UNIVERSITY OF ANTWERP

INSTITUTE OF DEVELOPMENT POLICY

Dissertation

Enabling household water treatment in rural Tanzania: change minds to save lives

Diana TIHOLAZ

Master of Development evaluation and management

Supervisor: Prof. Dr. Nathalie Holvoet

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Preface

This year has been difficult for many of us. Corona crisis hit unexpectedly. I have been unlucky and lucky to follow my Master degree during this period. I say "*unlucky"* because this crisis spoiled many opportunities given by this master program. But I also say "*lucky"* because, during difficult times, there are even more people to whom one may express her gratitude.

I am very grateful to my supervisor, Professor Nathalie Holvoet, for all of the support. guidance and encouragement during the entire academic year. Moreover, this dissertation would be the same without her critical insights and constructive feedback. I would like to thank you very much Sara Dewachter for all the help and for believing in me. I say a sincere thank you to the entire staff of IOB.

Of course, an enormous thank you goes to my beautiful family for their support and love. I would have not achieved anything without them.

There are, also, many friends who helped me, a big thank you to all of them. And I am, particularly, grateful to my dear friend, Tiziano.

Lastly, I would like to thank all my peers for this wonderful experience at IOB.

Executive summary

The burden of waterborne disease is an important problem in Tanzania that, heavily, falls on the shoulders of rural areas' dwellers. The ineffective water institutions and policies are at the core of this problem, and their change requires time and resources. In such a context, the HWT emerges as an intermediary solution for limiting the exposure to waterborne diseases.

By using data collected as part of the Fuatilia Maji project in twelve villages in rural Morogoro, I run multiple probits and ordinary least square models to identify the factors associated with the HWT practice in three villages in Tanzania. The dissertation finds that three psychological factors of the risk, attitude, norm and ability model are the best predictors of water treatment behaviour. These factors are factual knowledge, perceived necessity and descriptive norm. Such findings suggest that changing people's visions and perceptions will save and improve their lives. Education, access to information about HWT and, potentially, the type of WS are the socio-economic characteristics correlated with the behaviour to treat water. However, I call for additional research to further study how, exactly, the socio-economic factors impact water treatment behaviour. Based on the dissertation findings, I propose a combination of information and normative interventions with elements of persuasion, targeting the women. Apart from reducing the incidence of waterborne diseases, these interventions have the potential to empower women and encourage them to be more involved in the community's life.

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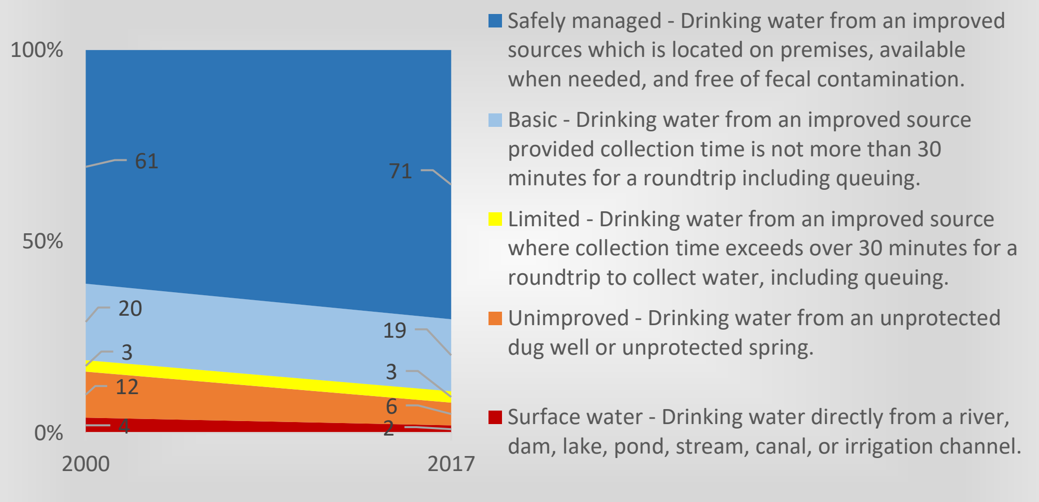
List of acronyms

AfDB	African Development Bank
AIDS	Acquired immunodeficiency syndrome
CBWSOs	Community based water supply organisations
COWSOs	Community Owned Water Supply Organizations
EWURA	Energy and Water Utilities Regulatory Authority
GoT	Government of Tanzania
HIV	Human immunodeficiency virus
HWT	Household water treatment
IBM-WASH	Integrated Behavioural Model for Water, sanitation and hygiene
JMP	Joint Programme for Water Supply, Sanitation and Hygiene
MAFSC	Ministry of Agriculture Food Security and Cooperatives of Tanzania
MDGs	Millennium Development Goals
MoF	Ministry of Water
NAWAPO	The second National Water Policy (2002)
NGOs	Non-governmental organisations
PO-RALG	President’s Office-Regional Administration and Local Government
RANAS	Risks, Attitudes, Norms, Abilities, and Self-regulation approach
SDGs	Sustainable Development Goals
SODIS	Solar water disinfection
UNICEF	United Nations International Children's Emergency Fund
VWCs	Village Water Committees
WASH	Water, sanitation and hygiene
WHO	World Health Organisation
WRM Act	Water Resources Management Act of 2009
WS	Water source
WSDP	Water Sector Development Program
WSP	Water Sanitation Program
WSS Act	Water Supply and Sanitation Act

1. Introduction

Water is the most important resource for human life and the economic growth coupled with growing population constantly push up the demand for water. One third of the population (2.3 billion) do not have enough water to satisfy all demand (physical water scarcity) and 4 billion people live under severe physical water scarcity at least one month a year (Hyvärinen et al., 2016:3). The majority of these people live in Africa and Asia (Hyvärinen et al., 2016:3) and for them the access to clean drinking water is vital to their health and wellbeing. In the last twenty years, the improvements in drinking water services allowed millions of people to gain access to clean water (UNICEF/WHO, 2019). The Joint Monitoring Programme for Water Supply and Sanitation (JMP)[1] (UNICEF/WHO, 2019:7) reports that from 2000 to 2017, the population using safely managed drinking water services increased from 61% to 71% (see figure 1). However, this means than more than a quarter of the world population still lack access to safely managed drinking water. Moreover, the same JMP report estimates that 579 million people do not have access to improved water sources (WS)[2] and there are large variations in provision of water services between and within countries. For example, eight out of ten people without access to improved WS are from rural areas and almost a half of them live in the least developed countries (UNICEF/WHO, 2019; WHO, 2020).

Figure 1.1: Global drinking water coverage, SDGs Ladder[3], 2000-2017



Source: UNICEF/WHO, 2019:7; WHO/UNICEF, 2017:4

[1] The Joint Monitoring Programme for Water Supply and Sanitation (JMP) represents the UN mechanism for monitoring progress in WASH objectives since 1990. JMP has reported on the progress in the Millennium Development Goals (MDGs) and since 2017 established the baseline estimates for monitoring the Sustainable Development Goals (SDGs).The program is hosted by hosted by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) (JMP Wash Data, n.d.a).

[2] Improved WS refer to piped water, boreholes, tube wells, protected dug wells, protected springs, and packaged or delivered water (WHO/UNICEF, 2017:4).

The waterborne diseases, such as cholera, diarrhea, dysentery, typhoid, polio (Prüss-Ustün et al., 2019; WHO, 2019a), put at risk the lives and wellbeing of people with limited access to safe water. In 2016, 1.6 million deaths and 105 million disability-adjusted life years (DALYS) were attributed to inadequate water, sanitation and hygiene (WASH) (Prüss-Ustün et al., 2019:771). These numbers represent 3,3% of global deaths and, respectively, 4,6% of global DALYS (WHO, 2019b:38). Almost one million deaths were caused by diarrhoeal diseases (Prüss-Ustün et al., 2019:771), half of them being associated specifically to inadequate water (Prüss-Ustün et al., 2019:770; WHO, 2019a). Children under five years are particularly affected, 13% of all deaths in this age are attributed to WASH related diseases (WHO, 2019b:38). Consumption of unsafe water also leads to school absenteeism, missed workdays, and high healthcare expenditure, impacting negatively the economic development of the country (Hutton & Haller, 2004 and Monse et al., 2013 as cited in Ojomo et al., 2015). Sub-Saharan Africa is the region with the largest WASH related disease burden where 12% of the disease burden and 17% of the total disease burden in children are related to inadequate WASH (WHO, 2019b:39).

Household water treatment (HWT) can improve the quality of water and reduce the incidence of diarrheal disease by 30-40% (Murray et al, 2020; Sobsey et al., 2008). Despite disagreements on whether the HWT promotion should be scaled up or not among poor population (Schmidt & Cairncross, 2009a,b; Classen et al., 2009), the researchers and policymakers agree that these interventions should be, at least, intermediary solutions to decrease the burden of water-borne infections (WHO/UNICEF, 2008 and Wolf et al., 2014 as cited in Burt et al., 2017; WHO, 2011 as cited in Murray et al., 2019; Sobsey, 2002 as cited in Ojomo et al, 2015; Dreibelbis et al., 2013; Lilje & Mosler, 2018; Classen 2007). The design of interventions promoting HWT should consider the enablers of HWT use (Ojomo et al., 2015). The literature has identified several potential factors nevertheless, the specificity of the social and environmental context where the potential interventions take place proved to have a crucial importance for a successful implementation (Ojomo et al., 2015).

[3] SDGs ladder represents the JMP statistical framework for monitoring the progress of SDG-6 targets (JMP Wash Data, n.d.b.). JMP developed initially a ladder for monitoring the MDG 7, target 10. The MDGs ladder was dividing the WS in improved and unimproved (Sutton, 2008). This ladder was criticised for considering only the design and technological construction of the WS, overlooking the capacity of blocking the bacterial contamination (Sutton, 2008). The SDG ladder attempts to respond to this criticism by incorporating the time needed to access the WS (World Bank, 2018).

This study attempts to identify the enablers of HWT practices in rural Tanzania. The aim is to provide useful information for designing and implementing HWT initiatives in this country. Almost half of all Tanzanians, 23.7 million people, do not have access to improved drinking WS (World Bank, 2018). 70% of Tanzanians live in rural areas, and namely, rural dwellers lack access to safely managed WS (AfDB, 2017). This fact, combined with inadequate sanitation and hygiene conditions, leads to a high incidence of waterborne diseases (AfDB, 201). The mortality rate attribute to unsafe water, sanitation and bad hygiene was 38.4 per 100000 population in 2016 (World Bank Databank, n.d.). Tanzania is one of the most malaria affected countries in the world, with an estimated of 10 million cases in 2010 (World Bank, 2018). According to a study of Water Sanitation Program (WSP), in Tanzania, approximately 26500 deaths, including 18500 children under five, are caused by diarrheal diseases each year (WSP, 2012). In almost 90% of these cases, the death cause is exposure to poor WASH conditions (WSP, 2012).

As suggested above, the research question of this dissertation is: "**What are the enablers of water treatment behaviour in rural Tanzania?**". By responding to this question, it is possible to propose better HWT promoting interventions. By using data collected as part of the Fuatilia Maji project in twelve villages in rural Morogoro, Tanzania, I run multiple probit and ordinary least square models to identify the enablers of HWT practice. The dissertation finds that three psychological factors of the RANAS model are the best predictors of water treatment behaviour, factual knowledge, perceived necessity and descriptive norm. Such findings suggest that changing the people's visions and perceptions my save and improve lives. Education, access to information about HWT and, potentially, the type of WS are the socio-economic characteristics correlated with the behaviour to treat water. Although, the dissertation puts forward the hypothesis that the socio-economic factors influence the HWT practice, indirectly, through the psychological factors.

The dissertation is structured as follows. The second chapter analyses the situation in the water sector in Tanzania, as well, water institutions and policies. The chapter concludes that the problem of limited access to clean water in rural Tanzania is related to inefficient institutions and policies governing this sector. In such a context, the promotion of HWT emerges as an intermediary solution for reducing the risk of waterborne diseases. The third chapter performs the literature review to identify the factors at individual and household levels associated with water treatment behaviour. The fourth chapter presents the methodology. The findings are analysed in the fifth and sixth chapter.

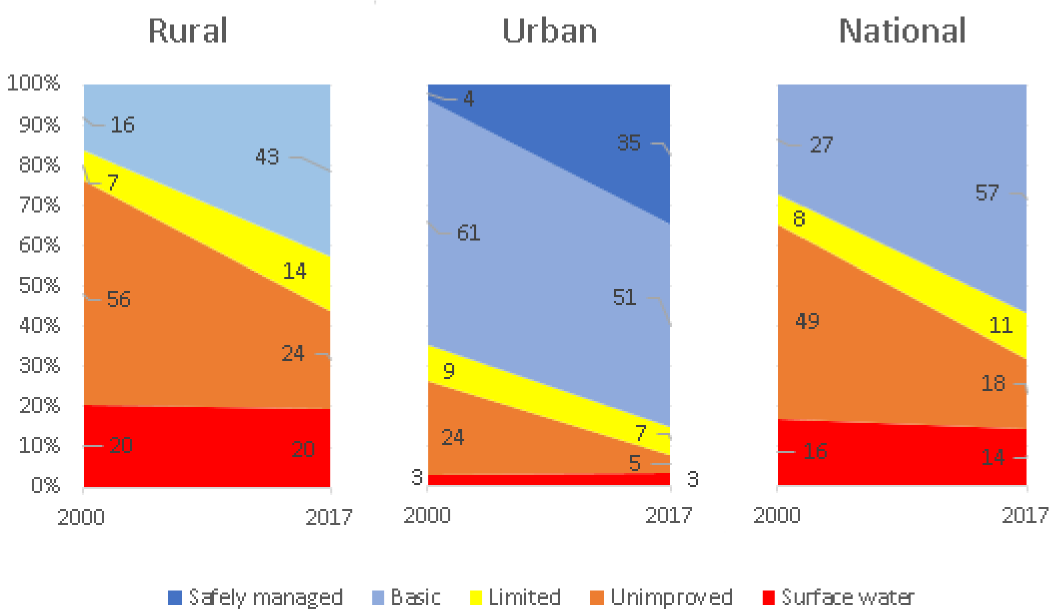
2. Water sector in Tanzania: visible progress but too slow

This chapter aims to present the situation in the water sector in Tanzania. With a special focus on the rural areas, I first analyse the Tanzanians' access to safe water, the economic cost of poor water coverage and the impact on the most vulnerable groups. Next, I present how the government of Tanzania (GoT) attempts to secure safe water for every citizen through various policies and institutional reforms and what are the main impediments of fast progress in the water sector. This chapter concludes that limited water coverage in Tanzania, in particular in the rural areas, is an institutional problem which requires time and resources for being solved. In such a context, the promotion of HWT should be envisaged as an intermediary solution to improve the quality of drinking water and reduce the risk of enteric diseases.

2.1. Tanzanians' access to water supply

Over the last decades, access to improved WSs increased steadily in Tanzania (see figure 2.1.). For instance, from 2000 to 2017, the proportion of the population having access at least to basic drinking[4] water increased from 27% to 57%. A massive improvement has been registered in the rural areas, in 2000 only 16% of the population had access to at least basic water services whilst in 2017 this proportion raised to 43%.

Figure 2.1.: Tanzania's drinking water coverage, SDGs ladder, 2000-2017

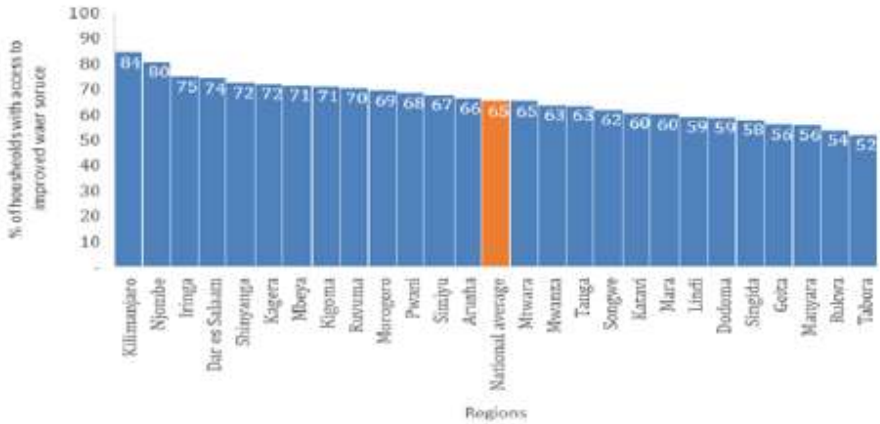


Source: JMP Wash Data (n.d.c)

[4] This categorization follows the SDG ladder, see footnote 3.

JMP Wash Data does not report the proportion of the population who has access to safely managed WSs at national level and in rural areas, because Tanzania has no national data on faecal contamination of water (World Bank, 2018:39). But according to a World Bank report, in 2016 only 7,8% of Tanzanians use on-premise improved WSs, a proxy of safely managed WS [5], and this proportion decreases to 3.5% in rural areas (World Bank, 2018:21). The first reason for such a low proportion refers to the interruptions in the water supply. Only 18% of the urban dwellers and 4% of the rural dwellers have access to uninterrupted and on-premise water (World Bank, 2018:21). 45% of Tanzanians who use piped water, tube-wells, or boreholes report at least one interruption in two weeks (World Bank, 2018:21). The second reason is the proximity of WSs. Indeed, the average time to collect water in Tanzania is 40 minutes (Origa et al., 2020:16). In the rural areas, the situation is worse, only a third of the rural residents need less than 30 minutes to collect water from an improved WS (World Bank, 2018:21). To avoid spending too much time collecting water from improved sources, people use unsafe sources. 24% of the rural population fetches water from unimproved sources and 20% use surface water (JPM Wash Data, n.d. c) (see figure 2.1.).

Figure 2.2.: Access to improved water sources in rural Tanzania



Source: Origa et al., 2020:16

If the collection time is not considered then from 2007 to 2018, the proportion of the population with access to improved WSs increased from 52% to 73% (Origa et al., 2020:16). The access in rural areas is around 65% (see figure 2.2.), though, this proportion varies across different regions. In Morogoro, the region where this study took place, 69% of the population has access to improved WSs.

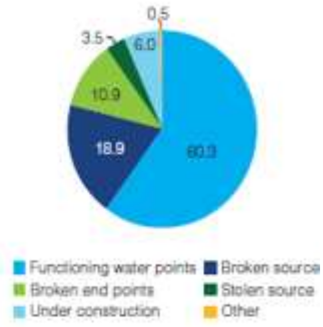
There are large inequities in access to water. The poorest have the worst access to safe WSs. For example, 84% of the richest quintile and only 45% of the poorest quintile have access to improved WSs (Word Bank, 2019:22). Regarding the access to on-premise pipe water, 37,5%

[5] On-premise improved water sources satisfy three out of four criteria for safely managed water sources (improved sources, located on premise and available when needed) and excludes the water contamination (World Bank, 2018:39).

of the richest and only 0.8% of the poorest quintile have access to such a WS (Word Bank, 2019:22).

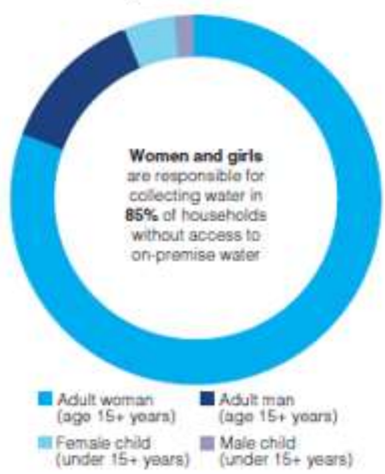
One of the biggest challenges for water services in Tanzania is the poor sustainability of rural water schemes and water points (Komakech et al., 2020; Origa et al., 2020). Around half of the water schemes fail within one year from commissioning (Komakech et al., 2020:1) and the poor operation and maintenance are considered the main causes (Origa et al., 2020). At the national level, 30% of the water schemes were non-functional in December 2019 (MoW, 2020:72), while in 2016 in Morogoro, 67% of the rural water points were in this state (Origa et al., 2020:17) (see Annex 1). Around 20% of newly constructed water points become non-functional within one year (Nganyanyuka et al., 2017:103). The reasons for these water points to be non-functional are different (see figure 2.3.), however, 30% of water points were non-functional due to a broken source or end point (World Bank, 2018:27). Cronk and Bartram (2017) found that the functionality of water points in Tanzania varies by technology type, Nira handpumps were the most functional ones. Additionally, the functionality was higher if the water services fees were collected monthly rather than in response to system breakdown (Cronk & Bartram, 2017). Although, another important problem is the allocation of funds for the maintenance work (see section 2.4.). The people quickly abandon the non-functional water points and return to the unimproved sources, putting their life and wellbeing in danger (Nganyanyuka et al., 2017).

Figure 2.3.: Water points failure: Causes



Source: World Bank, 2019:29

Figure 2.4.: Person responsible for collecting water in households without on-premise water



Source: World Bank, 2019:20

The reported use of HWT methods is low in Tanzania despite the limited access to safe water. Using the Demographic and Health Survey data, Geremew & Damtew (2020) finds that, in Tanzania, less than 40% of respondents reportedly treat the water and less than 25% of respondents treat them with adequate. The burden of consuming contaminated water is economically heavy at the levels of households and government. WSP (2012) calculated that premature death caused by enteric diseases, diarrhoea, malaria, and acute lower respiratory infections, costs Tanzania $171 million each year. Another $ 19 million are spent for medical consultation, medication, transport and hospitalisation for treating diarrheal diseases (WSP, 2012). Finally, $1.6 million are lost because of productivity losses as a result of being sick, looking for healthcare or caring for household members suffering from these diseases (WSP, 2012). Importantly, these estimates omitted several aspects such as the funeral costs, the impact of early childhood diarrhoea on cognitive development and the lost opportunities in the tourism sector due to poor WASH. The time required to fetch water is, also, excluded. A household needs more than four hours per week to collect water, and in Tanzania, in 85% of the households, this responsibility is assigned to adult women and girls (World Bank, 2018:19) (see figure 2.4.). The explanation of such a situation lies in the cultural view that the women should subordinate to the men and be socially marginalized to the domestic chores (Michael, 1998).

The burden of unsafe water falls disproportionally on the vulnerable groups. For example, the poor have limited access to safely managed WS, hence, the probability to suffer from a waterborne disease is higher. Besides, the cost of dealing with the consequences of using bad water presents a much larger proportion of a poor's income than that of wealthy persons (WSP, 2012). Unsafe water is particularly risky for people suffering from human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS) and has grave consequences on healthy childhood (see Annex 2).

2.2. Water policies and strategies

The evolution of water policies in Tanzania passed through two phases, the first phase is characterised by centralisation and the second one by the opposite process, the decentralisation. The first phase started right after independence. Promising safe water supply in sufficient quantities, within easy reach, all year round, the GoT decided to fund 100% of water supplies and took over the local authorities' responsibility to maintain the water points (Jimenez & Perez-Foguet, 2010). The international donors were, also, heavily involved in the realisation of this promise. For instance, during the International Drinking Water Supply and Sanitation Decade (1981–1990) the donors provided 63% of rural water sector funds (Jimenez & Perez-Foguet, 2010). However, just as many other development initiatives during that decade[6], these rapid water coverage plans failed.

[6] The 1980s or the third decade of development aid is often called the "lost decade" (Van Bilzen, 2015:392). A world-wide recession hit the developing countries, and the found solution, the controversial Structural Adjustment Programmes, brought zero growth (Easterly, 2001:101-104).

In the early 1990s, international donors started to actively support decentralisation processes to foster accountability and good governance in developing countries (Dickovick, 2014; Carlitz, 2017). Tanzania was quick to adopt decentralisation through devolution[7] and several legal and institutional changes took place in all sectors (World Bank, 2018; Komakech et al., 2020). This switch brought the second phase of water policies evolution in Tanzania characterized by decentralisation and adopting a demand-responsive approach (Carlitz, 2017). The decentralisation of water provision was supposed to increase the responsiveness to local needs and bring the government closer to the population which would sanction and reward the government's poor or good performance (Carlitz, 2017). In 1991, the first National Water Policy previewed that part of operation and maintenance costs of water points to be shifted to the end-users. In 2002, the second National Water Policy (NAWAPO) was launched and is still in place today. NAWAPO recognizes the access to water as a human right (Jimenez & Perez-Foguet, 2010) and, compared to the previous national policy, adopts an even more decentralised approach based on the principle of subsidiarity (World Bank, 2018). The central government is the main coordinator in the water sector and the district level is in charge of policy implementation (Jimenez & Perez-Foguet, 2010). The local communities should manage their water services following a demand-responsive approach and being fully responsible for the cost recovery of operations and maintenance (Komakech et al., 2020). More details about the institutional set-up are provided below. NAWAPO, also, promotes the participation of the private sector in service delivery (World Bank, 2018). The main implementation instrument of NAWAPO is the twenty-year Water Sector Development Program (WSDP). Two acts, the Water Resources Management Act of 2009 (WRM Act) and the newly enacted Water Supply and Sanitation Act of 2019 (WSS Act), legislate the water policy (Origa et al., 2020). Each of these three documents is, briefly, introduced below.

Spurred by MDGs and following the Paris declaration's aid effectiveness principles, the WSDP was established by a coalition between the GoT, Civil Society Organisations and donors (Carlitz, 2017). Through a sector-wide approach, the WSDP was designed in three phases, and aims to achieve, by 2025, universal access to water and sanitation (Origa et al., 2020; Carlitz, 2017). The first phase (2007-2014) was the largest water program in Africa, accounting for $1.4 bln disbursements from international donor agencies and the GoT (World Bank, 2018).

[7] Devolution, also called political decentralisation, refers to a transfer of authority from the representatives of the central government to the locally elected representatives (OECD, 2004). The devolution transfers powers either to local governments or community-based groups. If the second process takes place, the transfer of power to community-based groups, then this process reflects the demand-responsive approach (Carlitz, 2017).

The scale of the program comes with a high degree of complexity and inflexibility. For instance, there are more than 300 implementing agencies (Tilley, 2013:8). The evaluation of the first phase pointed towards several issues that hindered the achievement of its objective. For instance, insufficient resources were allocated in maintenance, repair, and replacement of water schemes, and to support and train district-level staff (Origa et al., 2020). There were, also, problems with institutional fragmentation, policy incoherence and weak coordination between local authorities and the Ministry of Water (MoW) (Origa et al., 2020).

WRM Act of 2009 clarifies the institutional and legal framework for the sustainable management of water resources (Origa et al., 2020). It focuses, in particular, on the prevention and control of water pollution (Origa et al., 2020). The WSS Act of 2019 is part of an attempt to reform the water sector (SWA, 2019). This act provides the legal and institutional framework for the management of water and sanitation services in Tanzania and outlines the responsibilities of different government authorities (Origa et al., 2020). Based on the WSS Act, I briefly introduce, in the next section, the main institutions of the water sector in Tanzania, along with their main functions.

2.3. Institutional structure of the water sector

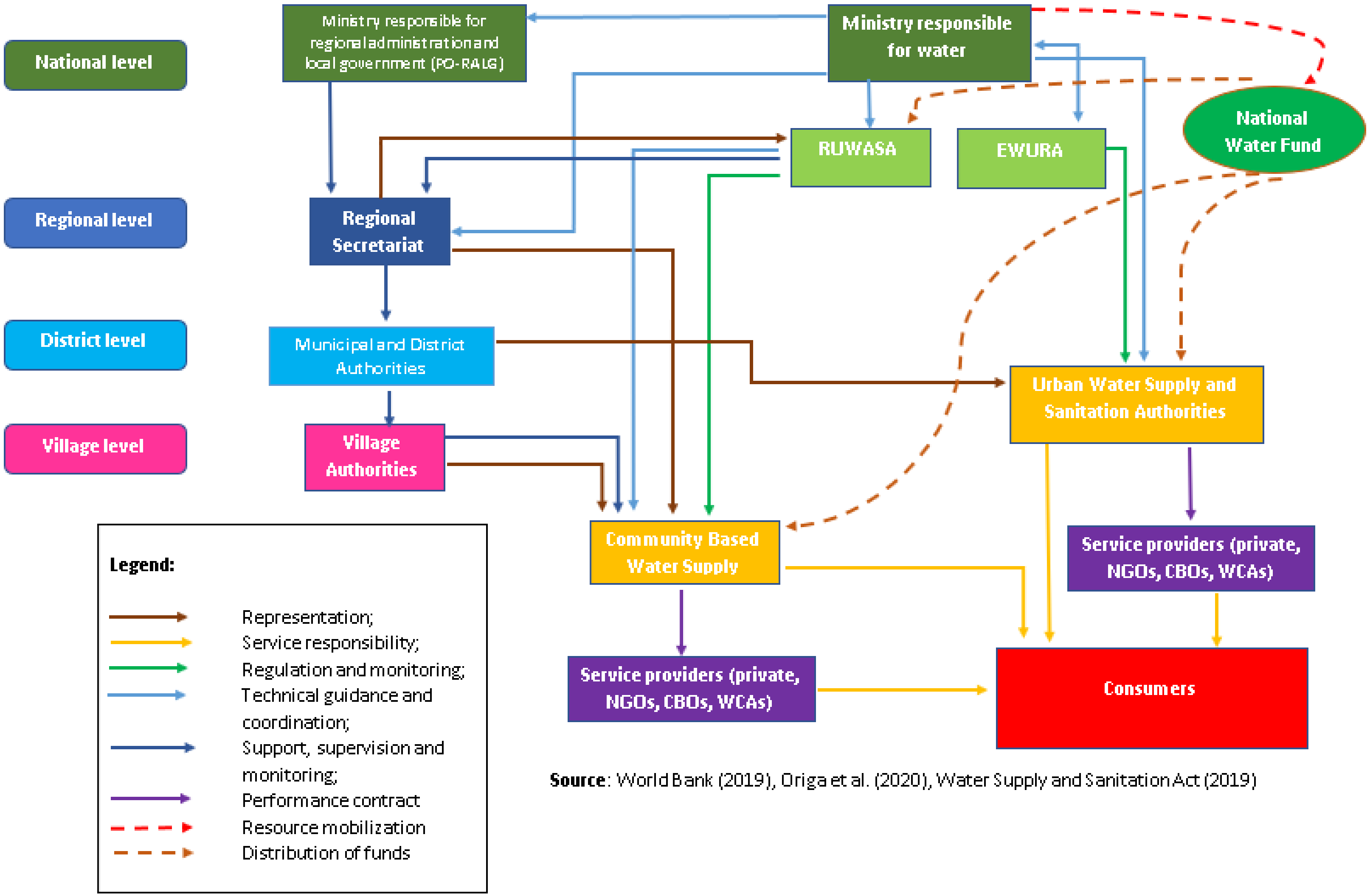
Figure 2.6. illustrates a simplified version of the water sector's institutions in Tanzania and the interactions among them. Because of the decentralized nature of the water sector, the MoW is not responsible for the direct implementation of water services delivery (World Bank, 2018). Instead, it formulates the national policies and strategies of the water supply and sanitation services provision, provides technical guidance to Water Supply and Sanitation Authorities (WSSAs) and Rural Water and Sanitation Agency (RUWASA), and monitors and coordinates community-based water supply organisations (CBWSOs) (WSS Act, 2019). According to the new WSS Act adopted in 2019, the MoW coordinates the resource mobilisation through external support, non-governmental organisations (NGOs) and the public sector (WSS Act, 2019). The WSS Act established, as well, the National Water Fund that should mobilize resources and invest in water service provision. The sources of funding are different, and they may be determined by the MoW upon consultation with the Ministry of Finance. Before the WSS Act, resource mobilisation was the responsibility of the President's Office-Regional Administration and Local Government (PO-RALG) (World Bank, 2018). PO-RALG is, now, responsible for creating a conducive environment for (i) the community and private sector

participation in water service delivery and (ii) WSSAs and RUWASA in the execution of their functions (WSS Act, 2019).

Energy and Water Utilities Regulatory Authority (EWURA) was established in 2001 and regulates the provision of energy services, water supply, and sanitation services by a water authority or other entities (Orega et al., 2020). Referring to water supply, EWURA exercises licensing and regulatory functions in respect to WSSAs by establishing the equipment standards and approving the tariffs for the provision of water (WSS Act, 2019). WSSAs are autonomous legal entities that operate following the commercial principles, and are accountable to, and monitored by the MoW (World Bank, 2018). A WSSA is obliged to do all necessary to provide water supply and sanitation in the areas falling under its jurisdiction (WSS Act, 2019).

The WSS Act has, also, changed the responsibilities of rural water delivery with the establishment of RUWASA (Komakech et al., 2020). Before the WSS Act, the district authorities were responsible for the WASH infrastructure works. The district executive director (DED) was responsible for the registration and supervision of COWSOs through the District Water Engineer (DWE). The DWE was reporting directly to DED who, respectively, was reporting to PO-RALG (Orega et al., 2020). COWSOs should have reported regularly to DWE but, in practice, they were reporting only water point breakdowns (Lemmens et al., 2017). COWSOs were working directly with the Ward Executive Officer and Village Executive Officer to ensure that the rural water schemes work properly, and the citizens pay the fees (Lemmens et al., 2017). Under the new law, the role of local government authorities, regional, district and village authorities, have shrunk to general oversight. The DWEs, now called district water managers, became the staff of RUWASA, they report to regional RUWASA manager who reports to MoW through the general director of RUWASA. RUWASA is responsible for planning, designing, constructing and managing water supply and sanitation in rural areas. Besides, RUWASA operates through regional and district authorities to ensure that Community Based Water Supply Organizations (CBWSOs) are established and well equipped to manage water and sanitation services (WSS Act, 2019). CBWSOs are responsible for operations and maintenance of rural schemes (WSS Act, 2019). The village councils support the establishment of CBWSOs, coordinate the village council budgets with the ones of CBWSOs, and resolve conflicts within CBWSO (Orega et al., 2020).

Figure2.6: Water institutions in Tanzania and their interactions



Source: World Bank (2019), Origa et al. (2020), Water Supply and Sanitation Act (2019)

In fact, the evolution of CBWSOs within the Tanzanian institutional framework is intricate and reflects the evolution of water sector decentralisation process and the purpose to stop the political interference at the community level. For instance, in 2006, Community Owned Water Supply Organizations (COWSOs) replaced the village water committees (VWCs) and became responsible for operations and maintenance of rural schemes. VWCs were not independent of village governments and did not have clear mandates (Komakech et al., 2020). This situation increased the risk of political interference and corruption. The establishment of independent legal entities, COWSOs, was considered the right solution to mitigate these risks (World Bank, 2018). There have been established over 3000 COWSOs in Tanzania (Komakech et al., 2020). However, the political interference in the management of rural water services continued and the establishment of RUWASA and CBSWOs aims to mitigate it (Orega et al., 2020).

2.4. Constraints in water service delivery in Tanzania: rationale for household water treatment

The constraints discussed in this section mostly refer to the situation prior to the adoption of the WSS Act (2019). The WSS Act aims to tackle part of these constraints. Although, as the previous sections mention, Tanzania is constantly reforming its water sector institutions. This "ritualization of reforms" is considered as a tool to create positive stories about the provision of water services for hiding the little progress observed at the local level and the rent-seeking practices (Tilley, 2018). Therefore, it is hard to predict whether WSS Act will succeed to solve the problems discussed below.

After almost three decades of implementing decentralised water management (Komakech et al., 2020), the decentralisation in Tanzania suffers from power struggles between different levels of governance. A first struggle was observed between the central government ministries and the districts. The central government ministries resisted decentralisation, and as result, the districts had to deal with policy incoherence, and overlapping functions and roles (Tilley, 2013). Additionally, despite more legal and policy power transferred to the local level, the local authorities, particularly in the rural areas, lack human, technical and financial capacity to deliver on their responsibilities (World Bank, 2018). Moreover, the local government authorities are constrained to administer the local employees. The district authorities lacked the power to hire or fire people, had limited control over the WSSAs' technical staff and no power over the decision of staff budgets (World bank, 2018). The fact that the local authorities had little control over their budget made them dependent on the central government, and the upward accountability increased which is contradictory with the decentralisation intent (World Bank, 2018). The RUWASA's creation aims to tackle this conundrum. Nevertheless, the establishment of another institution in an already complicated institutional set-up will add to the complexity and may have reverse effects than the initial intention.

A second struggle was taking place between the district authorities and COWSOs around the responsibilities for water provision. The districts remained in charge of constructing new water infrastructure and transferred their responsibility to supply water to COWSOs. But COWSOs were ill-equipped to deal with all challenges around their new roles (Tilley, 2013). Moreover, the water users had difficulties determining who was responsible for maintenance of water supply infrastructure. For example, before the WSS Act, the local government authorities were responsible for "major" rehabilitation works and COWSOs for "minor" works, but there was no definition of "major" works and how to distinguish them from "minor" ones (World Bank, 2018).

Additionally, COWSOs had little incentives to perform well. COWSOs' members were often not paid because their salaries should have come from water services fee collection and water users often refuse to pay for water charges, in particular in rural areas (World Bank, 2018). This concern is still valid under the new institutional framework. There are no financial resources guaranteed for RUWASA to manage and support the CBWSOs. In theory, CBWSOs will grow and become sustainable on their own, but the chance for CBWSOs to follow COWSOs' fate in this respect is high. Meanwhile, it is expected for RUWASA to hire technicians for operating and maintaining the rural water schemes (Origa et al., 2019). However, RUWASA has limited human resources capacity and lack the skills for managing, efficiently, the WS (Origa et al., 2019).

Another problem refers to the efficient allocation of resources. This problem is well-known for the dominant party regimes, and Tanzania is one of them (Carlitz, 2017). Political favouritism and pork-barrel projects [8]characterize the allocation of funds in water provision whilst the local needs are ignored (Carlitz, 2017; Tilley, 2013). Carlitz (2017) finds that the MoW's home district receives much more funds than other districts. Nevertheless, political favouritism is more visible at the local level. The district authorities skew the water resources to favour the localities with higher levels of support for the ruling party (Carlitz, 2017).

[8] Pork-barrel projects are a form of patronage spending where the public resources are used to bolster political support, and the main beneficiaries are a narrow group of people (Williams et al., 2009).

The allocation of financial resources suffers from other shortcomings. Most of the budget allocation is previewed for constructions of new water points, and the maintenance of already existing ones is ignored (World Bank, 2018). For instance, during the financial year 2015-2016, 80% of all expenditure in the rural areas were used to build new water points and schemes (World Bank, 2018:103). Such a situation explains the poor sustainability of rural water schemes discussed above.

There are other issues linked to the management of financial resources. The funds allocated to the water sector increased during the last decades, partially thanks to the funds transferred by the development partners. However, the local authorities, particularly in the rural areas, have limited capacity to absorb the allocated funds (World Bank, 2018). Besides, due to the accountability requirements to donors, the funds' disbursement follows a heavily bureaucratic process, involving the village authorities, districts and ministries. This creates inefficiencies and adds to power struggles between different levels of government (Lemmens et al., 2017).

Another problem is that despite continuous institutional reforms, the water sector in Tanzania is constrained by an outdated policy, NAWAPO. NAWAPO has been adopted in 2002 and does not include such emerging issues as climate change, sustainable technology, population dynamics and inclusion of disadvantaged groups (SWA, 2019). In addition, the monitoring and evaluation system of the water sector is plagued with numerous deficiencies (World Bank, 2018; Origa et al., 2019; Tilley, 2013). For example, the Water Point Monitoring System is currently in place, and in spite of high expectations, does not deliver useful data (World Bank, 2018).

Last but not least, women are often side-lined in water sector decision and policy making. Michael (1998) observed that women were not present in policy making in Tanzania despite their role in water collection and the situation has not changed since then. There are few women involved in water sector policymaking and management. Even if the law demands that 30% of all committees' members to be women, this is rarely applied (Origa et al., 2019). Female members of COWSOs are often not invited to meetings or are not given enough time to make contribution (Origa et al., 2019).

In conclusion, the reduced access to safely managed WS in Tanzania is in great part due to inefficient institutions. Or if I follow North's (1990) definition of institutions, inefficient "rules of the game" govern the water sector in Tanzania, creating high transaction costs and incertitude. The institutional economics school of thought, also, tells that the institutions are "sticky" and "hard to be changed". This view explains why, after so many reforms and efforts of international donors, the water sector in Tanzania is still badly managed. In such conditions, waiting for the water sector institutions to improve, so the access to safe WS improves, risks to be a wrong approach engendering the life and wellbeing of many Tanzanians. The HWT, therefore, should emerge as an intermediary solution for limiting the exposure to waterborne diseases.

3. Literature review

The literature review identified several characteristics at individual and household levels correlated with the HWT practice. These factors may be divided into two categories, socio-economic and psychological. The socio-economic category includes such contextual factors as education, income, gender, and type of WS. The psychological category refers to such "soft" characteristics as attitude, norms, knowledge, and other factors that enable the formation of new behaviours (Morse, 2012). In the end, the adoption of HWT represents a behavioural change (Morse, 2012; Peal et al. 2010; Kraemer & Mosler, 2011; Contzen & Mosler, 2015a) that starts in people's minds. I, first, focus on what the literature says about the relation between the socio-economic factors and HWT uptake and practice. Next, I present the findings on the psychological factors and the risk, attitude, norms, ability, and self-regulation model (RANAS). Finally, I discuss the relationship between these two groups of factors since this aspect helps to clarify the model for studying the enablers of HWT behaviour. The literature review helps to build three types of models for the identification of the HWT enablers.

3.1.Socio-economic factors

Table 3.1.: Literature review: the relation between socio-economic factors and water treatment behaviour

Factors	Relationship with HWT	Studies
Education	Positive	Daniel et al. (2018, 2019, 2020); Geremew et al. (2019); Fotuè Totouom et al. (2012); Nauges & van den Berg (2009); McConnell & Rosado (2000); Ahmed & Sattar (2007); Akram (2020); Geremew & Damtew (2020); Lilje et al., 2015
	No effect	Blum et al. (2014); Murray et al. (2020), Goodman et al. (2016)
Income	Positive	Daniel et al. (2018, 2019, 2020); Geremew et al. (2019); Blum et al. (2014); Fotuè Totouom et al. (2012); McConnell & Rosado (2000); Ahmed & Sattar (2007); Akram (2020); Ojomo et al. (2015); Geremew & Damtew (2020), Goodman et al. (2016)
	No effect	Anderson et al. (2010).
Type of water source	Positive	Daniel et al. (2018, 2019, 2020); Akram (2020); Christen et al. (2011); Workman (2019).
	Negative	Anderson et al. (2010).
	No effect	Geremew & Damtew (2020).
Presence of young children	Positive	Fotuè Totouom et al. (2012); McConnell & Rosado (2000); Christen et al. (2011).
	No effect	Daniel et al., (2020); Blum et al. (2014)
Waterborne diseases	Positive	Fotuè Totouom et al. (2012); Blum et al. (2014).
	No effect	Daniel et al. (2020); Ahmed and Sattar (2007)
Access to information	Positive	Christen et al. (2011); Akram (2020); Nauges and an den Berg (2009)
Gender	Male positive	Fotuè Totouom et al. (2012)
	Female positive	Ahmed and Sattar (2007); Christen et al. (2011)
	No effect	Murray et al. (2020)
Residence: Rural	Positive	Murray et al. (2020)
	Negative	Akram (2020)
	No effect	Geremew & Damtew (2020)
Large households	Negative	Akram (2020); Lilje et al., 2015;

Table 3.1. presents an overview of performed literture reivew of socio-econoic factors. Education is the most often mentioned factor that predicts the use of HWT. Based on previous variable-driven experimental research and meta-analyses on HWT interventions, Daniel et al. (2018) found education, more exactly, parental education, as one of the socio-environmental characteristics that influence the adoption of HWT. Education demonstrated to be significantly associated with HWT adoption in such studies as Daniel et al. (2019, 2020) in Nepal, Geremew & Damtew (2020) in 23 Sub-Saharn African countries, Geremew et al. (2019) in Ethiopia, Lilje et al., 2015 in Chad, Fotuè Totouom et al. (2012) in Cameroun,

Anderson et al (2010) in South Africa, Nauges and van den Berg (2009) in Sri Lanka, McConnell and Rosado (2000) in Brazil, and Ahmed and Sattar (2007) and Akram (2020) in Pakistan. Additionally, Ahmed and Sattar (2007) notice that the education of male members has a larger influence on water treatment behaviour than the education of female members. Figueroa and Kincaid (2010) identify studies that find mothers' education affects positively the adoption of preventive health behaviours such as treating water. Finally, in Kenya, Blum et al. (2014), Goodman et al. (2016) and Murray et al. (2020) did not find a statistically significant relationship between education and the decision to purchase and use HWT products[9]. Okpasuo et al. (2020) consider education important but base their view on secondary literature.

Income level is another socio-economic characteristic associated with HWT use (see table 3.1.). The positive relation between income, or affordability to purchase HWT tools, and water treatment behaviour was found by Geremew et al. (2019), Geremew & Damtew (2020) , Daniel et al. (2018, 2019, 2020), Blum et al. (2014), Fotuè Totouom et al. (2012), Akram (2020), McConnell and Rosado (2000), and Ojomo et al. (2015). Goodman et al. (2016) find that the food secure orphans and vulnerable children were more likely to practice HWT methods. Conversely, Anderson et al. (2010) do not find the monthly household expenditure variable statistically significant. Ahmed and Sattar (2007) find the wealth variable statistically significant coefficients only for the second upper quartile and their interpretation was that the wealthy people do not treat water but prefer to buy bottled water. Workman (2019) conducted a quantitative study in Lesotho, and she underlines that people rarely brought financial reasons as explanations for not treating the water. According to the researcher, though, the financial reasons still could hold since many people did not want to share their vulnerability.

Geremew & Damtew (2020) did not find any relationship between the WS type and HWT behaviour (see table 3.1.). Anderson et al. (2010) find that households with less clean and more distant WS were more likely to treat water. However, Daniel et al. (2018, 2019, 2020) and Akram (2020) found that connection to a pipe increases the chances of HWT practice. In a study about the adoption of solar disinfection of water (SODIS) in rural Bolivia, Christen et al. (2011) observe that the villagers living near the WS were more likely to adopt this treatment method. Workman (2019) underlines water insecurity as another factor. If people are without water for days, treating the water becomes insignificant; once they get it, they want to drink it. Therefore, the connections between the people's wealth, exposure to water insecurity, type of WS, and HWT practice remain unclear. The individuals who can afford better WS might be

[9] The contradictory evidence about the enablers and barriers to treat water can be explained by the different studies' settings and employed methodologies.

wealthier and at a lower risk of water insecurity; hence, it becomes easier for them to purify the water. Nauges and van den Berg (2009) share the same doubt about the relation between the WS and water treatment behaviour.

The presence of young children within the household is another identified determinant (see table 3.1.). On one hand, Daniel et al. (2020) and Blum et al. (2014) suggest that the presence of young children does not impact the decision to treat water. On the other hand, Fotuè Totouom et al. (2012) and McConnell and Rosado (2000) affirm that the number of children less than five years increases the probability to treat water. Christen et al. (2011) observe that households with malnourished children were more likely to adopt SODIS. This leads to another determinant, the health status which was found to be significant in explaining the water treatment behaviour by Fotuè Totouom et al. (2012) and Blum et al. (2014). However, according to Daniel et al. (2020) and Ahmed and Sattar (2007), the presence of previous waterborne illness within the household is also not associated with HWT.

The access to information is, also, discussed in the literature (see table 3.1.), although, different proxies are used to measure this determinant. Christen et al. (2011) and Daniel et al. (2019) confirm that the exposure to promotional activity about HWT is associated with higher adoption and use of HWT methods. Ahmed and Sattar (2007) and Akram (2020) identify the exposure to media as an important variable positively correlated with HWT. Geremew & Damtew (2020) say the same about owning a TV-set or radio. Nauges and van den Berg (2009) notice the access to information as a driving force of HWT.

The literature brings contradictory evidence about the relationship between gender and the decision to treat water (see table 3.1.). Fotuè Totouom et al. (2012) finds that in Cameroun the female-headed households are less likely to treat water than the male-headed households. Conversely, Ahmed and Sattar (2007) put forward the evidence that the female decision-makers are more likely to adopt water purification devices than the male decision-makers. In the same vein, Christen et al. (2011) find that the female was more likely to uptake SODIS and more women in the household were positively correlated with higher adoption of SODIS. Goodman et al. (2016) find that orphans with multiple sex partners were less likely to practice HWT, but among them the females had higher odds of treating water. The gender relations, nevertheless, impact the water treatment behaviours, extensive involvement of women in agricultural and household activities limits their time and willingness to treat water (Dreibel et al., 2013 citing Rainey & Harding, 2005).

Akram (2020) suggest that people who live in rural areas practice HWT less than the one living in urban areas while Murray et al. (2020) observe that the high-use communities of HWT were located in more rural areas. The Lilje et al., 2015 and Akram (2020) find that larger households, also, treat water less than the smaller ones (see table 3.1.). The explanation is that larger households need more water. Other socio-economic factors as potential predictors of HWT practice have not been identified.

3.2.Psychological factors

Before enumerating the identified psychological factors, I underline that their analysis is not as straightforward as in the case of socio-economic factors. Firstly, different studies analyse similar psychological factors, although, these factors are measured differently and may, in the end, represent different concepts. Secondly, the relation between various psychological factors is not straightforward and a theoretical model is then helpful to guide their analysis. Therefore, the first part of his section clarifies what literature says about psychological factors without following any model, whilst the second part analyses the findings of RANAS model.

The most often mentioned psychological factor is the attitude (i. e. to like the taste of treated water, ease of use of HWT tools) towards HWT. Murray et al. (2020) identified the positive attitude as an important factor for the uptake of three new HWT technologies, two filters and one electro-chlorinator. Besides, Kraemer and Mosler (2011) find that the positive attitude towards SODIS differentiates the regular users from irregular, fluctuating and non- users. There are factors close to the attitude toward HWT. For instance, the way the potential HWT users perceive the convenience to adopt an HWT method (e.g. the required time, investment, easiness to use) and the perceived resulted water qualities after treatment (e.g. colour, taste) proved to be important for HWT uptake (Geremew et al., 2019; Okpasuo et al., 2020; Ojomo et al., 2015, Tobias & Berg, 2011). Hayashi et al. (2019) prove the existence of a trade-off between the efficacy of HWT devices and users' compliance. Usually, effective HWT methods alter the taste and odour of water, require more effort and investment, thus inducing lower users' compliance. The researchers conclude that lower efficacy of HWT devices increase their use and, probably, improve the attitude towards HWT, while the risk of diarrheal diseases decreases.

Knowledge about HWT methods is another important psychological factor that encourages the use and adoption of water treatment methods (Daniel et al., 2019; Murray et al., 2020; Ojomo et al., 2015; Blum et al., 2014). Christen et al. (2011) find that the adoption of SODIS was positively correlated with the number of events about treating water visited by a household's member. Participation in these events may potentially lead to better knowledge about HWT.

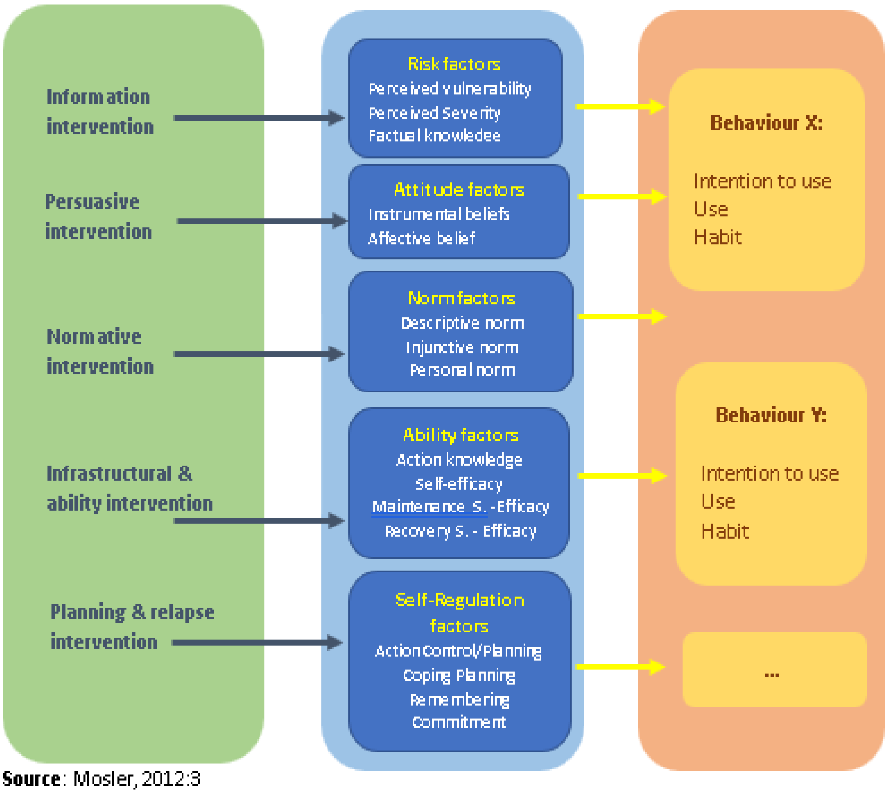
The studies of Daniel et al. (2018, 2019), Murray et al. (2020), Nauges and van den Berg (2009), and Okpasuo et al. (2020) suggest a positive relationship between perceived threat from consuming contaminated water and HWT practice. Moreover, the extensive literature review performed by Daniel et al. (2018) found that in 71% of analysed cases the risk perception is a precursor for adopting the HWT. In a study in Zimbabwe, Kraemer and Mosler (2011) affirm that compared with the SODIS users, the non-users are unaware of waterborne diseases and, potentially, have a lower perceived threat. A factor close to the perceived risk of consuming contaminated water is the perception of water quality. Blum et al. (2014) did not find any relation between perception of water cleanness and HWT, whilst Anderson et al. (2010) find a positive relationship between the two variables. The systematic review of Lucas and Cabral (2011) report that the dissemination of information about the quality of water and risks to consuming unsafe water did not significantly increase the water treatment behaviour. However, it is not clear whether dissemination of information increased the perceived threat.

Tobias and Berg (2011) investigate what psychological factors explain the decision to use, buy and maintain arsenic-removing sand filters in Vietnam. The perceived benefits of consuming filtered water (perceived positive health effects, improved taste of water) and social influencers are positively correlated with all three behaviours, decision to use, buy and maintain the filters. Social influencers refer to what the interviewees think the others do (descriptive norm) and what they think is correct to do (injunctive norm).

The literature review identified other psychological factors discussed in fewer studies. For example, Goodman et al. (2016) observe that higher level of self-efficacy (the person's belief to copy to life's challenges) is associated with a higher uptake of water purification practices. The analysis of all psychological factors identified by different studies is a challenging task, and following a theoretical model facilitates this analysis. Glanz and Bishop (2010) describe several behavioural models , used in health-promotion interventions, health belief (used by Nauges, C., & van den Berg, C. 2009), social cognitive theory, trans-theoretical (used by Kraemer and Mosler, 2011) and social-ecological models. RANAS model brings together a large collection of psychological factors from different theoretical models (Mosler, 2012), demonstrates a high capability to explain water treatment behaviour (Daniel et al., 2019) and has been widely used to study this subject (see next sub-section). Therefore, I employ this model to continue the analysis of psychological factors in the next sub-section.

3.2.1 The RANAS model

Figure 3.1: The RANAS Model



Source: Mosler, 2012:3

The RANAS model groups sixteen psychological factors into five-factor blocks (risk, attitude, norms, ability, and self-regulation). A new behaviour requires that all five factor-blocks are positive (Mosler, 2012), and a negative factor block points toward the hinder of the desired behaviour creation. The evidence produced by applying RANAS helps policymakers to target the negative factor block. Figure 3.1. presents the RANAS model's components. The first column indicates the interventions capable to trigger a change in the corresponding factor-block. The second column introduces the psychological factors grouped in five factor-blocks. The third column shows the factor outcome which refers to targeted behaviour and such aspects as the intention to use, the use, and the habit of using an HWT method. An intervention may target more than one behaviour; therefore, the third column could include more than one behaviour.

The RANAS model has been widely used in the WASH sector, in general, and in HWT promotion, in particular. Morse et al. (2020) used a RANAS-based questionnaire to determine the psychological factors pertaining to HWT and to elaborate a behaviour centred education campaign for promoting SODIS in Malawi. Following the RANAS model, Lilje et al. (2015) and Lilje and Mosler (2018) designed and evaluated a program promoting chlorination in Chad. Excluding self-regulating factors, Tamas et al. (2013) use a model similar to RANAS to compare the enablers of consumption of untreated, boiled and SODIS-treated water in Bolivia. Tamas and Mosler (2011) use the same data and model to find the differences between relapsers and continuers of SODIS practice. Excluding self- regulating factors, as well, Daniel et al. (2018) use RANAS framework to build a model for predicting the water treatment behaviour. Mosler et al. (2013) use RANAS framework to study the impact of different interventions aiming to promote the uptake of SODIS in Zimbabwe, although, they do not provide details about RANAS factors' findings. Table 3.2. presents the findings of these studies. The green cells present the factors that are positively correlated with HWT behaviours while the red ones are negatively correlated. The factors that are not associated with HWT behaviour are in blue and the ones that have not been examined by the study in issue are in grey.

Table 3.2.: Findings of studies that use RANAS model

Factors	Mosler et al. (2020)	Tamas et al. (2013)	Lilje & Mosler 2018, Lilje et al., 2015	Daniels et al. (2019)	Tamas & Mosler, 2011
Perceived vulnerability	o	o	-	o	o
Perceived severity	o	o	-	✓	o
Factual knowledge	o	o	✓	o	o
Instrumental belief	✓	✓ Health	o	o	o
Affective belief	✓ Taste	✓ Taste, liking	✓ Taste, cost	●	✓ Taste
Descriptive norm	✓	✓	o	✓	✓
Injunctive norm	✓	✓	✓	✓	✓
Personal norm	o	o	✓	o	o
Action knowledge	●	●	✓	o	o
Self-efficacy	●	●	✓	●	o
Maintenance S.	●	●	o	●	o
Recovery S.	●	●	o	●	o
Action Control	●	●	o	●	o
Coping Planning	●	●	o	●	o
Remembering	●	●	o	●	✓
Commitment	●	●	o	●	o

3.3. The relationship between socio-economic and psychological factors

The literature review performed by Daniel et al. (2018) indicates that the interactions between the socio-economic and psychological factors have the potential to explain the HWT behaviour, although the analysis of such interactions is challenging. The Integrated Behavioural Model for WASH (IBM-WASH) (see Annex 3) developed by Dreibelbis et al. (2013) is an example of a comprehensive framework that bring together these factors and classify them into three dimensions, contextual, psychological and technological. IBM-WASH assumes that both groups of factors directly impact the HWT behaviour. According to RANAS model, the socio-economic factors can impact the behaviours in three ways, one way directly and two ways indirectly through the psychological factors (Contzen & Mosler, 2015b). An example of direct impact is when the person is strongly committed to treating water, but the lack of HWT tools hinder to translate this commitment in a habit (Contzen and Mosler, 2015b). The indirect ways happen when the contextual factor alter (i) the psychological factors, or (ii) the intervention's influence on psychological factors. For example, the person's income impacts the perceived cost of HWT tools, and the level of education influences the person's understanding of medical information on diarrheal disease.

The studies including both groups of factors and analysing the WASH behaviours followed a different approach. Nauges and Berg (2009) took the indirect approach and considered that the socio-economic factors as mediating factors impacting the water treatment behaviour through the risk perception. Daniel et al. (2019) followed the same approach, however, they included in their model more psychological factors from the RANAS model (see table 3.2.). Seimetz et al. (2019) and Stocker and Mosler (2015) followed the direct approach and they used hierarchical regression analysis to identify the contextual and RANAS psychological factors that enable handwashing practices and, respectively, cleaning of water storage containers behaviour. These two studies followed IBM-WASH to justify the application of the direct approach for theorizing the relationship between socio-economic and psychological factors and their impact on the studied behaviour.

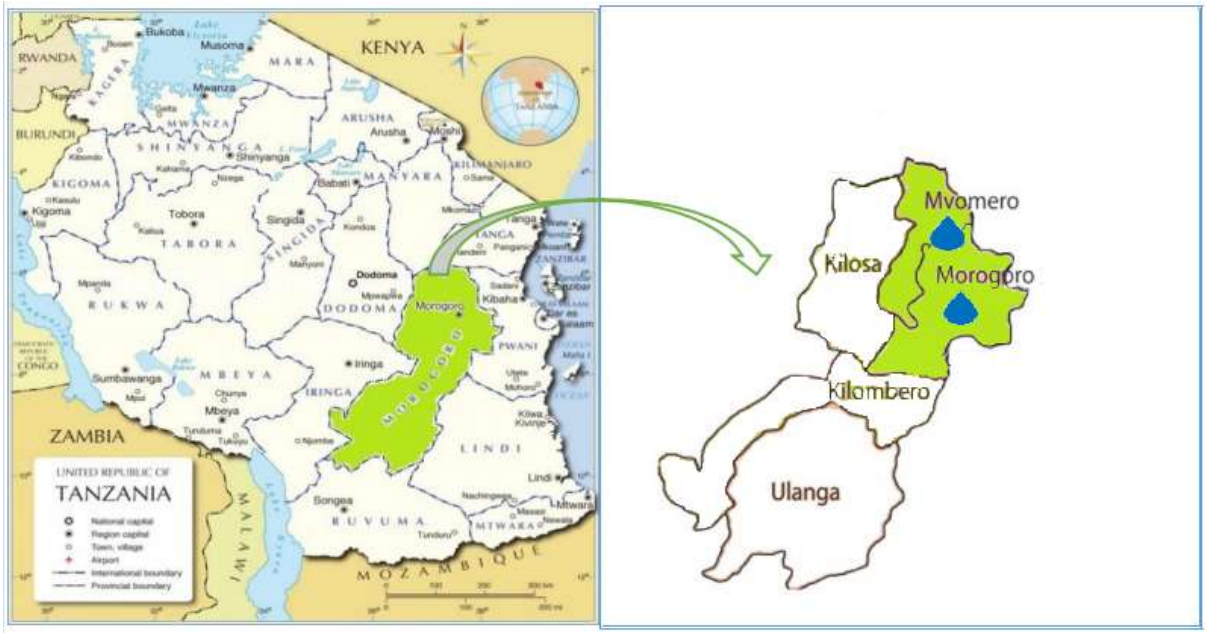
This chapter has identified the socio-economic and psychological factors that impact the decision to treat the drinking water. Based on these findings, I build two types of regression models, one of the socio-economic factors and the other one of RANAS psychological factors. Following the approach used by Seimetz et al. (2019) and Stocker and Mosler (2015), I add all these factors in the third type of model. The findings of this analysis help to design effective campaigns for promotion of HWT practices in rural Tanzania. Besides, these findings underline the need for further research on the relationship between socio-economic and psychological factors and their impact on HWT behaviour.

4. Methodology

4.1.Study settings and Fuatilia Maji project

The study uses data collected in the Morogoro region between March 2018. The Morogoro region is located on the Eastern side of the country and, after Tabora, is the second-largest region in Tanzania. Water bodies covers an insignificant part of the region's territory, only 3.1% (MAFSC, 2014:10). Administratively, the Morogoro region is divided into six districts (see figure 4.1.) which are, respectively, subdivided into divisions, wards, villages and streets (MAFSC, 2014).

Figure 4.1.: Tanzania administrative map: districts of Morogoro



Source: MAFSC, 2014

The data was collected as part of the Fuatilia Maji project[10], which is a joint undertaking of Mzumbe University and the Institute of Development Policy of the University of Antwerp and it is funded by VLIR-UOS (IOB, 2019). By producing detailed and timely information about the water services and quality, the project aims to improve the drinking water services and reduce the burden of water-borne diseases in the Morogoro region, Tanzania. The information is produced by the ICT-enhanced mobile monitoring systems which bring together the villagers, researchers, and water services duty bearers (IOB, 2019).

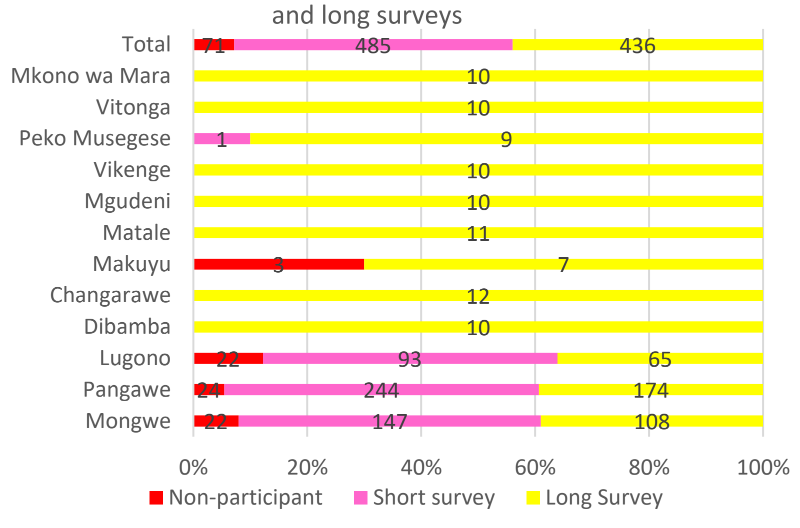
[10] More exactly, the project also refers to "Enhance good governance through integrated community-based activities - focus on community-based water monitoring" (Vlir-UOS IUC, Antigoon ID: 41579).

The Fuatilia Maji project tests three different monitoring water systems, expert-based, community-based and the ordinary Tanzanian monitoring systems, in ten villages from Mvomero and 2 villages of Morogoro district (see figure 4.1.). These twelve villages were selected following a purposive sampling technique. Students of the Mzumbe University monitor the water services and quality in five of the Mvomero district villages and this system constitutes the expert-based monitoring system. The mobile community-based monitoring system has been established in the other five Mvomero district villages. In this case, the monitoring activities are performed by representatives of the community supported by the Mzumbe University students. Finally, the remaining two villages serve as control villages and they represent the typical monitoring system of the water sector, in Tanzania.

4.2. Data collection

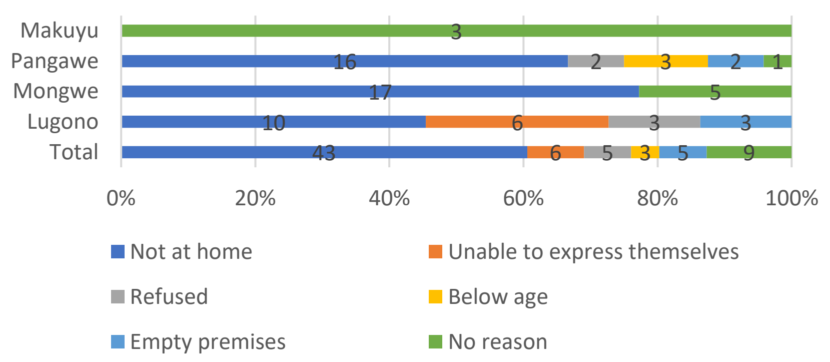
This study uses the baseline data collected from the 18th to 31st of March 2019 by a gender-balanced team of Mzumbe University students and an internship student of the Flemish Inter University Master of Arts program in Gender and Diversity (Mursali at al., n.d.). This team of students has been trained by the academic staff of Mzumbe University and the Institute of Development Policy of the University of Antwerp. Two types of semi-structured surveys were used to interview the villagers, a long survey addressed to women with most children within the household and a short survey addressed to the other members of the household (Daens, 2019). The short survey included questions about (i) salient problems in the village, (ii) monitoring activities of WS, (iii) access to information, (iv) water knowledge, (v) perceived efficacy of public officials and community members; (vi) social network water information. In addition to these subjects, the long surveys included questions about (vii) WS, (viii) storing and (ix) treatment of drinking water, (x) access to information, and (xi) water knowledge. For conducting the survey, the questionnaires were translated into the local language (Swahili) and back translated in English.

Figure 4.2.: Response rate and participation to short and long surveys



The research team attempted to conduct the survey with 992 villagers and 921 participated (response rate is 92.8%) (see figure 4.2.). 485 citizens responded to the short survey and 436 followed the long survey. In three (out of the 12) villages, Lugono, Mongwe, Pangawe, all citizens above eighteen years of age have been interviewed (see figure 4.2.). In fact, each of these three villages represents the three monitoring systems mentioned above. Following the long survey, the women from 10-12 households have been interviewed in the remaining nine villages. The selection of these 10-12 households started at the Village Office by two research assistants. Each of the research assistants took different random streets, interviewed the first household, skipped two households, interviewed the third household, skipped three households, interviewed the sixth household and so on (Mursali at al., n.d.). If the research assistant arrived in a dead end, he or she should have taken a side street or start again at the Village Office (Mursali at al., n.d.).

Figure 4.3.: Reasons for non-participation (number of observations)



The 71 non-participants were from four villages, Makuyu, Pangawe, Mongwe, Lugono (see figure 4.3.). 48 of them were not at home, or their premises were empty. Only 5 persons refused to do the questionnaire while 9 were either below the age limit or were not able to express themselves. The dataset does not mention any reason for nonparticipation for the other 9 non-respondents.

The Ethics Committee for the Social Sciences and Humanities (EA-SHW), installed by the Executive Board of the University of Antwerp, has approved the protocol of this study (reference SHW_20_10) on 31st of March 2020.

4.3 Method of analysis

The purpose of this dissertation is to analyse the socio-economic and psychological factors associated with HWT practice in rural Tanzania. I use probit and ordinary least square (OLS) regressions to build three types of models with three different dependent variables statistical method to estimate the relationships between two or more variables (Wooldridge, 2014).

Variations of probit model have been often used to study the factors determining the water treatment behaviours (e.g. Lilje et al., 2018; Fotue Totouom et al., 2012; Nauges & van den Berg, 2009; Ahmed & Sattar, 2007). Probit models are binary response models where the dependent variable can take two values, 0 and 1 (Wooldridge, 2014) (e.g. "to treat" and "not to treat" the drinking water). This model has two important advantages over the OLS models. The first advantage is that the probit models do not yield fitted probabilities outside the range of 0 and 1, while linear models do it (Wooldridge, 2014). The second advantage is that the probit model allows the partial effect of each explanatory variable to vary (Wooldridge, 2014). For instance, conversely to linear models, the probit model does not assume that acquiring primary education has the same marginal effect on people's income as acquiring tertiary education. I analyse data using STATA package.

I build three dependent variables, (1) practice HWT, (2) practice effective HWT and (3) levels of investment in HWT (see Annex 4, table A 4.2). The first two dependent variables distinguish between the households who treat ("doers") and do not treat ("non-doers") the drinking water and the third model differentiates between four level of investment in HWT tools. The dependents variables are based on the question: "*What do you usually do to the water to make it safer for drinking?*". This was a multiple-choice question, and the respondents could tick the box for "Nothing" or the boxes with different HWT methods. To generate the first dependent variable, practice HWT, I coded the response "Nothing" as 0 and 1 if the respondents reported to boil, chlorinate, filter, perform SODIS, strain and stand and settle the water. The second dependent variable, practice effective HWT, consider "doers" only the households who reported to boil, chlorinate, filter, perform SODIS (see Annex 4, table A 4.2). These two dependent variables are included in probit regressions. The third dependent variable distinguishes between the investment made in different HWT tools (see Annex 4, table A 4.2). Since this is not a dummy variable, I include it in the OLS regressions. Due to the fact that only the participants to the long survey reported about their water treatment practices, only these observations are taken into account in the regression analysis.

Following the literature review (see section 3.1), I include in the regression models the following socio-economic factors, (i) education, (ii) income, (iii) type of WS, (iv) presence of young children, (v) previous illnesses, and (vi) exposure to information about HWT (see Annex 5). The survey design does not allow to include the other identified socio-economic factors. The education variable corresponds with the declared level of education. I use the type of house as a proxy for income. The type of WS variable follows the SDGs scale (see Figure 1.1). This

WS classification has the advantage to include both, technological construction and the time needed to collect the water. The safely managed WS level of the SDG scale is excluded because of the lack of data about water contamination and its location (on-premise or not) (see section 2.1.). The observations about the respondents who have access to safely managed WS are included in the basic WS category. I use a dummy variable to incorporate the presence of children in the model. Unfortunately, the survey does not distinguish between the age of different children, therefore this dummy variable is a proxy of presence of children less than five years of age. The previous waterborne diseases variable includes the declared number of waterborne diseases cases per household. Finally, the respondents were asked whether they received any information about water treatment methods, and I considered this variable as a proxy for access to the information about HWT.

In order to identify what psychological factors are associated with the HWT practice, I build a model inspired by the RANAS model (see section 3.2.1). Unfortunately, the survey has not been designed to build an exact RANAS model. Nevertheless, there are questions that allow me to approximately measure several psychological factors of the RANAS model. Table 4.1. specifies the used questions and the methodology to construct these variables is clarified in detailed in Annex 6.

Table 4.1. shows that I exclude many factors of the RANAS model, and I set aside the entire self-regulation factors block. I justify this approach by the fact that the use of a simplified RANAS model has precedents in the literature. For instance, Daniels et al. (2019) use a highly simplified RANAS model. Besides, Daniels et al. (2019) and Lilje et al. (2018) do not include the self-regulation block in their model. These authors affirm that it is difficult to measure this block. From the risk's factors block, I measure the factual knowledge only[11]. The attitudinal factors block includes only instrumental beliefs such as beliefs about the taste of treated water and the necessity, costs and efficiency of water treatment tools. The descriptive norms and social discourse factors represent the normative factors block. Finally, action knowledge is the only factor of the ability factors block and is measured using the responses to two questions. The Annex 6 presents the justification for using the selected questions and the exact methodology to measure the psychological factors.

[11] The survey question "*Do you know how high the prevalence is of children under five dying from diarrhea (based on water aid statistics)?*" could have been useful for measuring respondents' perceived vulnerability, i.e. if they declare a high death prevalence they perceive a higher vulnerability. Nevertheless, their responses could, also, indicate how informed the respondents are, hence I decided not to use this question.

Table 4.1.: Questions and methodology to measure psychological factors

Block	RANAS factors	Questions from original questionnaire	Received values
Risk	*Factual knowledge*	Which factors influence your household's decisions TO INVEST in water treatment tools? a) Information about poor quality of WS; b) Information on relation between disease and water quality; c) Illness of household member; d) perception of poor quality of water	**0-2 scale: 0** – No; **1** – Respondent chose one of options; **2** – Respondents chose both options.
Attitude	*Taste*	a) Bad taste of water	**0-1 scale**: **0** - Respondent chose this option"; **1** - Respondent did not choose this option;
	Perceived benefits	b) Not necessary	
	Perceived cost	c) Lack of financial means	
	Perceived efficiency	d) Not efficient (does not believe the treatment works)	
Norm	*Injunctive norm*	During the last year, with whom did you discuss or share water related information regarding water services, e.g. the functionality of WS, access to WS, quality of the water, budget, management?	**0-1 scale: 0** - Reported person is from a household that doesn't treat water; **1** - The reported person is from a household that treats water;
	Social discourse	During the past 12 months, did you participate in a meeting where water functionality, quality, access or treatment were discussed?	**0- 5 scale: 0** - Never; **1** - Yes, once; **2** - Yes, several times; **3** - Once a month; **4** - Once a week; **5** -Once a day.
Ability	*Action knowledge1*	Which of these factors influence your household's decisions TO NOT INVEST in water treatment tools? Response options a) Does not know how to use it;	**0-1 scale: 0** – if respondent chose this option; **1** – if respondent did not choose this option.

4.4 Limitations of the study

This dissertation has several limitations. Firstly, it overlooks the potential of other water, sanitation and hygiene (WASH) initiatives to fight enteric illnesses in rural Tanzania. The meta-review performed by Schmidt and Cairncross (2009) suggest that, compared to HWT use, such WASH initiatives as improved water quantity access, better sanitation and handwashing promotion have a higher potential to diminish the transmission of enteric illnesses. To put forward good policy recommendations, the effectiveness of different WASH interventions should be compared and such a purpose falls beyond the scope of this study. Nevertheless, the improvement of water and sanitation access means to make the institutions managing these sectors more efficient. The second chapter demonstrates that the institutional change in Tanzania is a slow and difficult process and, in such conditions, the promotion of HWT emerges as an intermediary solution.

This dissertation represents a cross-section study therefore the causality relationship cannot be determined and, respectively, this impacts the internal validity of the study. Runnings numerous regression models has the purpose to remediate this issue. However, for having better results, additional research that uses the second round of the survey is required.

The dissertation uses data collected in only twelve villages from two districts in Morogoro region. The sample is not statistically representative of rural Tanzania and in other settings, the results may be different. This aspect diminishes the external validity of the study. Nonetheless, this dissertation provides insight into the water treatment practice and enablers in rural Tanzania and its conclusions should be viewed as preliminary.

The next limitations impact measurement validity. For instance, the data on health-related behaviour is collected through self-reporting which could introduce a lot of bias. Self-reported use of HWT proves to be lower than confirmed use (Murray et al., 2020). Based on numerous studies, Lilje and Mosler (2018) underline that self-reported data is biased through several mechanisms and self-reporting on health-related issues is, particularly, prone to socially desirable responses. However, Lilje and Mosler (2018), as well, underline that there are studies that find self-reported information on health behaviour valid and associated with real health effects.

Because the survey has not been designed to measure RANAS behavioural factors (see an example in Contzen & Mosler, 2015c), I had to approximate these factors using other questions and scales. Besides, I had to exclude several factors. However, the selected questions are close to the ones recommended to be included in a RANAS survey. Plus, the RANAS framework is a highly flexible model and its simplified version yield credible conclusions (Daniel et al., 2019). Finally, this dissertation completes the RANAS model by including the analysis of socio-economic factors.

5. The water story in rural Morogoro

5.1.Who are the respondents?

Table 5.1. presents the socio-economic characteristics of the interviewed villagers. The number of observations, from the second column, indicates the level, household or individual, of analysed characteristics. In order to interpret the mean and standard deviation from the fourth column, it is necessary to consider the values of the categorical variables indicated in the third column. If no value is indicated (e.g. age) then the analysed characteristic is a continuous variable.

Table 5.1.: Descriptive statistics: socio-economic characteristics

Socio-economic characteristics	Observations	Value, level and frequency (%)	Mean (standard deviation)
Gender	919	**1.Female**- 58.76%; **0. Male** - 41.24%	0.58 (0.49)
Age	919	**18-30** - 31.34%; **31-45** - 34.17%; **46-65**- 24.05%; **66-100** - 10.45%;	41,4 (16.30)
Education[12]	920	**1.No education** - 19.67%; **2. Some education** - 5.87%; **3. Primary** - 64.57%; **4**. **Secondary** - 9.46%; **5. Tertiary** - 0.43%	2.65 (0.91)
Children within household	430	**No children** - 9.30%; **1-3 children** - 57.21%; **4-6 children** - 28.60%; **7 and more children** - 4.88%	2.95 (2,00)
Type of house	436	**1.Permanent, cemented bricks, roof bolted** - 16.28%;**2. Permanent, baked bricks roof bolted** - 54.13%; **3. Permanent, roof not bolted** - 14.91%; **4. Semi-permanent** - 8.72%; 5. **Temporary** - 5.96%.	2,46 (1.39)
Type of main WS	436	**1.Improved** - 55.50%; **2**. **Unimproved** - 19.50%; **3. Surface water** - 25.00%.	0.55 (0.49)
Time necessary to fetch water	436	**<10 min** - 8.49%; **10-30 min** - 36.70 %; **30 min -1.5h** - 26.83%; **1,5h - 3h** - 20.41%; **>3h** - 7.57 %;	88.22 (113.08)

[12] The survey divides the education into 8 levels and houses into 7 types, (see Annex 5 for more details), for simplicity matters, though, in table XXX I compress them into less levels.

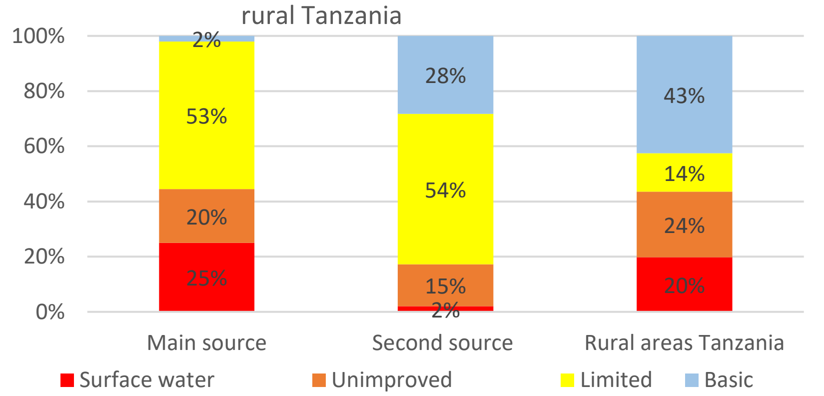
Treaters	436	**0. Non-doers**- 55.28%; 1. **Doers** - 44.72%	0.45 (0.50)
Water Borne diseases	436	**1.no cases** - 38.07%; **2.1-3 cases** - 54,59%; **3. 4-6 cases** - 6.65%; **4. 7-12 cases** - 0.69%	1.27 (1.45)
Received information about HWT	921	**0. No** - 82.74 **%; 1. Yes** - 17.26 %	0.17 (0.38)

The respondents' average age is 41.5 years, 58,78% of them were women, and almost three quarters (74.46%) have at least primary education. Only 10.3% of the households did not have any children. The research assistants indicated the respondent's type of house which serves as a proxy of households' wealth. The majority of households (54.13%) have permanent houses built with baked bricks and with a bolted roof. The remaining characteristics from table 5.1. refer specifically to the situation in the water sector and the HWT practice. The next sub-sections analyse these issues for gaining a better understanding about the studied villages and for putting forward relevant policy recommendations.

5.2. Water sector: context and challenges

The analysis of the types of WS shows that the situation in the studied villages is worse than the one at the national level in Tanzania (see figure 5.1.). 55% of households in the twelve villages use improved WS. 20% fetch water from unimproved WS, and 25% use surface water. If I, also, consider the time necessary to fetch water, as according to the SDGs scale, then only 2% of the respondents in the studied villages have at least basic access to improved WS[13] and all of them are from Vikenge (see Annex 7, figure A7.1). The access to at least basic WS is 43% in the rural areas and 57% at national level in Tanzania (see figure 5.1. and 2.1.). The analysis of WS in each village indicates that there are important differences between them (see annex 7, figure A7.2). For instance, analysing the three villages where all of the citizens were surveyed, Pangawe has the

Figure 5.1.: Drinking water coverage in studied area and rural Tanzania



[13] It is not possible to calculate how many people have access to safely managed water sources, because the data about water quality is missing.

safest WS. Around 90% of Pangawe villagers have access to limited WS. This is a good situation as 70% of interviewed citizens in Mongwe use surface water and around 80% of the population in Lugono fetch water from unimproved sources. However, as it is indicated below, the situation in Pangawe is shadowed by a limited number of WS. Figures A 7.3 and 7.4 of the Annex 7 present more details about the number and type of WS and used technologies, in eight of the twelve villages.

It does not entirely come as a surprise that the households with the lowest housing quality, lower education levels and more children have access to the lowest quality WS. The results of the OLS regression from table A2.1 of annex 2 presents such a correlation. These three socio-economic characteristics, i.e. lowest housing quality, low education and high number of children, are usually associated with poverty (Gregg & Machin, 1999). This fact confirms what has been mentioned in chapter 2, and namely that the poor people are the ones using unsafe WS more and are at higher risk of suffering from waterborne diseases.

146 households use an alternative source of water. The general picture of the second sources seems better than the one of main sources (see figure 5.1.). An OLS regression indicates that the chances to have a second WS increase if the time needed to fetch water from the main WS increases and the functionality of the main WS decreases (Annex 7, table A 7.2). At first glance, there is, also, a counterintuitive relation between the chance to have a second WS and the type of respondents' main WS (see figure 5.2. and annexe 7, table A 7.2). The chances to use an alternative WS decreases if the type of main WS is of lower quality. One may think that people with lower quality WS should find an alternative one. However, my interpretation is that people who use unsafe WS, in particular surface water, have few or no alternative WS around. Conversely, the respondents who have access to safe WS, also, have more alternatives and safe WS around. This fact, also, explains why, the general picture of alternative WS is better than the one of main sources.

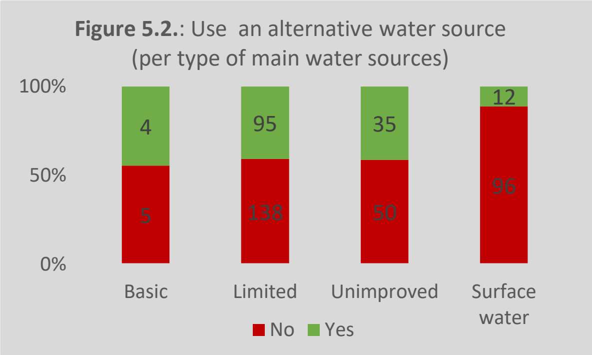


Figure 5.2.: Use an alternative water source (per type of main water sources)

The time needed to collect water is a substantial problem in these villages since the long time required for fetching water increases the chance of water contamination (Reference). Figure 5.3. presents the time needed to fetch water from the main WS (including queueing) in the villages where all citizens were interviewed and in all twelve villages[14]. 54.81% of all respondents need more than 30 minutes to fetch water and around a third of interviewed families (27.98% or 122 households) spends more than one hour and a half to fetch water. 33 households dedicate more than three hours for collecting water and all of them are in Pangawe. Analysing these 33 households, I observe that 21 of them need four hours to collect water, 13 need seven hours, and 2 dedicate ten hours (see Annex 7, figure A7.5 for more details). This is explained by the fact that in Pangawe, there are only two functional WS. A public tab is located in the centre of the village and the queue is often very long. The second one, an improved spring, is located far from the households.

FIGURE 5.3.: TIME NEEDED TO COLLECT WATER

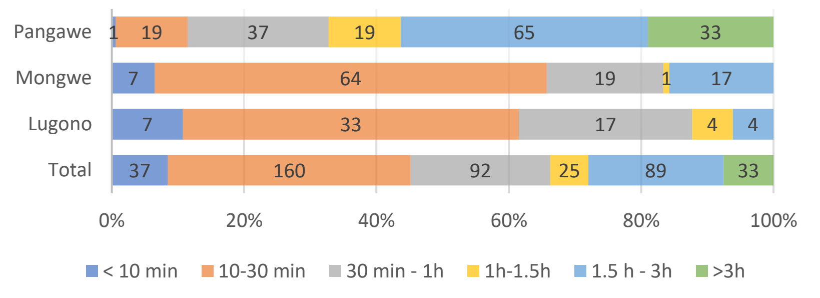


Figure 5.4.: Responsibility to fetch water

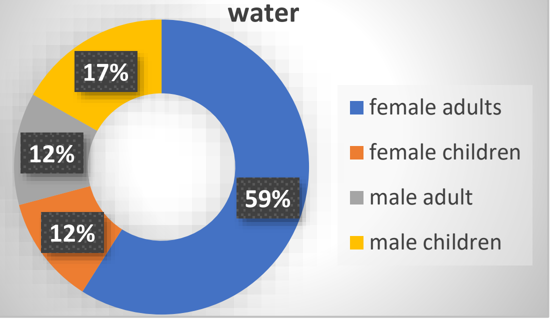
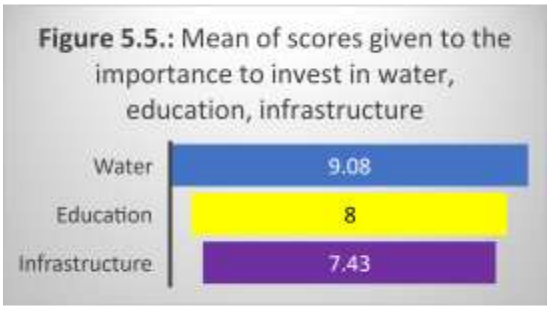
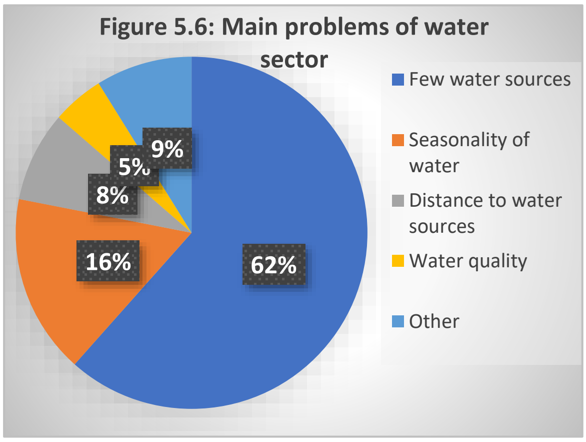


Figure 5.4. presents to whom the responsibility to fetch water is assigned within the households. Similar to the situation at the national level (see figure 2.4.) in most of the cases, the adult women hold this responsibility (59%). However, at the national level, in 89% of the cases the women and young girls are responsible for fetching water while in these twelve villages, this proportion stands at 71%. It seems like in these villages, male children more often fetch water (17%) than the averages at the national level. The Annex 7, figure A7.6provides more information about it.

[14] See Annex 7, figure 7.3 for the information referring to the other villages.



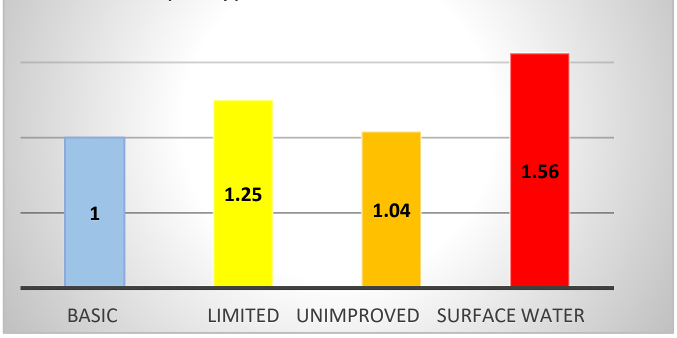
Limited access to improved WS and the long time needed to collect water make many villagers to consider the investments in the water area crucial for their wellbeing. The survey asked the people to rate, on a scale from 1 (not important) to 10 (very important), the importance of investment in water, education and infrastructure. Figure 5.5. shows that the respondents gave higher scores for the investment in water than in the other two areas. More than a half of respondents (482) considered investment in water as very important (they gave the score 10). The investment in the water area was viewed less important in Mongwe (see Annex 7, figure A7.7). This result makes sense since citizens in Mongwe need less time to collect water compared to other villages, for instance, 65% of Mongwe households need less than 30 minutes to fetch water (see Annex 7, figure 7.2).



When people were asked about the main problem in the water sector, and they were allowed to choose only one response, the limited number of WS was the main issue in all villages (see figure 5.5.). However, when people were allowed to mention more water problems, then the seasonality of water was the most mentioned issue (see Annex 7, figure A7.7). The reduced number of WS and the low functionality were specified as the other two important problems. Analysing the responses at the level of the villages shows that different villages are confronted with different problems. Unsurprisingly the limited number of WS is considered the main problem in Pangawe. The villagers in Mongwe are preoccupied by the seasonal availability of water and the villagers in Lugono are worried about the water's quality (see Annex 7, figure A7.8).

62% of respondents reported that at least one member of their household suffered from a waterborne disease[15] in the year before the survey. The households using surface water declared the highest number of disease cases in their families (see figure 5.7.). Moreover, figure 5.7. shows that the chances to suffer from a waterborne disease decreases if the WS improves. The most often reported diseases were malaria, diarrhea and typhoid (see Annex 7, figure A7.9). 39% of households (or 172) had at least one child sick of malaria, while 28% of households (or 121) had at least one adult who suffered from malaria. 75 households (or 17%) had at least one of its members suffering from diarrhea and 41 of them (or 9.4%) reported that this was a child. Finally, 65 households reported that at least one of their members suffered from typhoid of which 34 households mentioned that these were children.

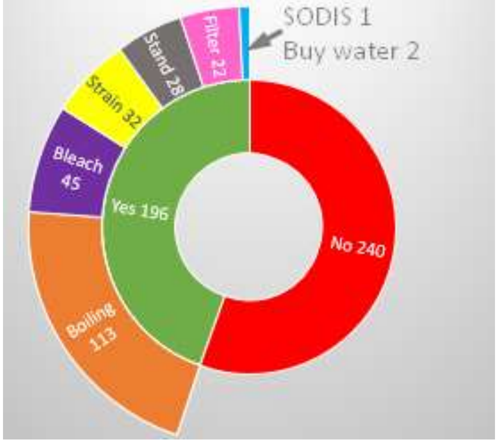
Figure 5.7.: Mean of water borne diseases cases per type of water source



5.3. Household water treatment: practice and methods

The survey reveals that only 45% of all households (i.e. 196 households) treat their drinking water (see figure 5.8.) using such methods as: (i) boiling (58%); (ii) chlorination (23%); (iii) straining and standing (17%); and (iv) filter (11%). One household uses SODIS and three other households buy bottled water. Many households use more than one HWT method. For instance, 12 households boil or chlorinate their drinking water. The Annex 8, table A8.1 provides more details about the households that combine different HWT methods.

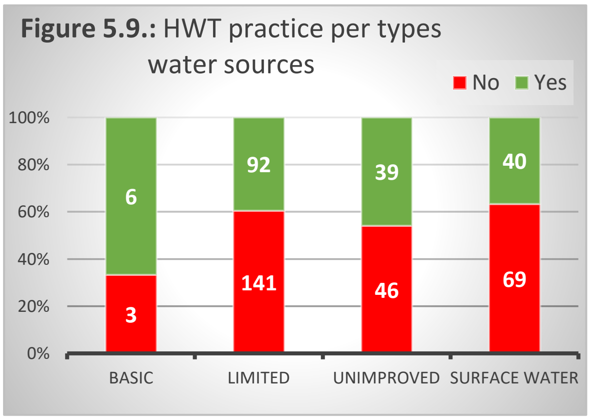
Figure 5.8.: Treatment of water and the used methods



The survey, also, reveals some differences between villages when it comes to HWT practices. From the three villages where all households were interviewed, the proportion of citizens who treat their water is the largest in Lugono and the smallest in Mongwe (see Annex 8, figure A8.1). Nevertheless, in all these three villages, boiling remains the most popular HWT method (see Annex 8, figure A8.2).

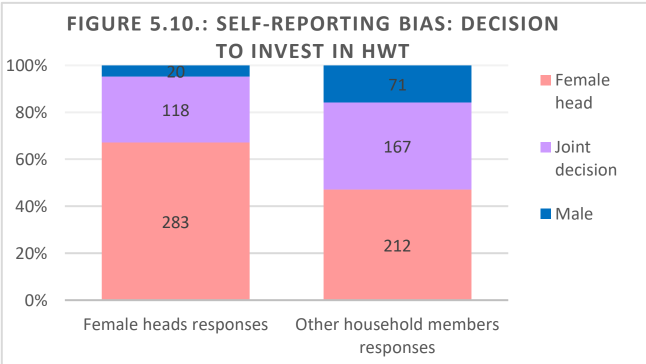
[15] The survey referred to such diseases as: diarrhea, cholera, typhoid, skin disease, eye disease, malaria, bilharzia (schistosomiasis), skeleton fluorisis and dental fluorisis.

Figure 5.9. presents the practice of effective HWT (see Annex 4, table A4.2) per types of WS.



Only 37% of villagers who use surface water treat their water compared to 46% of villagers who use unimproved WS and 40% of the villagers who collect water from limited WS. Therefore, the ones using the most unsafe source of water practice HWT the least. This situation may be linked to poverty. As it has been mentioned above, socio-economic characteristics associated with poverty are correlated with the type of WS (see Annex 7, table A7.1). As shown in figure A7.3 of Annex 7, the villages and the type of WS are associated variables in this study. For instance, 70% of citizens in Mongwe use surface water, also the villagers in Mongwe practice HWT the least.

495 of the respondents affirm that, in their households, the decision to buy water treatment tools is taken by the female spouses (see Annex 8, figure A8.3). 285 respondents say that this decision is taken jointly by the male and female spouses, and 91 respondents declare that the male heads decide about it. Nevertheless, the citizens' responses should be interpreted with



cautious because of self-reporting bias. Compared to the other members of the households, the female spouses tend to affirm more often that they take the decision about HWT investment (see figure 5.10). The analysis at the level of the villages shows that Mongwe is a particular case. 78% of respondents said that the female spouses alone decide about HWT, whilst in Lugono and Pangawe this proportion decreases to around 40%. The self-reporting bias is, also, less noticeable in Mongwe. As I observe in the section 5.2 the gender relations in Mongwe differ from the other villages and this aspect impacts how the water issues are viewed by men and women. The fact that Mongwe is a matrilineal village might explain this difference between the villages (e.g. Lugono is a mixed patrilineal-matrilieal village) (Aernout, 2019).

It is interesting to see whether the used HWT methods depends on the decision-maker within the household. Figure 5.11. presents these four levels of investment in HWT (see Annex 4) and the types of decision making. Joint decision making is visibly higher in the households that use boiling and chlorination, i.e. these households invest more in HWT tools. In the households where filters or SODIS are used, and hence invest moderately in HWT, the female-heads are mainly the decision-makers and compared to other categories, the prevalence of male-heads as the decision-makers increases too.

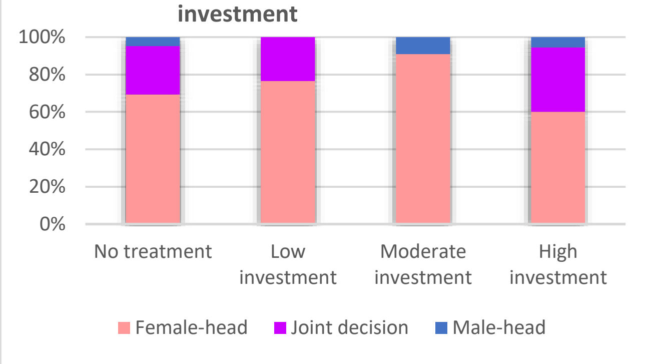


Figure 5.11. : Decision maker and HWT investment

The respondents have been, also, asked about the reasons for not investing in HWT tools and figure 5.12 presents their responses. Lack of time was the most often mentioned reason (246) followed by the view that treating water is not necessary (150) and the lack of availability of HWT tools (106).

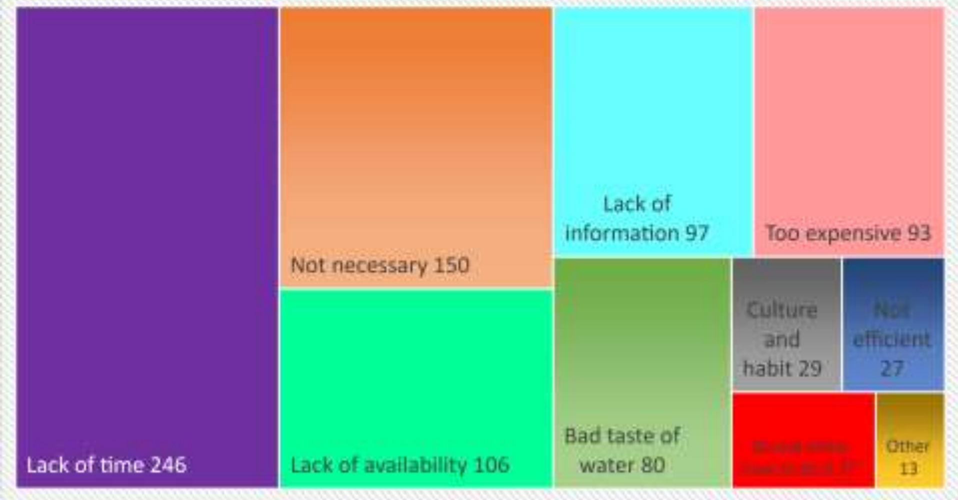


Figure 5.12: Reasons for not investing in HWT tools

The people from different villages and with access to different types of WS view the reasons not to invest in HWT tools differently (see Annex 8, figures A8.4, A8.5). For example, the villagers from Pangawe and the ones with access to improved WS responded more often that treating water is not necessary than the citizens from other villages and with access to different WS (see figure A8.4 of Annex 8). As mentioned above, the villages and the type of WS are associated variables in this study. Therefore, it is hard to say whether there is a link between the reasons not to invest in HWT and the village, or the reasons not to invest in HWT and the WS. Intuitively, the people's reasons about non-necessity of water treatment tool investment are rather influenced by the views and interactions among community's members in a village than by the type of used WS.

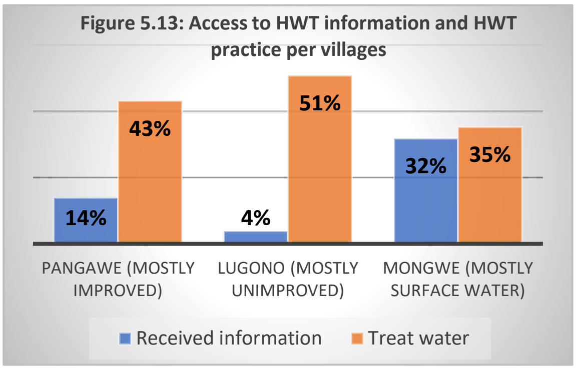


Figure 5.13: Access to HWT information and HWT practice per villages

The survey results indicate that the respondents have limited access to HWT information. Only 17.3% of 921 respondents declared that they received such kind of information during the year before the survey and most of them are from Mongwe (see figure 5.13). 32% of Mongwe villagers received information about HWT (see figures XXX). Despite being more informed, Mongwe citizens treat water less than the citizens in other villages (see figures 5.13). This aspect is paradoxical because in Mongwe, most of the citizens have access to surface water, thus, they are more at risk, and HWT practice is essential for their health and wellbeing.

I also checked who exactly received information about HWT and how it was used. I find that more males (20%) than female (16%) were informed about HWT (see figure 8, Annex 6.6). Moreover, only 15% of the female spouses said that they received such information. Considering that usually the decision about investing in water treatment tools is taken by the female spouses or jointly, the audience targeting strategy for providing information about water treatment is deficient in the region. Besides, it is more efficient to target female spouses. 65% of female spouses who received information about HWT reported that this information positively changed their behaviour in water treatment while only 42% of informed males reported such a change (see figure 5.14).

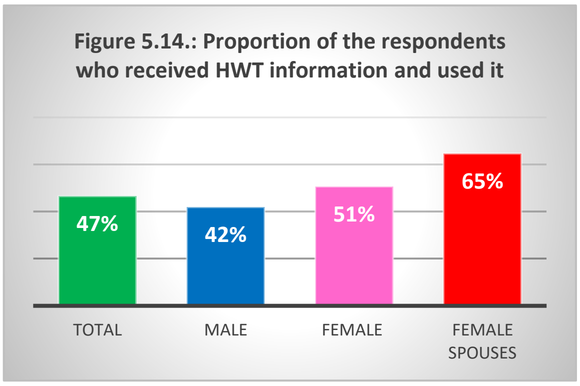


Figure 5.14.: Proportion of the respondents who received HWT information and used it

5.4. In the minds of the respondents

In this section, I analyse the psychological factors relying on the RANAS model and following the methodology described in section 4.5. Table 5.2. presents the descriptive statistics of the psychological factors and it is structured similarly to the table 5.1.

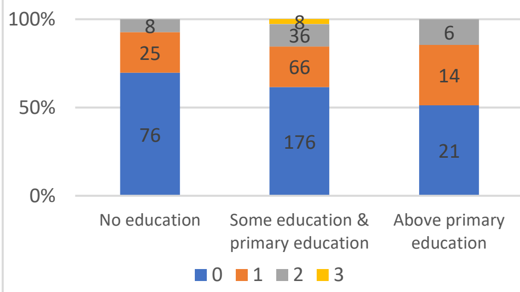
The descriptive statistics show that the respondents have reduced factual knowledge about the HWT. 62.6% of the respondents did not consider that the illness of a household member or the perceptions and information about poor water

Table 5.2.: Descriptive statistics of psychological factors based on RANAS model

Factor block	RANAS factors	Observations	Value, level and frequency	Mean (standard deviation)
Risk	**Factual knowledge**	436	**0** – 62.6%; **1** - 24%; **2** – 11.5%; **3** – 1.9%;	0.53 (0.77)
Attitude	**Taste**	921	**0** - 12%; **1**- 88%;	0.88 (0.33)
	Perceived benefits	921	**0** - 20%; **1**- 80%;	0.8 (0.4)
	Perceived cost	921	**0** - 26%; **1** - 73%;	0.73 (0.44)
	Perceived necessity	921	**0** - 6.4%; **1** - 93.6%;	0.94 (0.25)
Norm	**Descriptive norm**	564	**0** - 56%; **1** - 44%;	0.44 (0.5)
	Social discourse	919	**0** - 56%; **1** -19%; **2** - 24.35%; **3-4** - 0.65%;	1.69 (0.86)
Ability	**Action knowledge**	921	**0** - 4%; **1**- 96%;	0.96 (0.19)

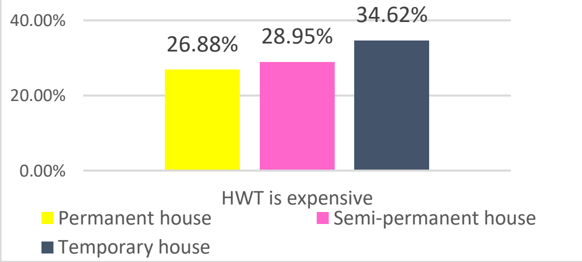
quality, and the relation between disease and water quality are good reasons for investing in HWT tools. As it was expected, the education level is positively correlated with the factual knowledge scores (see figure 5.15).

Figure 5.15.: Education and factual knowledge factor

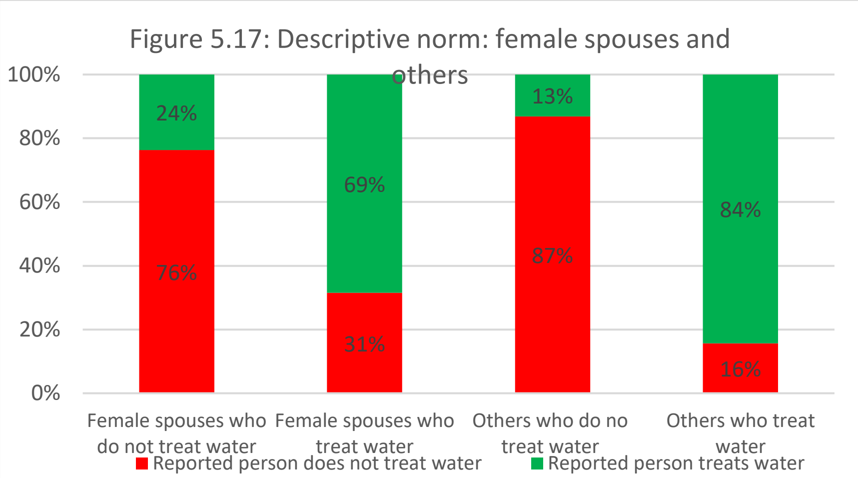


The majority of respondents have a positive attitude towards treating water. Most of the respondents did not consider the taste of treated water and the lack of financial means as good reasons for not investing in water. However, slightly more men (13%) consider that taste could be a reason for not treating water than women (12%). Conversely, slightly more women (28%) view the cost of water treatment tools as a reason for not investing in HWT than men (25%). The cost is important for people with lower incomes. For instance, the respondents living in worse houses ticked more often the "expensive" box as a factor influencing the decision to invest in HWT (see figure 5.16).

Figure 5.16.: Perceived cost and the house type



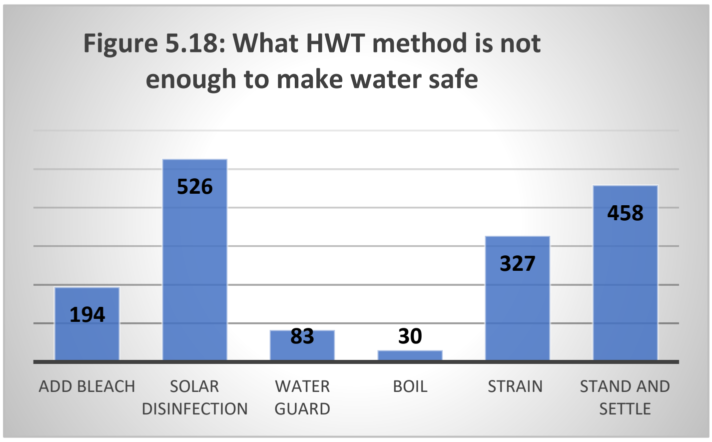
As the table 5.2. shows, most of the respondents do not see the HWT tools inefficient or unnecessary. 10% of women and 27.5% of female spouses consider the water treatment tools inefficient, whilst only 1.3% of men share this opinion. Interestingly, these results are mostly yielded by the Mongwe respondents' opinions. If Mongwe is excluded, only 5% of women and 0% of men view HWT inefficient. 4.5% of men, 27.7% of women and 31.5% female spouses in Mongwe consider the HWT inefficient. This is an interesting situation since Mongwe is the village with the highest percentage of the population that do not treat their water and who received information about HWT (see figure 5.13).



The descriptive norm factor indicates whether the persons whom the respondents discuss with about water issues are from households that practice HWT. The survey results suggest that 56% of respondents communicate with people who do not treat their water (table 5.2). Moreover, people tend to discuss water issues with the ones who have the same HWT behaviour. This fact was also confirmed by Daens (2019) in her analysis of Lugono village. On one hand, 75% of respondents from households that treat water reported to communicate with a person who treats water. Disaggregating the data, I find that the proportion drops to 69% in the case of female spouses and increases to 84% in the case of all other respondents (see figure 5.17.). On the other hand, 24% of the female who do not treat the water communicates with persons who treat water and in the case of other respondents, this proportion decreases to 13%. This point may suggest that the female spouses' network is more diverse than the one of the other respondents.

56% of respondents do not participate in meetings where the water issues are discussed. 19% of interviewed persons participated in such meetings just once, while 24% of them did it several times. Women participate less in such meetings than men. For instance, 65% of women said that they have never participated in meetings where water issues are discussed while 44% of men declared the same (see figure 5.18). Approximately, the same rate of participation is observed in all villages. In Mongwe, though, more people (64%) said that they had never participated in a meeting about water (see Annex 8, figure A8.7). This proportion is 51% in Lugono and 53% in Pangawe. Nevertheless, also more people in Mongwe (29%) said that they participated once in such a gathering than the citizens in Lugono (18%) and Pangwe (13%).

The positive aspect is that the respondents have good knowledge about how to treat the water. Only 4% of respondents declared that they do not invest in HWT because they do not know how to do it. Slightly more villagers in Mongwe (5%) reported that they do not know how to use HWT than in Lugono (3%) and Pangawe (4%). Additionally, the checkbox about not knowing how to treat the water was ticked more often by the respondents who live in semi-permanent (9%) and temporary houses (8%). Only 2% of the respondents who live in permanent houses did the same.



Finally, 25% of respondents chose wrong HWT methods as insufficient methods for treating the contaminated water. 526 respondents consider that SODIS is insufficient (see figure 5.19). This high number of sceptical respondents confirms what has been observed in the literature (Morse et al., 2020). However, SODIS is one of the HWT technologies that has been approved in the International Scheme to Evaluate HWTS technologies, and this method proved to reduce childhood dysentery by 45% (Morse et al., 2020). 194 respondents share the same sceptical view about adding bleach, however, only 83 respondents think the same about waterguard which is in fact, the same method as chlorination. The fact that only 30 interviewed persons consider boiling insufficient explains why boiling is the most popular HWT in these villages (see figure 5.19), although, this method is relatively expensive (it requires fuel and decreases the volume of water) (Anderson et al., 2010).

6. Findings and analysis

This chapter presents the results of the regression analysis. It is important to underline that several variables included in the models are based on the long surveys filled only by the female spouses. Therefore, the findings of these models can be extrapolated only to the female spouses. It has been noted above that the decision to invest in HWT tools is often taken by the female spouse or jointly, hence I can rely on these findings to put forward several policy proposals to promote HWT practice.

6.1. The models of socio-economic factors

Before running the regression models, I checked the correlations between the independent variables, and they are weakly correlated. The relationship between exposure to HWT promotional activities and type of WS displays the highest pairwise correlation coefficient (0.29). This positive relation confirms what has been said in the previous chapter. Most of respondents who received water treatment information were from Mongwe and they use surface WS. The correlations between the other variables were lower than 0.2.

Table 6.1.: Regressions results: socio-economic factors

Variables	(1)	(2)	(3)
	Probit		OLS
	Practice HWT	Practice effective HWT	Level of investment in HWT
Education	0.1482**	0.1790***	0.1725***
	(0.0604)	(0.0615)	(0.0614)
House type	0.0260	0.0534	0.0413
	(0.0424)	(0.0445)	(0.0428)
WS type	0.0400	0.1411	0.1228
	(0.1433)	(0.1456)	(0.1511)
Presence of children	-0.0904	-0.0505	-0.0390
	(0.2267)	(0.2343)	(0.2321)
Exposure to HWT information	0.1878	0.3841**	0.2982
	(0.1963)	(0.1957)	(0.1999)
Water Borne diseases	0.0580	0.0142	0.0184
	(0.0471)	(0.0459)	(0.0473)
Observations	423	423	430
R-squared (pseudo)	(0.0703)	(0.0639)	0.0935
Standard errors in parentheses			
***** p<0.01, ** p<0.05, * p<0.1**			

Table 6.1. presents the results of three regression models[16]. Section 4.3 and Annexes 4 and 5 clarify the differences between the models and the methodology to construct the used variables.

As a large part of the literature says (see section 3.1) better WS, higher levels of education, income (better houses) and exposure to HWT information are positively correlated with a higher probability to treat the drinking water. The presence of children is associated with a decrease in the probability to treat the drinking water. This fact is counterintuitive and with no evidence in the literature. The presence of children may also hint towards larger households

[16] I, also, controlled for villages, but to avoid bulky tables, I present here the table without the villages (see Annex 9).

which is found to be negatively correlated with the HWT practice (Akram, 2020; Lilje et al., 2015). The probability that households treat water increases if any of its members suffered from a waterborne disease.

Education is the only variable that yields statistically significant coefficients in all regression equations. The education's p-value is 0.014 in the first equation, 0.004 in the second one and 0.005 in the third equation. In addition, the relation between the dependent variable and the education is robust, the inclusion or exclusion of other dependent variables did not significantly change its coefficients and significance level. The OLS model predicts that holding all independent variables fixed, acquiring the next level of education is associated with 0.173 increase in the level of investment in water treatment.

The exposure to information about HWT follows education. Its p-value is 0.339 in the first equation and 0.050 and 0.137 in the second and third equations. This means that once I consider only the efficient HWT method and I differentiate between the investment in HWT, this variable gain statistical significance. According to the OLS model, if the level of exposure to HWT information changes from not receiving information to receiving information and all other variables are held fixed, then this change is associated with 0.358 increase of the level of investment in water treatment.

Table 6.2.: Predicted probability to treat water effectively of different levels of education and exposure to information

Education levels	Coefficient (standard error)	p-values
No formal education	0.272*** (0.044)	0.000
Primary education (not graduated)	0.230** (0.101)	0.023
Primary education	0.370*** (0.030)	0.000
Secondary education (not graduated)	0.317** (0.151)	0.036
Secondary education	0.560*** (0.097)	0.000
Some post-secondary education (not university)	0.698** (0.243)	0.004
Did not received information about HWT	0.331*** (0.025	0.000
Received information about HWT	0.484*** (0.067)	0.000

*** p<0.01, ** p<0.05, * p<0.1

The interpretation of coefficients is the most difficult aspect of the probit models (Wooldridge, 2014; Ahmed & Sattar, 2007) and I use Stata's margins command to do it. I calculate the predicted probabilities of HWT use at each level of education and exposure to HWT information, holding all of the other independent variables at their means. Table 6.2 presents the obtained results for second probit model (see Annex 10 for the predicted probability of the first model). If the female spouse has no formal education, then the probability to treat water using effective methods is 0.272 and it decreases to 0.230 for those who have some primary education.

This strange finding has no clear explanation, apart from the fact that there are few observations. There are 12 households where the female households have some level of primary education and do not treat water. Four of them have limited access to WS and the rest to unimproved and surface water; and interestingly, six of these households are from Mongwe. The probability to treat water is 0.370 if the female spouse has the primary level of education and decreases to 0.317 if the female spouse has some level of secondary education. This fact could be explained by access to better WS. The probabilities to treat water is 0.560 for the households headed by a female with secondary education and 0.698 if the female spouse has some post-secondary education. Finally, if the female spouse said that she did not receive any information about HWT, then the probability to treat water is 0.331 and increases to 0.484 in the opposite case.

Finally, these models do not explain very much the behaviour to treat the water. The interpretation of pseudo R-squared generated by probit is not very useful. Pseudo-R-squared tells that these regressions are better than the intercept model without predictors. Conversely, the R-squared of OLS is more useful. It suggests that the model explains only 9.35% of the variation in the investment to treat water. This fact indicate that many important explanatory variables are left aside. The next section presents the regression analysis of the psychological factors following the RANAS frameworks and these models prove to have higher explanatory power.

Table 6.3.: Regressions results: psychological factors

	(1)	(2)	(3)
	Probit		OLS
Variables	Practice HWT	Practice effective HWT	Level of investment in HWT
Factual Knowledge	1.7050***	1.1294***	1.0390***
	(0.2249)	(0.1568)	(0.0970)
Perceived necessity	0.5589*	0.5731*	0.3799**
	(0.2863)	(0.2928)	(0.1691)
Perceived taste	-0.0617	0.3435	0.2277
	(0.3681)	(0.3740)	(0.2195)
Perceived cost	0.1462	0.1132	0.0594
	(0.2537)	(0.2368)	(0.1472)
Perceived benefits	-0.0904	0.2742	0.1050
	(0.3565)	(0.3683)	(0.2135)
Social discourse	0.1005	-0.0976	-0.0456
	(0.1470)	(0.1388)	(0.0900)
Action Knowledge	-0.3352	-0.4258	-0.2912
	(0.6423)	(0.5806)	(0.3670)
Descriptive Norm	1.0066***	0.7396***	0.5891***
	(0.2145)	(0.2050)	(0.1358)
Lugono	-0.4101	-0.5485*	-
	(0.3270)	(0.2945)	
Mongwe	-0.9060***	-0.4480*	-0.0937
	(0.3043)	(0.2708)	(0.1925)
Pangawe	-	-	0.2277
			(0.1765)
Observations	255	255	255
R-squared (pseudo)	0.4717	0.3630	0.4718
Standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

6.2.The models of psychological factors

Computing the pairwise correlation between the analysed psychological factors shows that they are weakly correlated. Although, as it is clarified below, the factors with the highest statistical significance in the model display the highest correlation coefficients, as well. For instance, the pairwise correlation coefficient between factual knowledge and the injunctive norm is 0.31 and between factual knowledge and perceived necessity is 0.23. Nevertheless, these are low coefficients to suspect the presence of multicollinearity in the model.

Similar to table 6.1., table 6.3 shows the regression results of the three psychological factors' model inspired by RANAS (see section 4.3 and Annexes 4 and 6). Unfortunately, the missing responses and the limited data to identify whether the respondents are communicating with people who treat or who do not treat the water results in only 255 observations included in the regressions. Descriptive norm variable could be constructed only for three villages so, I do not control for other villages. Looking to pseudo- and R-squared, the explanatory power of the psychological factors is much higher than the one of socio-economic factors. For instance, the R-squared of the OLS model is 0.4718 which means that the model explains only 47.18% of the variation in the investment to treat water. This evidence confirms the title of this dissertation that changing people minds have a stronger impact on their health and wellbeing.

Action knowledge and social discourse (except the first regression) are the only variable negatively associated with the behaviour to treat the water. Additionally, the coefficients of perceived costs and taste may turn to negative, but they are not robust. The variables with statistically significant coefficients are factual knowledge, perceived necessity and descriptive norm and I analyse them in more details below.

The OLS model predicts that holding all independent variables fixed if the female spouse increases her factual knowledge with one level this translates in a transition to the next level of investment in HWT. If the respondent starts to consider the HWT necessary, then the level of investment in HWT increases with 0.38. If the female spouse starts to communicate with somebody who treats water, then the level of investment in HWT increases with 0.59. I use, once again, the STATA's margins command to interpret the probit models and predicted probabilities of these three factors.

Table 6.4.: Predicted probability to treat water at different levels of factual knowledge, perceived necessity and descriptive norm

Variable	Levels	Coefficient (standard error)	p-values
Factual knowledge	Level 0	0.157*** (0.032)	0.000
	Level 1	0.857*** (0.054)	0.000
	Level 2	0.936*** (0.060)	0.000
Perceived necessity	HWT is not necessary	0.263** (0.084)	0.002
	HWT is necessary	0.470*** (0.049)	0.000
Descriptive norm	Communicates with person who doesn't treat	0.271*** (0.048)	0.000
	Communicates with person who treats water	0.654*** (0.059)	0.000

*** p<0.01, ** p<0.05, * p<0.1

The predicted probabilities to practice HWT of the first probit model, at different levels of factual knowledge, perceived necessity and descriptive norm, holding all of the other variables fixed, are shown in table 6.4. The probability to treat water is only 0.157 if the female spouse demonstrates weak factual knowledge and increases to 0.857 if she accumulates the second level of factual knowledge. The third level of factual knowledge misses because the descriptive norm variable reduced the number of observations to 255. The female spouses who have the level 3 of factual knowledge are in the omitted observations. The predicted probability to treat water is 0.47 if the persons consider the necessity to treat water as a good reason to invest in HWT. The predicted probability to treat water decreases to 0.263 if the persons have the opposite opinion. The predicted probability to treat water is 0.654 if the female spouse communicates about water issues with somebody who treats the water, in the opposite case, the predicted probability decreases to 0.271.

Table 6.5.: Regressions results: socio-economic and psychological factors

	(1)	(2)	(3)
Variables	Probit		OLS
	Practice HWT	Practice effective HWT	Level of investment in HWT
Education	0.1333	0.2153**	0.1053*
	(0.1068)	(0.1022)	(0.0582)
House type	-0.0625	-0.0674	-0.0578
	(0.0722)	(0.0729)	(0.0424)
WS type	0.3104	0.4789**	0.3409***
	(0.2197)	(0.2222)	(0.1279)
Presence of children	-0.1475	-0.0924	-0.1220
	(0.3602)	(0.3812)	(0.2200)
Exposure to HWT information	0.1037	0.0455	-0.0075
	(0.3820)	(0.3523)	(0.1959)
Water Borne diseases	0.0647	0.0804	0.0343
	(0.0864)	(0.0836)	(0.0481)
Factual Knowledge	1.6743***	1.1289***	1.0217***
	(0.2335)	(0.1639)	(0.0968)
Perceived necessity	0.5980**	0.6687**	0.4187**
	(0.3015)	(0.3220)	(0.1706)
Perceived taste	-0.0770	0.2984	0.2299
	(0.3708)	(0.3860)	(0.2177)
Perceived cost	0.2510	0.2187	0.1290
	(0.2684)	(0.2572)	(0.1479)
Perceived benefits	-0.0614	0.4077	0.2278
	(0.3799)	(0.4147)	(0.2219)
Social discourse	0.1323	-0.0626	-0.0226
	(0.1557)	(0.1498)	(0.0923)
Descriptive Norm	0.9929***	0.7361***	0.5396***
	(0.2210)	(0.2158)	(0.1355)
Action Knowledge	-0.2824	-0.3748	-0.2247
	(0.6645)	(0.6157)	(0.3627)
Lugono	-0.1556	-0.1222	-0.1752
	(0.3594)	(0.3417)	(0.2333)
Mongwe	-0.4915	0.2529	-
	(0.4611)	(0.4409)	
Pangawe	-	-	-0.2170
			(0.2587)
Observations	251	251	251
R-squared (pseudo)	0.4825	0.4021	0.4986
Standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

6.3. The models of socio-economic and psychological factors

Table 6.5. presents the results of three regression models that combine the socio-economic and psychological factors. The R-squared of the OLS model is 0,49 hence, the inclusion of socio-economic variables adds only 2% to the explanation of the variation in the investment to treat water. None of the socio-economic factors produces statistically significant coefficients in the first probit model. Conversely, the education and, surprisingly, the type of WS have statistically significant coefficients[17] in

[17] Although, there are studied in the literature that found positive relationship between type of WS and behavior to treat water.

the models where I consider as "doers" only the households who practice effective HWT methods (second model) and I differentiate between the investment in water treatment (third model). In these two models, the type of WS gains its statistical significance once I control for factual knowledge. Interestingly, the coefficients of income proxy variable (house type) are negative and the literature review did not identify such evidence (see section 3.1.). Regarding the psychological factors, the situation does not change. Factual knowledge, perceived necessity and descriptive norm continue to have statistically significant coefficients in all three models.

The OLS model predicts that holding all other independent variables fixed, graduating the next level of education translates in a 0.1 increase in the level of investment, while the improvement of WS to the next category results in 0.3 increase in the level of investment in HWT. The psychological factors are stronger correlated with the level of investment in HWT. The improvement of the factual knowledge with one level is associated with the advancement to the next level of investment in HWT. The increase with around half a level of investment in HWT results if the female spouse considers the behaviour to practice HWT a necessity (0.4) or starts to discuss the water issue with somebody who treats water (0.5).

Table 6.6.: Predicted probability to treat water effectively at different levels of the statistically significant variables

Variable	Levels	Coefficient (standard error)
Education	No formal education	0,176**
	Primary education (not graduated)	0.058
	Primary education	0.258***
	Secondary education (not graduated)	0.09
	Secondary education	0.581***
Type of WS	Surface water	0.068
	Unimproved	0.328***
	Limited	0.286***
	Basic	0.877***
Factual knowledge	Level 0	0.065***
	Level 1	0.786***
	Level 2	0.544***
Perceived necessity	HWT is not necessary	0.109**
	HWT is necessary	0.287***
Descriptive norm	Communicates with non-"doers"	0.157***
	Communicates with person who treats water	0.394***

*** p<0.01, ** p<0.05, * p<0.1

Table 6.6. shows the results of the predicted probabilities of the variables with significant coefficients of the second probit model. The education and water source demonstrate strange probabilities. For instance, the predicted probability to treat water is 0.176 if the female spouse has no level of education and decreases to 0.058 if she has some primary education, it increases to 0.258 if the female spouse has primary education and after it decreases to 0.09. Similar ups and downs are observed in values of predicted probability of the other variables. There are several potential explanations. The first one is the reduced

number of observations, in particular for certain categories such as the female spouses with some secondary education or the ones with access to basic WS. The second explanation is that important variables are omitted. Many of the RANAS-model variables are not included because of the lack of data. Additionally, the omission of important variables might clarify why the source of water variable becomes significant. The third explanation is that the model requires more important adjustments than inclusion of additional variables. The reduced explanatory power added by combining these two groups of factors, the lack of robustness of socio-economic factors and turning to negative of variables that have never been found to be negative in literature (house type) hit towards the second explanation. Following Nauges and Berg (2009) and Daniel et al. (2019), I suggest that the socio-economic factors might be mediating factors that impact the decision to treat water through the psychological factors. These observations open the avenue for future research that requires other methods and more observations.

6.4 . Discussion and policy recommendations

I run multiple probits and OLS models to identify the factors associated with the HWT practice in three villages in Tanzania. The models of socio-economic factors suggest that education and exposure to HWT information are potential enablers of water treatment behaviour. However, these models demonstrate reduced explanatory power. The models of psychological factors have a much better explanatory power that indicate factual knowledge, perceived necessity and descriptive norm as enablers of HWT practice. The literature review confirms that these factors are important in explaining the HWT practice (see table3.2.).

The three identified psychological factors maintain the statistical significance of their coefficients in the models combining both groups of factors, socio-economic and psychological. The education and, surprisingly, the type of WS yield statistically significant coefficients in two of these models, however, these variables are not as robust as the psychological factors. Additionally, the models combining both groups of factors do not improve significantly the explanatory power compared to the one offered by the psychological factors only. The coefficients of the income proxy, the type of house, turn negative, and there is no such evidence in the literature. Finally, the predicted probability of several variables of the last probit model proved to be counterintuitive. These aspects point towards the limited number of observations or the need to adjust the models with both groups of factors. The models might be adjusted by including additional explanatory variables or by modifying the assumption about the causal linkages between the socio-economic and psychological factors. More precisely, I refer to assuming that the socio-economic factors impact the behaviour to treat water through the psychological factors. In such a context, one may hypothesize that education and, potentially, exposure to HWT information impact the water treatment practice through factual knowledge and perceived necessity. In addition, education may influence the HWT practice through the descriptive norm. Dewacher et al. (2018) show that in Uganda women share water information along educational lines. Regarding the type of WS, there is needed more research for clarifying the linkages between this variable and the behaviour to treat water.

The fact that education, factual knowledge, perceived necessity and, potentially, access to HWT information are identified as enablers of water treatment behaviour suggest that information and capacity to understand it correctly are crucial. With the other words, what is in the people’s minds matters. In spite of this finding, chapter five demonstrates that women and female spouses are constantly being excluded from access to water information, however, the decision to treat water is taken by them or jointly with their male spouses. Mongwe, a matrilineal village, is not an exception and the consequences impact negatively people’s lives. More women in Mongwe consider water treatment tools inefficient and unnecessary than elsewhere. As result, Mongwe is the village with access to highly unsafe WS and treats water the least. Moreover, providing information to women proved to be more efficient than to men. 65% of women who received HWT information said that the information impacted positively their water treatment practices. In the studied village, the women who treat water communicate more often with the “non-doers”. Therefore, the promotion of HWT through information interventions targeting women may also extend by triggering the descriptive norm path.

Besides the identification of HWT enablers, this chapter aims to put forward several interventions to promote HWT uptake. Considering that factors of risk, attitude and norms blocks proved to be statistically significant, I propose a combination of information and normative interventions with elements of persuasion, targeting the women. In addition to HWT promotion the campaign may contribute to women’s empowerment. The removal of waterborne diseases burden will give women more time to dedicate to other activities and involve in the community’s life. Additionally, stressing women’s role may encourage the community to engage women more often in water sector decision making at local level.

The focus of the information campaigns should be on the linkages between consuming contaminated water and water-borne diseases (Mosler, 2012) and about other circumstances of contracting these diseases. This fact will help women to better understand the risks. The normative part of the interventions should show that there are people already performing HWT and present their experiences highly positive. The messages may be released by credible and highly respected persons within the community as Ochaney (2018) recommends, as well. It is important to adjust the information depending on the education level and to put additional effort delivering the information to communities that use surface water.

In order to ensure that the success of these campaigns, the people need more information about how to correctly perform water treatment. Plus, I propose to promote cheaper and more accessible HWT methods in the villages. For instance, the respondents have misconceptions about SODIS effectiveness, and they practice more boiling and chlorination. However, SODIS is an effective method that is cheaper than boiling and chlorination. The fact that SODIS is less easy to be used can be remediated by combining it with other HWT methods. Least but not last, the campaigns promoting HWT should go hand in hand with the campaign promoting other WASH behaviours.

7. Conclusion

The waterborne disease is an important problem in Tanzania that hits heavily the villagers and vulnerable groups. The ineffective water institutions and policies are at the core of this problem and the institutional change requires favourable conjunctures, time and resources. In such a context, the HWT emerges as an intermediary solution for limiting the exposure to waterborne diseases.

In order to identify the potential enablers of HWT, I perform an extensive literature review. The previous studies suggest that at the individual and household level, two groups of factors, socio-economic and psychological, are capable to trigger the HWT uptake. I use data collected as part of the Fuatilia Maji project in twelve villages in rural Morogoro, Tanzania and I run multiple probit and OLS models. This dissertation finds that three psychological factors, factual knowledge, perceived necessity and descriptive norm are strongly correlated with the behaviour to treat water. Education, exposure to information about HWT and type of water source are the socio-economic factors associated with water treatment practice. However, these three socio-economic factors demonstrate reduced explanatory power while exposure to information about HWT and type of water source do not prove to be robust. This aspect hits to the fact that socio-economic variables are mediating factors that influence the HWT behaviour through the psychological factors. Although, for confirming this hypothesis additional research is needed.

Based on the dissertation findings, I propose a combination of information and normative interventions with elements of persuasion, targeting the women. Apart from reducing the incidence of waterborne diseases, these interventions have the potential to empower women and encourage them to be more involved in the community's life.

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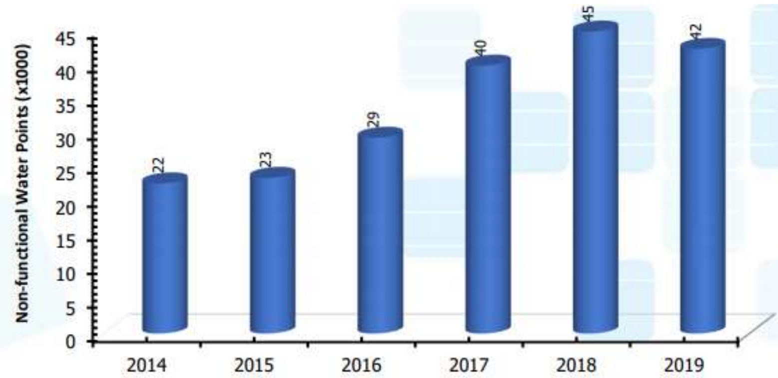
Annexes

Annex 1: Non-functional water sources in Tanzania

Figure A 1.1: Cumulative Number of non-functioning Water Points



Source: MoW, 2020:72

Figure A 1.2: Rate of functional and non-functional water points

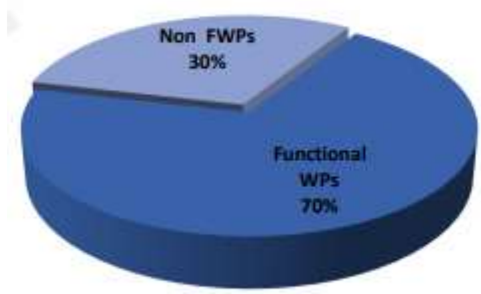
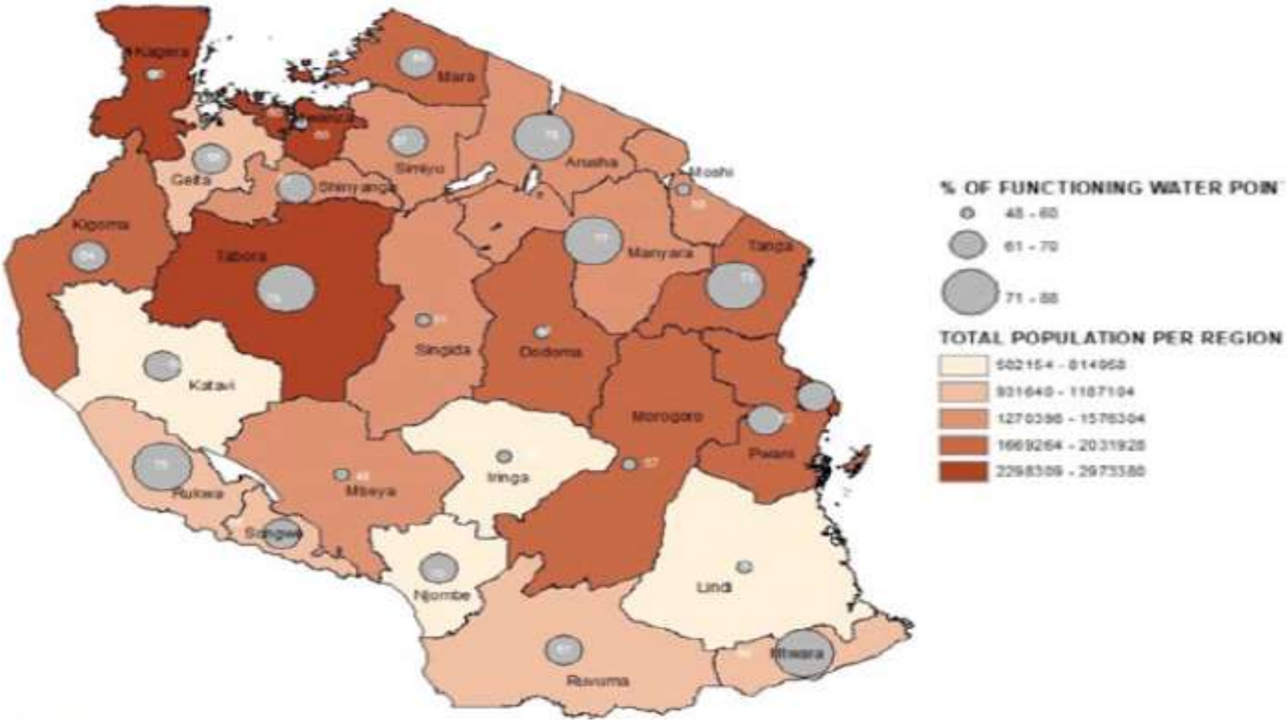


Figure A 1.3: Rate of functional rural water points per region in Tanzania



Source: Origa et al., 2020:17

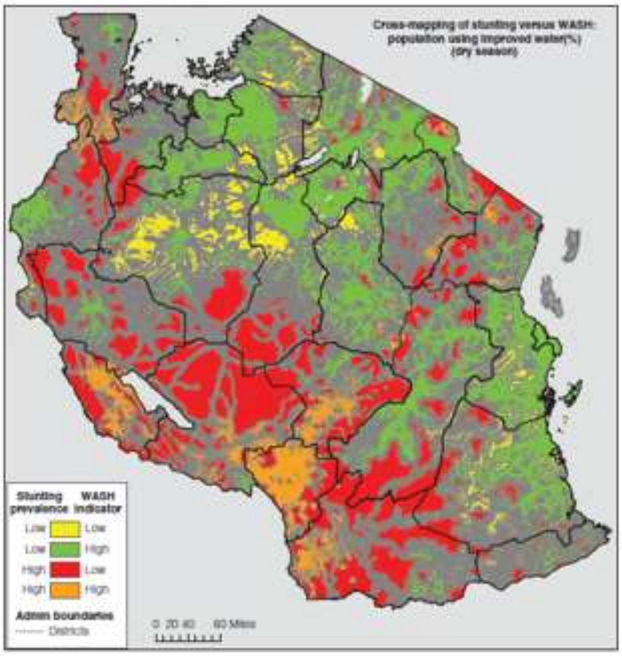
Annex 2: Impact of unsafe water on vulnerable people

Info Box 2.1.: Impact of unsafe water on HIV/AIDS positive persons and children

Unsafe water is particularly risky for people suffering from human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS). HIV/AIDS positive persons are immunocompromised and more susceptible to enteric illnesses (Workman, 2019). Moreover, diarrhoea reduces the effectiveness of antiretroviral treatment and can lead to drug resistance (World Bank, 2018). In Tanzania, the national average of HIV/AIDS prevalence was 4.8% of population ages 15-49 (Word Bank Data Bank, n.d.). However, in southwestern Njombe and Iringa regions, HIV prevalence attains 21 % (World Bank, 2018:69) hence the population in these regions is highly exposed. Moreover, once again, the women are more at risks since, as a result of gender-based violence, they are more likely to suffer from HIV. In 2019 the women's share of population living with HIV in Tanzania was 61% (Word Bank Data Bank, n.d.).

Apart from increasing the child mortality, poor WASH has grave consequences on healthy childhood. It reduces the children's dietary intake and increases the risks of diseases (World Bank, 2018). These two factors are immediate causes of stunted growth which limits children's chance to reach their full physical and cognitive potential. In the last decades, Tanzania registered important progress in fighting stunting, in 1990 stunting prevalence among children under five was 50% (MoHCDGEC et al., 2019:1) and it reduced to 32% in 2018 (MoHCDGEC et al., 2019:xii) Still, stunted growth remains a big problem in Tanzania, as these 32% of stunted children represents, 3 million children of which 1 million suffer of severe stunting (MoHCDGEC et al., 2019:xii). Indeed, Tanzania is the third country with the highest population of stunted children in Sub Saharan Africa (World Bank, 2018). The link between stunted growth and WASH has been well established (World Bank, 2018). Figure XYX shows the overlap between stunting and water coverage. The dominance of red (regions with high prevalence of stunting and limited access to improved water sources) and green (regions with low prevalence of stunting and high access to improved water sources) spots on the map show the correlation between stunting and access to safe water.

Figure 2.5.: Cross mapping of stunting versus population using improved water (%), dry season



Source: World Bank, 2019:75

Annex 3: IBM-Wash framework

Table A.3: IBM-Wash framework

Levels	Contextual dimension	Psychological dimension	Technological dimension
Societal	Policy and regulations, climate and geography	Leadership/advocacy, cultural identity	Manufacturing, financing, and distribution of the product; current and past national policies and promotion of products
Community	Access to markets, access to resources, built and physical environment	Shared values, collective efficacy, social integration, stigma	Location, access, availability, individual vs. collective ownership/access, and maintenance of the product
Household	Roles and responsibilities, household structure, division of labour, available space	Injunctive norms, descriptive norms, aspirations, shame, nurture	Sharing of access to product, modelling/ demonstration of use of product
Individual	Wealth, age, education, gender, livelihoods	Self-efficacy, knowledge, disgust, perceived threat	Perceived cost, value, convenience, and other strengths and weaknesses of the product
Habitual	Favourable environment for habit formation, opportunity for and barriers to repetition of behaviour	Existing water and sanitation habits, outcome expectations	Ease/Effectiveness of routine use of product

Source: Dreibelbis et al., 2013:6

Annex 4: Dependent variables and the methodology to build them

Table A 4.1. Evaluation of effectiveness and needed investment in different HWT methods

HWT method	Effectiveness	Cost	Availability	Ease of use	Investment (cost + avail. +ease of use)
Boiling	High (3)	High (3)	Medium (2)	Medium (2)	7
Chlorination	High (3)	High (3)	Limited (3)	High (1)	7
Filter	High (3)	Medium (2)	Medium (2)	Medium (2)	6
SODIS	Medium (2)	Limited (1)	High (1)	Limited (3)	5
Strain	Limited (1)	Limited (1)	High (1)	High (1)	3
Stand and settle	Limited (1)	Limited (1)	High (1)	High (1)	3

Source: Based on Sobsey et al. (2008), Anderson et al. (2010); Geremew & Damtew, 2020

Table A 4.2. Methodology to build the dependent variables

Dependent variables	Values	Category	HWT methods
Practice HWT	1	Doers	Boiling, chlorination, filter, SODIS, strain, stand and settle
	0	Non-doers	None
Practice effective HWT	1	Doers	Only medium and highly effective methods (see table A 4.1: Boiling, chlorination, filter, SODIS)
	0	Non-doers	Limited HWT methods (see table A 4.1: strain, stand and settle) and none
Levels of investment in HWT	3	High	Investment score (table A 4.1) ≥7 (boiling and chlorination)
	2	Moderate	Investment score (table A 4.1) <7 & >3 (filter and SODIS)
	1	Low	Investment score (table A 4.1) ≤3 & >0 (strain, stand and settle)
	0	None	Investment score =0 (none)

Annex 5: Independent variables for measuring the socio-economic factors

Table A 5.1.: Socio-economic factors

Variable	Value	Category
Type of WS (SDG scale)	1	Surface water
	2	Unimproved
	3	Limited
	4	Basic
Education	1	No formal education
	2	Some primary education (not graduated)
	3	Primary education
	4	Some secondary education (not graduated)
	5	Secondary education
	6	Some post-secondary education (not university)
	7	Completed post-secondary education (not university)
	8	University
Type of house (proxy income)	1	Permanent - finished: cemented bricks and iron roof bolted
	2	Permanent - finished: baked red bricks and iron roof bolted
	3	Permanent - finished: cemented bricks and iron roof not bolted
	4	Permanent - finished: baked red bricks and iron roof not bolted
	5	Semi - permanent: mud walls & iron roof
	6	Semi - permanent: bricks & grass thatch roof
	7	Temporary: mud walls and grass thatch roof
Presence of children (proxy presence of children less 5 years)	0	No children within the household
	1	Presence of children within the household
Cases of water borne diseases	Continuous variable: min=0; max=12; mean=1.28	
Information about HWT (proxy exposure to HWT promotional activities)	0	Did not received information about HWT
	1	Received information about HWT

Annex 6: Used methodology to build the RANAS inspired model for psychological factors

Info Box 6.1.: Methodology to build the model for psychological factors

- Factual Knowledge (risk factors block)

Risk	Based exclusively on factual knowledge variable	0-2 scale
Factual knowledge	Which factors influence your household's decisions TO INVEST in water treatment tools? e) Information about poor quality of water source; f) Information on relation between disease and water quality; g) Illness of household member; h) perception of poor quality of water	**0-4 scale: 0** – No; **1** – Respondent chose one of option - **4** – Respondents chose all these 4options.

The used question "Which factors influence your household's decisions TO INVEST in water treatment tools?" is a multiple-choice question and the abovementioned options are just some of the given options. If the respondents chose any of these four options, it can be implied that they have an understanding about the health risks of consuming bad water and that HWT practice could prevent these risks. The methodology of giving values is simple. If the respondent did not choose any of these options, then the variable received value "0" for that observation. If the respondent chose only one option, then the variable received value "1" and so on.

- **Taste, perceived costs, efficiency and necessity (attitude factors block)**

These variables are based on the responses to the following question: Which of these factors influence your household's decisions TO NOT INVEST in water treatment tools? Response options:		
Taste	e) Bad taste of water	**0-1 scale**: **0** - Respondent chose this option"; **1** - Respondent did not choose this option;
Perceived necessity	f) Not necessary	
Perceived cost	g) Lack of financial means	
Perceived efficiency	h) Not efficient (does not believe the treatment works)	

The factors of attitudinal block are defined based on the responses given to another multiple-choice question, "Which of these factors influence your household's decisions TO NOT INVEST in water treatment tools?". If the respondent chose "Bad taste", I consider that the respondent has a negative attitude towards the taste of treated water, and the Taste variable receives value "0" for that observation. If the respondent does not choose "Bad taste" as a reason not to invest in water treating tools, then I assume that the respondent has a positive attitude towards the taste of treated water. In this case, the variable receives the value "1". Similar assumptions and methodology apply to the other factors. For instance, if the respondent chooses "not necessary", then the respondent does not see any benefits in practicing HWT and the variable perceived benefits receives value "0".

- **Descriptive norm and social discourse (normative block)**

Norm	Sum of Descriptive norm and Social discourse variables	0-6 scale
Descriptive norm	During the last year, with whom did you discuss or share water related information regarding water services, e.g. the functionality of water sources, access to water sources, quality of the water, budget, management?	**0-1 scale: 0** - Reported person is from a household that doesn't treat water; **1** - The reported person is from a household that treats water.
Social discourse	During the past 12 months, did you participate in a meeting where water functionality, quality, access or treatment were discussed?	**0- 5 scale: 0** - Never; **1** - Yes, once; **2** - Yes, several times; **3** - Once a month; **4** - Once a week; **5** -Once a day.

The normative block included two factors: injunctive norm and social discourse. The descriptive norm factor reflects the way people close to the respondents approve or disapprove a certain behaviour (Mosler, 2012). I consider that if the persons the respondents discuss with about the water issue treat their water, then these persons have a positive attitude. The questionnaire asked the respondents from the villages where all citizens were interviewed to mentioned maximum six persons whom they discuss with about the water issues. Thanks to the unique identification number of each respondents, I could clarify whether these persons treat the drinking water, or they are from a household that do it. If the respondent declared a person who treat the water, the injunctive norm variable received the value "1", in the opposite case, it received the value "0". If the respondent declared more than one person, I relied on the status of the first person mentioned by the respondent. In case that the respondent declared a member of his or her household and somebody from the outside, I considered the status of the person from outside for defining the value of that observation. If only members of the household were named, then I was relying on whether the water is treated in that household or not. I chose such an approach because if the person communicates only with the members of his or her households then his or her beliefs are reconfirmed inside the household. Finally, if the respondent did not name anybody or named a duty bearer, there was no information about the water treatment behaviour of water bearers, then I checked whether that person was named by somebody else.

Social discourse factor was included in the RANAS model designed by Lilje et al. (2018) and it reflects how often people discuss about water treatment. In the case of this study, the respondents were asked how often they participated to meetings whether various water issues, including the treatment, are discussed. The methodology for giving values to the observations of this variable is straight forward, the more often, the higher the value.

- **Action knowledge (ability block)**

Ability	Sum of Action knowledge 1 and 2 variables	0-2 scale
Action knowledge1	Which of these factors influence your household's decisions TO NOT INVEST in water treatment tools? Response options a) Does not know how to use it;	**0-1 scale: 0** – if respondent chose this option; **1** – if respondent did not choose this option;

The ability block includes only one psychosocial factor, action knowledge. If the respondent chose "does not know how to use it" option to answer the question about the reasons for not investing in water treatment tools, then the respondent had limited knowledge about HWT, and this observation received the value "0". In the opposite case, it received the value "1".

Annex 7: Access to safe water: context and challenges

Fig. A 7.1.: Water coverage in studied villages: SDGs scale

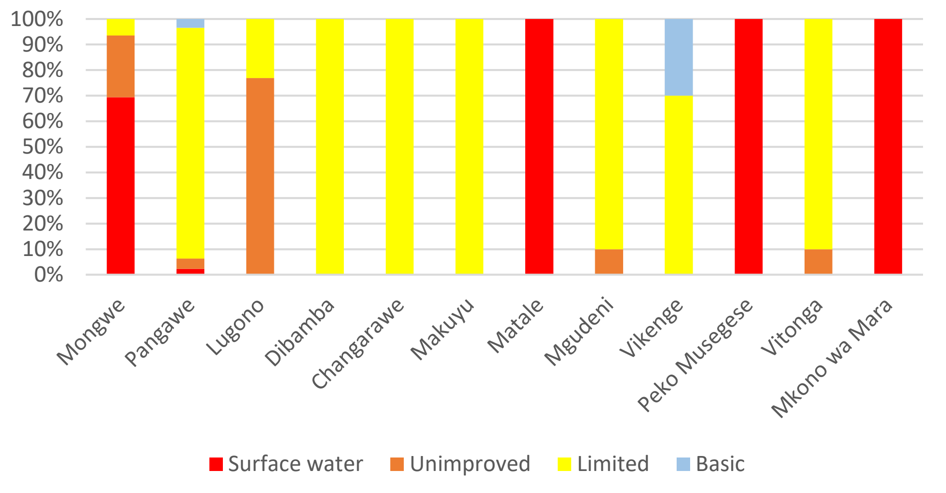


FIG. A7.2: TIME TO FETCH WATER IN STUDIED VILLAGES

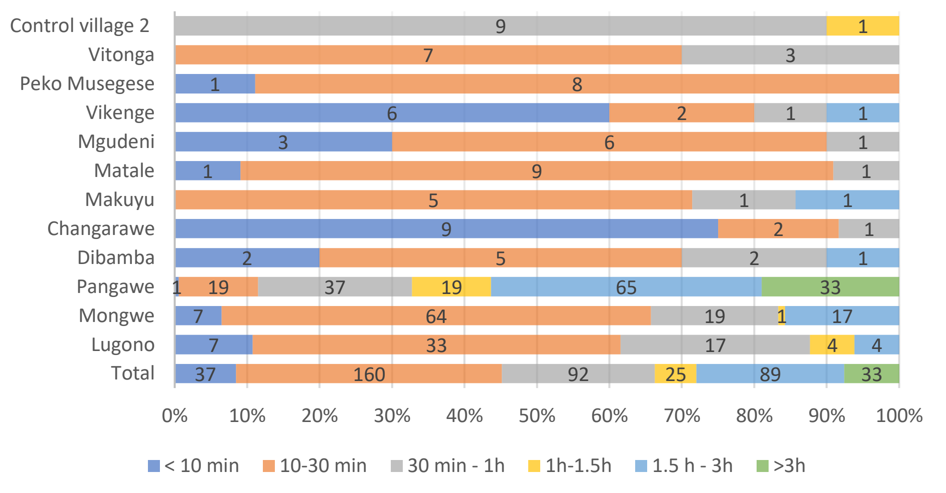


Fig. A7.3: Type of water sources

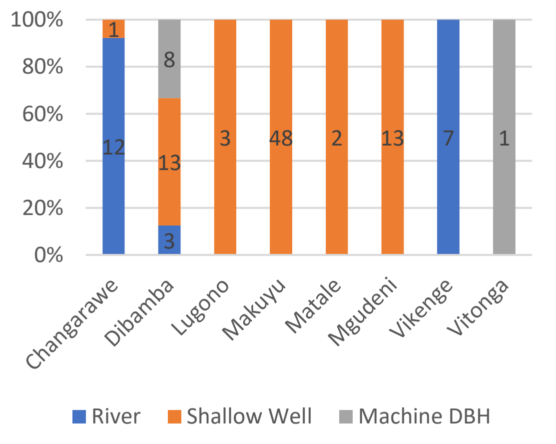
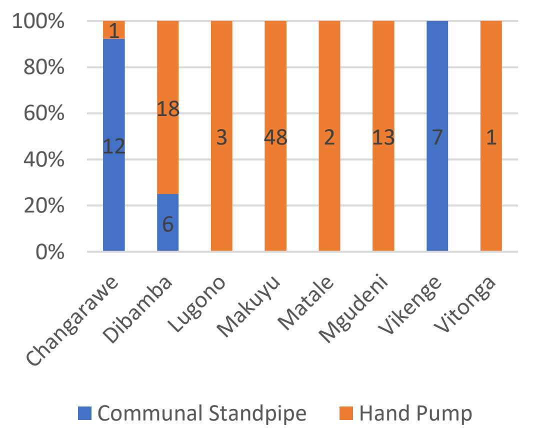


Fig. A7.4: Type of technology



Tab. A7.1: OLS results: correlation between type of water sources and socio-economic characteristics[18]

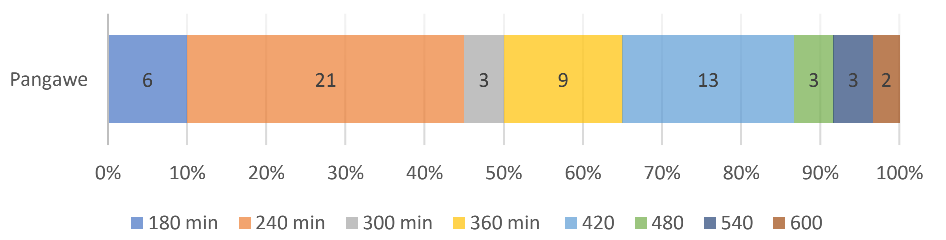
VARIABLES	SDG scale
House type	0.046*
	(0.027)
Education	-0.072*
	(0.037)
Number of children in household	0.080***
	(0.021)
Observations	430
R-squared	0.050
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Table A 7.2.: OLS results: relation between the chance to use a second water source and the type of main water source, its functionality and time needed to fetch water

VARIABLES	Use second water source
Time needed to fetch water from main water source	0.001***
	(0.000)
Functionality of main water source	0.116***
	(0.043)
Type of main water source	-0.132***
	(0.030)
Observations	435
R-squared	0.105
Standard errors in parentheses	
***** p<0.01, ** p<0.05, * p<0.1**	

VARIABLE	VALUE, LEVEL
Use second water source	0 - No
	1 - Yes
Functionality of main water source	1 - Good
	2 - Seasonal
	3 - Almost dry
Type of water source	1 - Improved
	2 - Unimproved
	3 - Surface water
Time to fetch water	Continuous variable, in min.

FIG. A 7.5: HOUSEHOLDS THAT NEED MORE THAN 3 HOURS TO FETCH WATER IN PANGAWE



[18] For the interpretation of the results, check Annex 5 for the values of variables levels

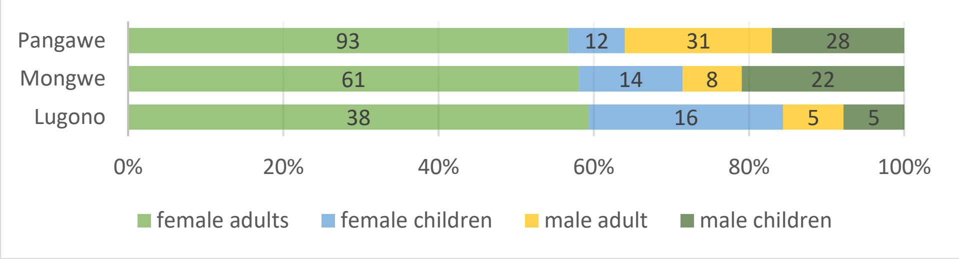


FIG. A 7.6: RESPONSABILITY TO FETCH WATER

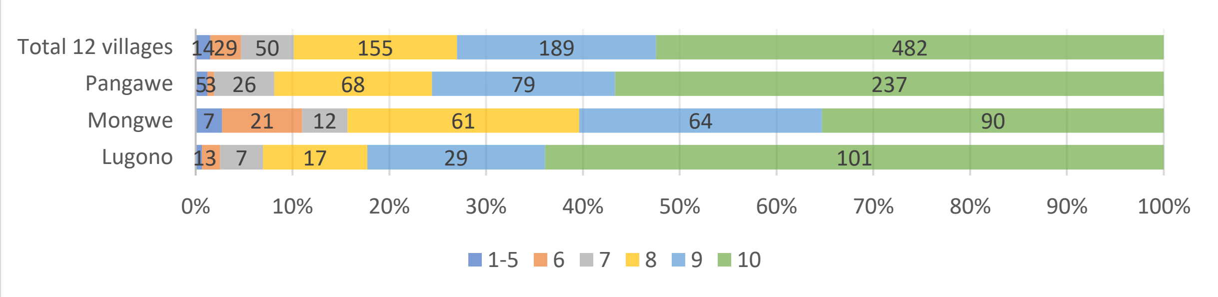


FIG. A 7.7: THE SCORE GIVEN TO THE IMPORTANCE IN WATER AREA

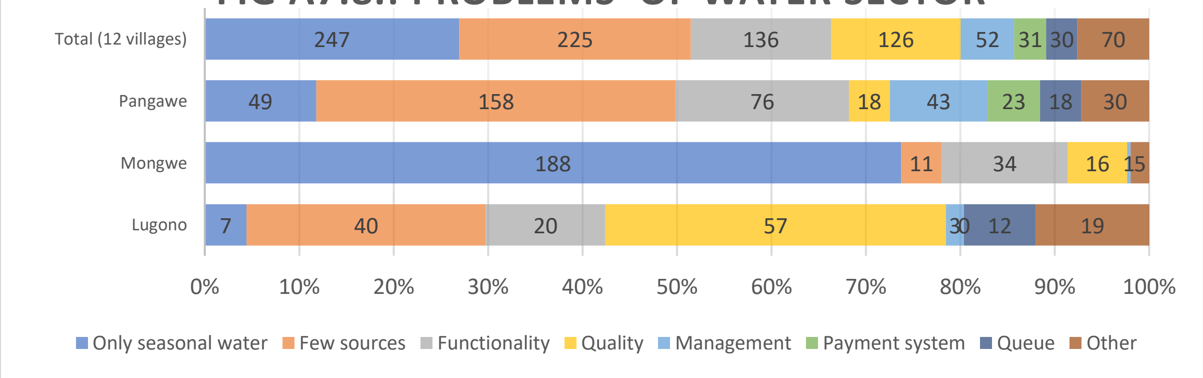


FIG A7.8.: PROBLEMS OF WATER SECTOR

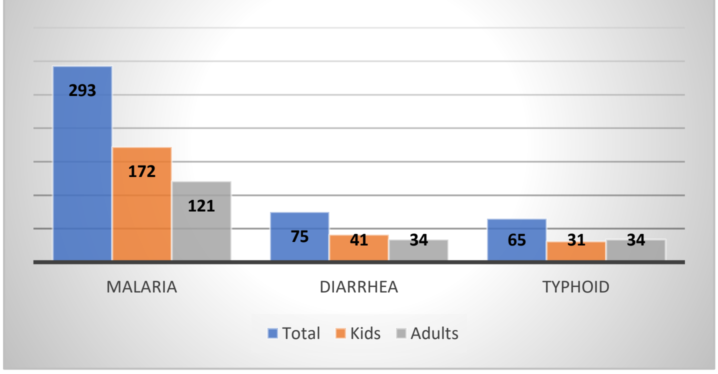


Fig. A7.9: Number of households where at least one member suffered from malaria, diarrhea and typhoid

Annexe 8: Household water treatment

Table A8.1: How villagers combine various HWT methods

Boil	**Boil**						
Bleach	12	**Bleach**					
Strain	9	1	**Strain**				
Stand & settle	4	0	7	**Stand & settle**			
Filter	11	1	4	4	**Filter**		
Solar	1	0	1	1	0	**Solar**	
Buy water	2	0	0	0	1	0	**Buy water**

FIGURE A8.1: HWT USE IN STUDIED VILLAGES

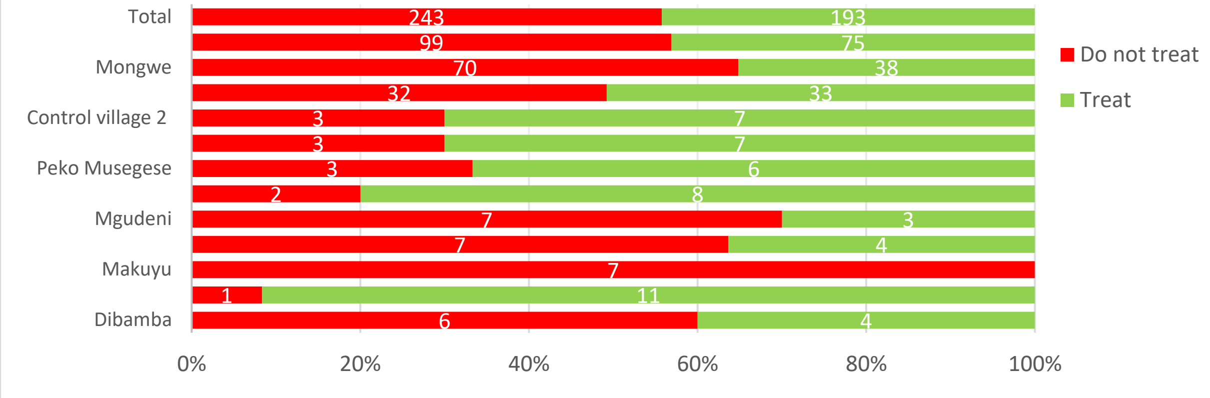


FIGURE A8.2: HWT METHODS IN THE STUDIED VILLAGES

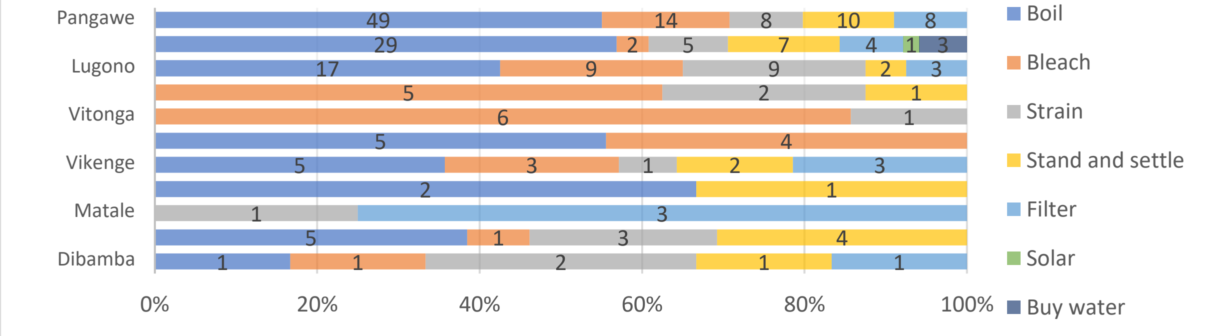
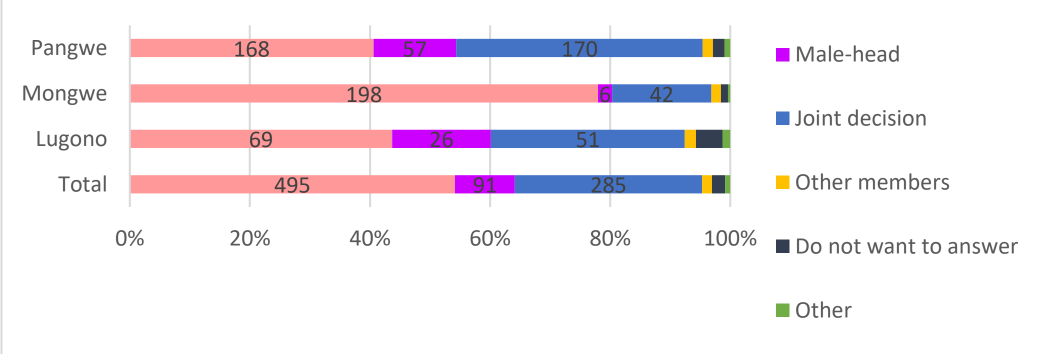


Fig. A 8.3.: Decision to buy the water treatment tools



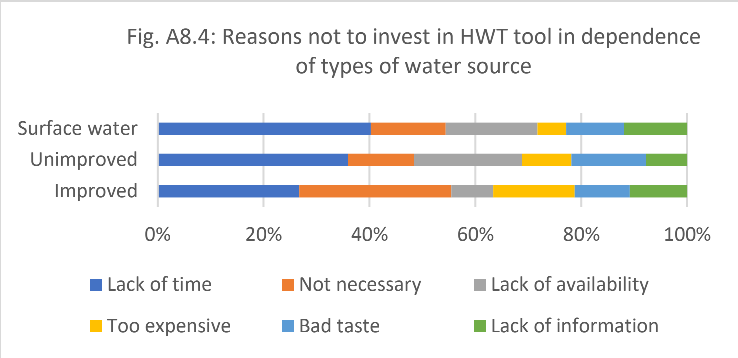


Fig. A8.4: Reasons not to invest in HWT tool in dependence of types of water source
Surface water
Unimproved
Improved
0%
20%
40%
60%
80%
100%
Lack of time
Not necessary
Lack of availability
Too expensive
Bad taste
Lack of information

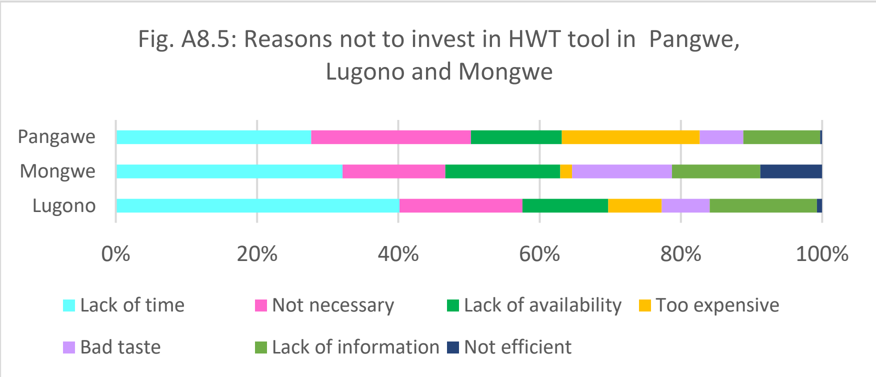


Fig. A8.5: Reasons not to invest in HWT tool in Pangwe, Lugono and Mongwe
Pangawe
Mongwe
Lugono
0%
20%
40%
60%
80%
100%
Lack of time
Not necessary
Lack of availability
Too expensive
Bad taste
Lack of information
Not efficient

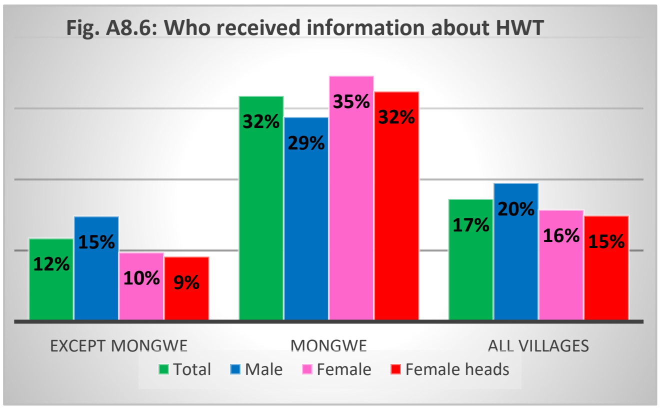


Fig. A8.6: Who received information about HWT
12%
15%
10%
9%
32%
29%
35%
32%
17%
20%
16%
15%
EXCEPT MONGWE
MONGWE
ALL VILLAGES
Total
Male
Female
Female heads

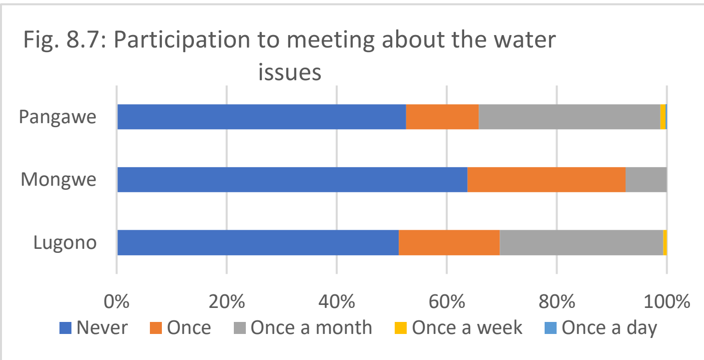


Fig. 8.7: Participation to meeting about the water issues
Pangawe
Mongwe
Lugono
0%
20%
40%
60%
80%
100%
Never
Once
Once a month
Once a week
Once a day

Annex 9: Analysis of results: Socio-economic factors

Table XX: Regressions results: socio-economic factors including the villages coefficients

Variables	(1)	(2)	(3)
	Probit	OLS	
	Practice HWT	Practice effective HWT	Level of investment in HWT
Education	0.1482**	0.1790***	0.1725***
	(0.0604)	(0.0615)	(0.0614)
House type	0.0260	0.0534	0.0413
	(0.0424)	(0.0445)	(0.0428)
WS type	0.0400	0.1411	0.1228
	(0.1433)	(0.1456)	(0.1511)
Presence of children	-0.0904	-0.0505	-0.0390
	(0.2267)	(0.2343)	(0.2321)
Exposure to HWT information	0.1878	0.3841**	0.2982
	(0.1963)	(0.1957)	(0.1999)
Water Borne diseases	0.0580	0.0142	0.0184
	(0.0471)	(0.0459)	(0.0473)
Dibamba	-0.7943	-0.7405	-1.1897*
	(0.6521)	(0.6462)	(0.6999)
Changarawe	0.8569	-0.4895	-0.3764
	(0.7434)	(0.6209)	(0.6779)
Lugono	-0.3851	-0.3710	-0.6740
	(0.4945)	(0.4749)	(0.5356)
Makuyu	-	-	-1.9522**
			(0.7610)
Matale	-0.8605	-0.5245	-1.1725*
	(0.5886)	(0.5786)	(0.6258)
Mgudeni	-1.0331	-0.9169	-1.2803*
	(0.6582)	(0.6602)	(0.6940)
Vikenge	0.1516	0.3856	-0.0745
	(0.7333)	(0.7242)	(0.7252)
Mongwe	-0.8977**	-0.6001	-0.9934**
	(0.4576)	(0.4338)	(0.4939)
Peko	-0.1856	0.3645	-
	(0.6290)	(0.6170)	
Vitonga	-0.2188	-0.1485	-0.3644
	(0.6622)	(0.6334)	(0.6962)
Pangawe	-0.7485	-0.5754	-0.9512*
	(0.5210)	(0.4999)	(0.5620)
Mkono wa Mara	-	-	-0.1905
			(0.6382)
Observations	423	423	430
R-squared			0.0935
Standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			

Annex 10: Predicted probability of first probit model of socio-economic factors

Info Box: Predicted probability to treat water of different levels of education

Table xx: Predicted probability of different education levels

Education levels	Coefficient (standard error)	p-values
No formal education	0.383*** (0.048)	0.000
Primary education (not graduated)	0.395*** (0.115)	0.001
Primary education	0.458** (0.213)	0.000
Secondary education (not graduated)	0.298** (0.148)	0.045
Secondary education	0.684*** (0.092)	0.000
Some post-secondary education (not university)	0.694** (0.240)	0.004

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Only education generates statistically significant coefficient in the first probit model of table 6.1. Thus, I calculate the predicted probability of this variable only and the table xx presents the results. The predicted probability to treat water is 0.383 for the female heads who do not have any formal education and increases to 0.458 for the female heads who completed primary school. The odd fact is that the probability to treat water is only 0.298 for the households whose female heads acquired some secondary education. However, only ten female heads have this level of education and six of them use water from an improved water source (limited water source). The predicted probability increases to 0.684 for the female heads who have secondary education, and 0.694 for the ones who have some post-secondary. However, the results for the post-secondary category are not reliable because only ten respondents have this level of education. The probabilities for "Completed post-secondary education (not university)" and "University" levels were not calculated because there are no female heads with this level of education.