor in this study. More time along with much higher financial capabilities would have led to a much bigger sample size and a higher coverage of area. This would lead to a higher reliability of the results. Generally, the principle of this research can be applied for any other side in Kenya.

But the character of this study is more explorative, with limited time and financial capabilities. In a field with difficult accessibility and cultural characteristics. The goal was to create a profile about a rural Kenyan community in terms of drinking water handling. This goal has been reached due to the mixed method approach, targeting the rural community with assistance of a local representative.

8.2 Discussion of results

The socioeconomic data collected in the field showed that the sampling method was successful. The sample were characterized by a low educational level, low livestock and limited mobility. Predominantly, children were living in the households. Children are the most important target group concerning the diminishment of waterborne diseases. The goal was to target households with these characteristics.

The observation has shown that the drinking water handling of the sample was very unsafe. Not a single participant has washed her/his hands before dealing with drinking water. That was surprising, because 38 households were in possession of soap. 8 participants were observed touching the water with their hands during the collection. All households were in possession of animals. The actions with their animals and the poor sanitary conditions made it very likely that the water was polluted in that course. Furthermore, the water containers were frequently not closed which makes it easy for animals to access and pollute the water. It was even observed that the containers were stored outside the hut, where the animals rummaged around. It cannot be excluded that these households shared their drinking water with goats, sheep or cows. Regarding these results, it is not surprising that 25 respondents estimated the influence of drinking water on their health as “not very high” or “very low”.

It was striking that boiling was the best known HWT-method. Liquid chlorine was also known by 28 of the 41 participants. But all the other ways of HWT, for example filtration, were nearly unknown. The question arises why so few households used liquid chlorine, although they know it helps to make water safe? That speaks for a rudimental knowledge about HWT and limited accessibility to HWT-products in that area. This assumption is confirmed by the fact that 30 of 41 respondents never received any kind of training on HWT. It is also alarming that many adults and children frequently drink untreated water, although most households know at least one method to purify water and are confident on their ability to use HWT. In part, that can be explained by the poverty and the lack of awareness. Because HWT costs money. Even for water boiling there is need of fossil fuels like charcoal. But we cannot escape the conclusion that there are grievances on the supply side as well.

The most common waterborne diseases were relatively well known. It was apparent that Typhoid, Cholera and Diarrhoea were most frequently mentioned. Alarming is that two respondents did not know any waterborne disease. Diarrhoea and Typhoid also occurred in

this relatively small sample size. Diarrhoea occurred in six cases in only two months preceding the study. In five of six cases, children under five years were diseased. Looking at the low health awareness and the devastating living conditions, it is not surprising these diseases occurred in the sample. It is unknown if the reported cases were diagnosed by a doctor. It is also unknown how many undiagnosed cases occurred.

The Interview/observation has shown that the sample has fundamental issues with drinking water handling. Second, the sample has shown limited understanding of how drinking water influences people´s health. The observation has furtherly shown that there is a language barrier to use alternative HWT-methods. And when people never received a training and the explanations for the HWT-methods are in an unknown language, it is obviously likely that this method won´t be used or will be used wrongly. So, the problem is not solved only with access and financial resources.

For future research projects, recommendations include involving community-based organisations with empowered community members. It is critical for the research success, because it ensures a high response, trust and truthful information. It is also important for clearer understanding and a sustainable increase of knowledge, because the empowered community members stay in the community and the competence remains as the research project comes to an end. What is to be explored in the future is whether the hindering factors of drinking water handling are different in other communities. The problem is multifactorial. It can be the access, education, costs, language barrier or limited awareness. All these factors are possibly solution approaches. To conduct a more extensive study based on this exploratory study, it is necessary to target bigger sample sizes and more areas for a longer time. In this course, it would be of importance to detect the mentioned hindering factors from using alternative HWT-methods as well as to fathom what hygienic behaviour means for rural communities in Kenya when it comes to drinking water.

9. Conclusion and recommendations

In conclusion, the drinking water handling observed in Mweiga was highly insufficient. Dangerous hygienic behaviour could be observed throughout the research. Particularly alarming was that nobody saw the importance of washing hands before dealing with drinking water with bare hands. There were also unhygienic storage conditions observed in the field, whether it was the cleanliness, the closure or the location of the water tanks. At the sight of

the special occasion that a European researcher observed the drinking water handling, it cannot be excluded that the behaviour is even worse in daily routine without any observance.

Waterborne diseases may be known but the awareness of the people is low. With better knowledge about waterborne diseases, sick people and relatives could easier recognize certain symptoms and consult a doctor. HWT-methods were not frequently used. Considering that most of the households collected their water from the river that is a very concerning condition. The range of HWT-methods and how to use them was not well known. Thus, it was not surprising that diarrhoea and Typhoid occurred.

The study revealed that there is a high need of better knowledge and awareness about drinking water handling and what it requires. Households in Mweiga relied on boiling water for HWT. Boiling is more costly than other alternatives of water treatment (Clasen & Haller, 2008). 28 participants knew about liquid chlorine which is a reasonable alternative, but only 4 households actually used it. Second, more than half of the world relies on biomass which is limited (Rehfuess, Mehta & Prüss-Üstün, 2006). Additionally, the procurement of biomass can be another detracting factor from other potentially productive or health-promoting activities (Brian, Abbot & Mace, 2004). Third, boiling can cause other health hazards, for example respiratory infections (Smith, 2002). Finally, as soon as the water cools down, it is vulnerable for contamination from hands and utensils again (Wright, Gundry & Conroy, 2004). Households in Mweiga and comparable sub-Saharan villages need alternatives to boiling water for Household Water Treatment. For example, liquid chlorine. It protects the water from recontamination and there are no extra costs or other procurements needed. Liquid chlorine, in Kenya known as WaterGuard, is moreover already available in more densely populated areas. The challenge is to make alternatives for HWT available and practicable in rural areas.

The efforts made in the past like the First International Drinking Water Supply and Sanitation Decade (1981-1990) by the United Nations had limited success. A higher focus on cultural appropriate local initiatives, led by community-based organisations and empowered community members could lead to a greater success. Especially in a community like Mweiga, where many people cannot speak or understand sufficient English or Kiswahili. Looking to the future, efforts should include the consideration of water scarcity as well as greater use of alternative HWT-methods.

Another point of emphasis should be the expansion of accessibility of improved drinking water sources and sanitation. In this context, it is important to recognize that improved drinking water sources are not necessarily safe sources. These structural investments are needed to improve people´s health in rural Kenya.

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Field notes from the data collection in Mweiga

Notes/Observations

Household Number: 7
Location: Mweiga Town
Time: 18.00
Date: 23/05/16

Free ranging animals are rummaging around the property. Their faeces are spread around the house. The water container is not stored inside the house where the animals cannot reach the tanks. The tank is open.

Household Number: 11
Location: Mweiga Slums
Time: 11.27
Date: 24/05/16

The pit latrine is shared with a neighbour. The water container is closed but the cover is damaged. There is enough space for flies and mosquitos to enter the tank and pollute the water.

Field notes from the data collection in Mweiga

Notes/Observations

Household number: 18
Location: Mweiga Slums
Time: 14.47
Date: 24/05/16

The bowl the water is fetched with just lies loose in the open water tank. The bowl can hardly be removed from the tank without the hands are touching the water.

Household number: 24
Location: Mweiga Slums
Time: 11.10
Date:5/7/16

The participant reports that the household occasionally consumes rainwater that is caught by the roof. They wait until they think the rain must have cleaned the roof. Then they drink the water without treatment.

The household is also in possession of Water Guard (liquid chlorine). The explanations on the bottle is written only in English and Kiswahili. The respondent is not fluent in both of these languages.

Household number: 29
Location: Mweiga Slums
Time: 13.37
Date: 5/7/16

At first, she wanted to provide a cup of water but then she denied. The participant was unsure whether the water was clean. Apparently, the participant was not confident in the water quality.

Notes/Observations

Household number: 35
Location: Mweiga Slums
Time: 12.35
Date: 6/7/16

The water container is not closed and it is dirty. A child played outside and came in to drink water. He fetched the water without washing hands and drank it from the bowl. The bowl is lying on the floor.

Household number: 39
Location: Mweiga Slums
Time: 14.38
Date: 6/7/16

The cow stable is very dirty. The participant was currently working in the stable when we came for the interview/observation. The participant went inside the house for the interview without removing her shoes or washing her hands. She did not use gloves to work in the stall either.

Good morning / good afternoon. My name is Lukas Koenneke. I am assessing drinking-water practices in your community. I will interview approximately 40 households in Kenya. Your house has been randomly selected to participate. If you participate, I will ask you questions about your drinking-water and collect a sample of your water. The interview will take approximately 30 minutes. No one except me will know that it was you who answered these questions. Would you like to participate?

Household number:

Date:

Time:

Location:

Household demographics, including education and socioeconomic status

Q1: Sex of respondent Female☐1 Male☐0

Q2: How old are you? _____years

Q3: Did you go to school?(If no, go to Q5) Yes☐1 No☐0

Q4: How many years did you go to school? _____years

Q5: Can the head of household read? Yes☐ 1 No☐ 0

Q6: Are children living in your household? If yes, how many are under five years old?

____children ____under five years old

Q7: How many animals does the household own?

Chicken☐1 Goats☐2 Cows☐3

Donkeys☐4 Sheep ☐5

Q8: Does this household own one of the following things?

Bicycle☐1 Motorcycle☐2 Car ☐3

Water related diseases

Q9: How high is the influence on your health of drinking water in your opinion?

Very high ☐ 1 High ☐ 2 Not very high ☐ 3 Very low ☐ 4 I don´t know ☐ 5

Q10: Which water-related diseases do you know?

Diarrhoea ☐ 1 Malaria ☐ 2 Dengue-fever ☐ 3

Yellow-fever ☐ 4 Typhoid ☐ 5 Cholera ☐ 6

Hepatitis ☐ 7 Other_____

Q11: Have you or one of your household members had diarrhoea in the last 2 months?

Yes ☐ 1 No ☐ 0 I don´t know ☐ 99

Q12: How many members and how many times in the last two months?

Number of children under five years old: _____

Number of times: _____

Number of other people: _____

Number of times: _____

Q13: Have you or one of your household members had Typhoid in the last year?

Yes ☐ 1 No ☐ 0 I don´t know ☐ 99

Q14: How many members and how many times in the last year?

Number of children under five years old: _____

Number of times: _____

Number of other people: _____

Number of times: _____

Q15: Have you or one of your household members had Cholera in the last year?

Yes ☐ 1 No ☐ 0 I don´t know ☐ 99

Q16: How many members and how many times in the last year?

Number of children under five years old: _____

Number of times: _____

Number of other people: _____

Number of times: _____

Q17: Have you or one of your household members had Hepatitis in the last year?

Yes ☐ 1 No ☐ 0 I don´t know ☐ 99

Q18: How many members and how many times in the last two months?

Number of children under five years old: _____

Number of times: _____

Number of other people: _____

Number of times: _____

Q19: Have you or one of your household members had Polio in the last year?

Yes ☐ 1 No ☐ 0 I don´t know ☐ 99

Q20: How many members and how many times in the last year?

Number of children under five years old: _____

Number of times: _____

Number of other people: _____

Number of times: _____

Handling of drinking water

Q21: Can you tell me all the ways you know to make water safer to drink in your home?

Boiling ☐ 1 Liquid chlorine ☐ 2 Chlorine tablets ☐ 3
Flocculant ☐ 4 Solar disinfection ☐ 5
Ceramic filter ☐ 6 Biosand filter ☐ 7
Membrane filter ☐ 8 Cloth filter ☐ 9
Settling ☐ 10 None ☐ 11

Q22: May I observe you giving me a cup of your current drinking water?

Yes ☐ 1 No ☐ 0 Do not have ☐ 99

Q23: OBSERVE *was water collected safely (without touching hands)?*

Yes☐1 No☐0

Q24: OBSERVE were the hands washed with soap before the water was fetched?

Yes☐1 No☐0

Q25: What source did this water come from?

Pipe in household☐ 1 Public standpipe☐ 2
Borehole☐3 Dug well☐4 Spring☐5
Rainwater☐6 Vendor water☐7
Bottled☐8 Tanker☐9 Other_____

Q26: OBSERVE *is the container closed/covered?*

Yes☐1 No☐0

Q27: OBSERVE *is the container clean?*

Yes☐1 No☐0

Q28: OBSERVE *is the container out of reach of animals?*

Yes☐1 No☐0

Q29: OBSERVE: *what container is used?*

Bucket☐1 Jerry Can☐2 Collapsible bucket☐3
Gallon jug☐4 Bucket with tap☐5 Other_____

Q30: Did you do anything to make the water safer to drink?

Yes☐1 No☐0 Don´t know☐99

Q31: What did you make this water safer to drink?

Boiling☐ 1 Liquid chlorine☐2 Chlorine tablets☐3
Flocculant ☐4 Solar disinfection☐ 5
Ceramic filter ☐6 Biosand filter☐7
Membrane filter☐8 Cloth filter☐ 9
Settling☐ 10 None☐ 11

How often do…(Until Q33)

Q32: …Adults drink untreated water?

Always☐ 2 Sometimes☐ 1 Never☐0

Q33: …Children drink untreated water?

Always ☐ 2 Sometimes ☐ 1 Never ☐ 0

Q34: Do you always use the household water treatment?

Yes ☐ 1 No ☐ 0

Q35: Why do you use household water treatment?

Makes water safe ☐ 1 Free ☐ 2
Prevents diseases ☐ 3 Someone told me ☐ 4
Kill germs ☐ 5

Q36: Did you receive training on how to use HWTM?

Yes ☐ 1 No ☐ 0

Can you state that you strongly agree, agree, disagree or strongly disagree with the following statement?

Q37: I feel confident I can treat my water at home.

Strongly agree ☐ 1 Agree ☐ 2 Disagree ☐ 3
Strongly disagree ☐ 4 Don´t know ☐ 5

Hygienic behaviour

Q38: Do you have soap for washing hands in your household?

Yes ☐ 1 No ☐ 0

Q39: What kind of toilet facility do members of your household usually use?

flush piped sewer ☐ 1 flush to septic ☐ 2
latrine ☐ 3 bucket toilet ☐ 4 no toilet/bush ☐ 5

We are now done with the interview. Thank you very much for participating. Do you have any questions?

Notes:

Affidavit

I hereby confirm that I am the author of the Bachelor Thesis presented. I have written the Bachelor Thesis as applied for previously unassisted by others, using only the sources and references stated in the text.

Date: 20.02.17
Submitted by: Lukas Könneke