MSc. Thesis

Personal and Interpersonal Factors influencing Household Water Treatment in urban Lucknow, India

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Abstract

Diarrhoea is, after pneumonia, the second most common cause of death among children under five globally and accounts for 10.5 % (0.8 million) of all child deaths. Although household water treatment and safe storage (HWTS) seem to be promising and convincing solutions to make water potable and reduce diarrhoea incidences and other drinking water related diseases, the diffusion of water hygiene practises has neither reached large scales yet in India nor globally. This cross-sectional research focuses on this issue and aims to increase understanding of which personal and interpersonal factors predict water treatment, in order to provide guidance for the development of interventions to increase the diffusion of HWTS. The second objective of this study is to investigate what the effects of applied water hygiene practices are on drinking water quality. For this purpose an extensive literature review was conducted and the results were integrated in a theoretical framework of behavioural change theories. In order to test the influence of background factors, motivational factors, and intention on water treatment, quantitative interviews were performed in a poor, water contaminated area in Lucknow, India. Using an objective measure for water quality and a pre-tested questionnaire, this research showed by means of a hierarchal logistic regression analyses that water serving practises and water treatment were influential in determining water quality when controlled for source water quality. A hierarchal linear regression revealed that intention to treat water best predicts water treatment behaviour. Washing hands with soap at critical times, higher perception of vulnerability, positive attitudes, higher social pressure emerging from injunctive norms, and higher self-confidence influenced more positive intentions to treat water significantly. These factors can all be addressed in promotional campaigns.

Keywords: water contamination, water treatment, determinants, diarrhoea, India, theory of planned behaviour

Table of Contents

1. Introduction 11

2. Background Information 14

2.1 Definition and consequences of diarrhoea 14

2.2 Transmission pathways of diarrhoea 15

2.3 Key actions to reduce the burden of diarrhoea 15

2.4 Household water treatment and safe storage options 16

2.4.1 Household water treatment 16

2.4.2 Safe storage 17

2.5 Water supply and quality in India, Uttar Pradesh, and Lucknow 18

3. Theoretical Framework 20

3.1 Research methods and description of the results 21

3.1.1 Search strategy 21

3.1.2 Description of studies 21

3.1.3 Data abstraction 22

3.1.4 Organising the results 22

3.2 Determinants from the literature review 23

3.2.1 Individual level factors 24

3.2.2 Interpersonal Level 32

3.2.3 Community and society level 33

3.2.4 National Level 35

3.3 Overview of the outcome of the literature research 35

3.4 Integrative behaviour change models 38

3.5 Integrated theoretical framework 40

3.6 Study objectives 42

4. Methods 42

4.1 Setting 42

4.2 Study Population 44

4.3 Measures 45

4.3.1 Questionnaire 45

4.3.2 Water quality tests 49

4.4 Procedure for conducting the quantitative interviews 51

4.5 Statistical analysis 51
4.5.1 Checking data for errors and interview bias 52
4.5.2 Bivariate /correlation and multivariate analyses 52
5. Results 53
5.1 Description of the Study Population 53
5.1.1 Demographics 53
5.1.2 Water treatment and storage related descriptive statistics 55
5.2 Correlations 56
5.2.1 Background factors correlating with intention, water treatment and stored water quality 57
5.2.2 Socio-cognitive and post-intentional factors correlating with intention and water treatment 59
5.2.3 Factors correlating with stored water contamination 59
5.3 Regressions 59
5.3.1 Predictors of intention 61
5.3.2 Predictors of water treatment 61
5.3.3 Predictors of stored water contamination 64
6. Discussion and conclusion 67
6.1 Summary of the results 67
6.2 Theoretical implications 67
6.2.1 Determinants influencing intention and water treatment 67
6.2.2 The effect of applied water hygiene practices on water quality 72
6.3 Practical implications 74
6.4 Limitations of this study 76
6.5 Future research 77
6.6 Conclusion 78
References 80
Appendix A Search syntax for the literature review 89
Appendix B Overview of literature review 90
Appendix C Semi-structured interviews and institutional context 92
Appendix D Water treatment promotion campaign in Lucknow 95
Appendix E Chlorine colouring scheme 97
Appendix F Questionnaire 98

Abbreviations

DALYs	Disability adjusted life years
FGD	Focus group discussion
GEN	General
H2S	Hydrogen sulphide
HTWS	Household water treatment and safe storage
MDGs	Millennium Development Goals
MF	Membrane filtration
MPN	Multiple tube fermentation (most probable number)
NGO	Non-governmental organisation
OBC	Other backward classes
ORS	Oral rehydration salt
P-A	Presence-absence
POU	Point-of-use
SC	Scheduled caste
SODIS	Solar water disinfection
ST	Schedule tribe
SUDA	State Urban Development Agency
UP	Uttar Pradesh
USAID	United States Agency for International Development
WHO	World Health Organisation

1. Introduction

Diarrhoea is, after pneumonia, the second most common cause of death among children under five globally and accounts for 10.5 % (0.8 million) of all child deaths (United Nations, 2005; WHO, 2009; Liu et al., 2012). It kills more young children than AIDS, malaria and measles combined (WHO, 2009). Although remarkable results have been achieved by decreasing the annual under five child death toll from 4.6 million in the early 1980s to 0.8 million in 2010, the current number of deaths caused by diarrhoea remains unacceptably high. Little progress has been made in recent years, making it difficult to attain the Millennium Development Goal (MDG) 4 "Reducing child mortality by two thirds between 1990 and 2015" (Liu et al., 2012; Rudan et al., 2007). Moreover, whereas under five diarrhoea mortality rates declined due to concerted efforts of the World Health Organization (WHO), no cutback in diarrhoea morbidity for the overall population – with approximately four billion cases annually over the last decades – was realised (Rudan et al., 2007; Victoria et al., 2000; Kosek et al., 2003; Clasen, 2009).

A vast and diverse amount of literature examines the potential effectiveness of different interventions in reducing the incidence of diarrhoea for the population in general (UNICEF, 2007; Fewtrell et al., 2005; Waddington et al., 2009). Regardless of the precise magnitude of the different prevention strategies, researchers widely acknowledge that the most effective strategies include hand washing with soap, improving water quality and safe excreta disposal (Bloomfield, 2003; WHO, 2009; Cairncross et al., 2010; Unicef, 2007; Fewtrell et al., 2005; Waddington et al., 2009; Eisenberg et al., 2007). The effectiveness in dropping the incidence of diarrhoea vary from 37% - 48% for hand washing with soap, 39% - 46% for household water treatment and safe storage, and from 32% - 37% for improved sanitation, see table 1 (Cairncross et al., 2010; Unicef, 2007; Fewtrell et al., 2005; Waddington et al., 2009; Curtis & Cairncross, 2003; Clasen et al., 2006). The overall effectiveness of improving water quality at its source is estimated around 11% - 17%. The relatively low effectiveness of source water interventions in preventing diarrhoea is caused by its post-source contamination. Latter is very common in developing countries, where 24/7 tap water supply is not guaranteed and people rely on open collective sources. Through the process of its collection, transportation and storage, water can get easily recontaminated, although it was initially safe at its source. Therefore usage of household point-of-use water treatment (i.e. water treatment at the point of consumption instead of at a centralised distribution scale) and safe storage techniques are encouraged as a cost-effective prevention strategy of diarrhoeal disease (Wright et al., 2004; Clasen et al., 2007; Sobsey, 2008; Quick et al., 2002; WHO, 2007; WHO, 2008).

Table 1: Reduction in diarrhoea morbidity per intervention type in low income countries

Intervention type	Effectiveness of intervention
Hand washing with soap	37% - 48%
Point of use water treatment and safe storage	39% - 46%
Sanitation	32% - 37%
Source water treatment	11 - 17%

All the (theoretically) effective prevention strategies against diarrhoea described above were primarily tested in trials or experimental settings. They might be of no value if people do not use them (correctly), adapt, and change accordingly in practise (Waddington et al., 2009). Although household water treatment and safe storage (HWTS) seem to be promising and convincing solutions to make water potable and reduce diarrhoea incidences and other drinking water related diseases, the diffusion of water hygiene practises has not reached large scales yet globally (IIPS, 2008; Clasen, 2009).

The estimated use of household water treatment products was around 18.8 million globally in 2007, excluding boiling, which is practised by over 350 million households. However, given the fact that more than 800 million people have access to only unimproved water supplies worldwide, and not merely regular and continuous users are meant with the 18.8 million people, these figures appear unsatisfactory (Clasen, 2009). Clasen (2009, p. xi) summarises the barriers for a large scale uptake of HWTS as follows: "*1) the persistent belief that diarrhoea is not a disease; 2) scepticism about the effectiveness of water quality interventions; 3) special challenges associated with uptake, including low aesthetic appeal for consumables, high up-front cost, the need to replace components for durables and the need to continuously use the product, even in the face of disease through other transmission pathways; 4) public health suspicion of the agenda of commercial products and strategies; 5) the orphan status of HWTS at the public sector level, with neither the water sector nor the health sector willing and able to assume ownership of the intervention; 6) minimal public sector participation in the promotion of HWTS; 7) a lack of focused international effort and commitment to advance HWTS; and 8) perceived policy conflict with efforts to promote piped-in water supplies*."

Research has shown that even in cases where the products are widely available and awareness exists, people do not necessarily use the techniques (Figueroa & Kincaid, 2010). In addition, according to a consumer study of PATH (Kols, 2008), a large part of the Indian population which could theoretically afford low cost household water treatment methods are not willing to purchase them, but on the other hand are willing to spend money on goods such as televisions, washing machines, microwaves or refrigerators, even if they have to take up instalment plans for these products. It has also been shown that low-income households are ready to invest in more consistent water supplies, but for treating the water the relation seems to be less clear (Kols, 2008; Lakshmi et al., 2011).

Thus factors influencing behaviour are crucial in determining, explaining and predicting up-take and sustainable adoption of HWTS. Sustainability over time and diffusion of the techniques are fundamental if the benefits of improved water should be maintained after an intervention terminates (Fewtrell et al., 2009; Sobsey et al., 2009). Understanding the reasons behind acceptance, compliance and adoption could help to develop customised promotion strategies and increase product enhancement and development. Waddington et al., (2009), Nagata et al., (2011) and Murcott (2006) criticise that very few studies try to explain why, or why not, people start applying water purification methods at home and instead just focus on the effectiveness of the intervention methods to reduce diarrhoea incidences or on compliance in general (Waddington et al., 2009). This is true if one looks at studies that focus on the effectiveness of certain intervention methods or promotional interventions. However, the amount of literature focusing solely on predictive determinants of the uptake of household water treatment methods and the application of behavioural change theories is emerging especially since the past three to four years (e.g. Figueroa & Hulme, 2008; Heri & Mosler, 2008; Mäusezahl et al., 2009; Figueroa & Kincaid, 2010; Mosler & Kraemer, 2011; Kraemer & Mosler, 2011 a; Kraemer & Mosler, 2011 b; Christen et al., 2011; Tamas & Mosler, 2011). This body of research however, remains incomplete and fails to capture the full scope of uptake of household water treatment practices. To a large part these studies only focus on solar disinfection as a water treatment method and health oriented motivational reasons. However, health reasons alone are often not sufficient to convince people to adopt long-term water hygiene practices (Figueroa & Kincaid, 2010; Clasen, 2009). Therefore, it is important to find other benefits perceived next to health improvements. Another aspect worthwhile to be further investigated are the synergy effects of other domestic hygiene practices and usages on household water treatment (Nath et al., 2006; Murcott, 2006; Figueroa & Kincaid, 2010; Bloomfield, 2003), for example, if washing hands at critical times and using own sanitation facilities have a positive impact on treating contaminated water at home due to a better hygiene awareness and being more sensitised and open to further hygienic measures (Nath et al., 2006). Such group of people would be an important entry point for household water promotions and for diffusing the methods.

This study attempts to understand the determinants behind water treatment adherence. The fieldwork of this research was conducted in a water contaminated area of Lucknow, in Uttar Pradesh (UP), India. It was decided to undertake this study in India, which has problems assuring safe drinking water quality to its population and the highest under five child mortality rates caused by diarrhoea globally (WHO & UNICEF, 2010). By means of a quantitative research the study explored explanatory determinants why people adopt water treatment practises at home and sustain this behaviour over time, whilst others do not treat their water. Furthermore, it was analysed if water treatment practises had an effect on improved water quality, meaning if they were performed correctly, by means of testing the water quality of stored water at home. Individuals will only be able to experience the full health

benefits of treated water if they also perform the behaviour correctly. Finally, the opinion of local influential stakeholders from governmental institutes upon HWTS and their support in establishing a successful uptake of HWTS was investigated briefly by means of semi-structured interviews. This helps to place the study in its environmental context.

Chapter 2 of this research will provide background knowledge on the causes and consequences of diarrhoea, and information on key actions to decrease the burden of the illness, including water treatment methods and safe storage practices. Furthermore, the reader will be made familiar with the Indian water quality context, with a special focus on UP and Lucknow. Chapter 3 consists of a thorough literature review, as well as the theoretical framework and the specific study objectives following from this literature review. The next chapter describes the methods applied for this thesis, including information on the research design, measures and statistical analyses. Chapter 5 will give an overview of the results and finally in chapter 6 the results will be discussed and conclusions will be drawn.

2. Background Information

2.1 Definition and consequences of diarrhoea

Diarrhoea is defined as the passage of loose, liquid, or watery stools at least three times a day, which generally lasts three to seven days. Episodes which last longer than two weeks are called persistent diarrhoea and cases were blood can be found in loose or liquid stools are defined as dysentery (Boschi-Pinto et al., 2009; WHO, 2009). The fatal characteristic about diarrhoea is that it leads to massive fluid and electrolytes loss, such as sodium, chloride, potassium, and bicarbonate, and thus to dehydration. This can result ultimately in death or other severe consequences when the lost fluids are not replaced. Continued cases of diarrhoea in individuals cause malnutrition, as normal food ingestion and adsorption of nutrients is hindered, which can result to weakened physical growth and cognitive functions in children, reduced immunity, potentially long-term gastrointestinal disorders and in severe cases it ends with death (WHO, 2009; Clasen et al., 2007; Boschi-Pinto et al., 2009; EHP, 2004). Children are more susceptible to dehydration than adults as water constitutes a larger proportion of their body weight. Children in low income countries experience four to five episodes of diarrhoea per year (EHP, 2004; WHO, 2009). Out of 1.490 million Disability Adjusted Life Years lost (DALYs) [1], 61 million can be attributed to diarrhoea (WHO, 2002).

[1] DALYs: Measure for the global burden of a disease. It is composed out of the number of years lost due to ill-health, disability or premature death. It is a single measure combining life years lost due to early death and the number of years lived with a disability because of a particular disease.

2.2 Transmission pathways of diarrhoea

There are multiple pathways for people to catch diarrhoea. The primary causes are infectious agents from human or animal faeces through the faecal-oral route (see Figure 1 below). There are several paths these pathogens can take to reach individuals or to travel between them (WHO, 2009). Modes of transmission include ingestion of contaminated food or water (through flies, bad sanitation, sewage systems and water treatment systems, poor personal hygiene, cleaning food with contaminated fluids), any direct contact with infected faeces, person-to person contact and poor personal hygiene (WHO, 2009, Ejemot et al., 2008, Prüss et al., 2002; Clasen et al., 2007; EHP, 2004.) Furthermore, maternal education, poverty, already existing malnutrition, poor housing, crowding and limited access to care facilities have been listed as the main risk factors for contracting diarrhoea (Boschi-Pinto et al., 2009).

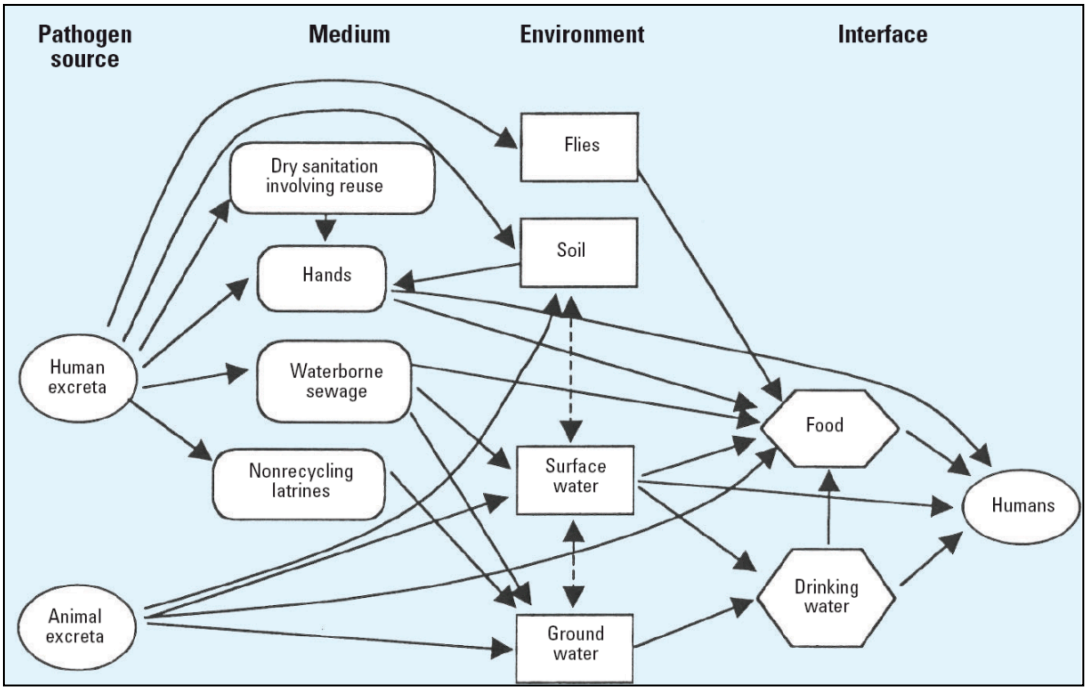

Figure 1: Transmission pathways of faecal–oral diseases. Source: Prüss et al. (2002), p. 538

2.3 Key actions to reduce the burden of diarrhoea

The steady enhancement of the diarrhoea mortality figures since the 1980s can be largely attributed to improvements in the dehydration treatment, consisting of a simple fluid mixture of different sodium salts and glucose, called Oral Rehydration Salt (ORS), and continuous feeding (EHP, 2004; Boschi-Pinto et al., 2009; Victoria et al., 2000). ORS was hailed as potentially the most important medical advance of the 20th century (Anon, 1978). Recent research results propose inclusion of increased zinc in the treatment in order to reduce severity and duration of diarrhoea episodes (WHO, 2009; Boschi-Pinto et al., 2009). Early and exclusive breastfeeding and Vitamin A supplementation are also able to reduce children's susceptibility to severe diarrhoea and dehydration (WHO, 2009).

Rotavirus vaccination can directly prevent infections leading to diarrhoea by the rotavirus, which is in total responsible for 40% of children's hospital administration from diarrhoeal disease and the cause of 350.000 to 600.000 child deaths (WHO, 2009). Currently the application of this promising vaccination is restricted to few countries in the American region. The downside of the vaccination is its high costs (Boschi-Pinto et al., 2009).

Not only more efforts need to be undertaken on the treatment and preventive nutritional side, but the underlying causes of the morbidity also have to be addressed in order to achieve better results and some relieve for the population (EHP, 2004). As previously mentioned, the most effective preventive interventions on diarrhoea seem to be improved water quality, sanitation facilities and hygiene practises. One could assume that combined interventions have an amplified effect on diarrhoea morbidity reduction compared to single interventions, but this is not always the case (Waddington et al., 2009; Fewtrell et al., 2005; Eisenberg et al., 2007). Studies present contradictory results for synergy effects of combined interventions. Eisenberg and colleagues (2007) give one plausible explanation for this enigma. They argue that the effectiveness of single or combined multiple interventions depends on the baseline conditions and the *critical pathway*. Water quality interventions highly depend on the sanitation and hygiene context: "*When sanitation conditions are poor, water quality improvements may have minimal impact regardless of amount of water contamination. If each transmission pathway alone is sufficient to maintain diarrheal disease, single-pathway interventions will have minimal benefit, and ultimately an intervention will be successful only if all sufficient pathways are eliminated. However, when 1 pathway is critical to maintaining the disease, public health efforts should focus on this critical pathway*" (Eisenberg et al., 2007, p.846).

2.4 Household water treatment and safe storage options

2.4.1 Household water treatment

Different wter treatment methods exist for different purposes. The most effective methods in eliminating microbes that cause diarrhoea are considered to be following: (i) boiling, (ii) filter, (iii) chemicals and (iv) solar disinfection (UNICEF, 2008).

Boiling is the oldest means of disinfecting water at the household level. It is known to kill or deactivate all classes of waterborne pathogens (Sobsey, 2002). Though boiling is an effective strategy it has some drawbacks. It is time consuming to first heat and then cool the water, it changes the taste, there are costs involved in procuring the fuel or wood, respiratory infections can occur as fuel is usually aburnt indoors in poorly ventilated rooms in developing countries and it is environmentally unsustainable (UNICEF, 2008; Clasen, 2009).

There are mainly two types of different filters described in the literature. The bio-sand filter and the ceramic filter (UNICEF, 2008). The advantage of filters is that they can improve taste, odour and colour of the water and are usually easy to apply. However, they need regular cleaning and some filters require regular replacements of different parts. Biosand filters can reduce bacteria on average by 81-100%, but do not remove viruses effectively. Ceramic filters kill 99.9 % of bacteria and their effectiveness on virus reduction is unknown (Lantagne et al., 2006). Prices of filters differ widely and obtaining a filter is much more expensive than boiling or chlorine treatment.

Chlorine effectively inactivates bacteria (99.99%) and most of the viruses. The huge benefit of chlorine next to its low cost and high effectiveness is that it prevents recontamination in its residual form in water. However, chlorine also alters the taste and smell of the water, which many people dislike (UNICEF, 2008).

Solar disinfection, which combines thermal and ultraviolet radiation, has been shown to be effective for eliminating microbial pathogens and reduces diarrhoeal disease (UNICEF, 2008). Among the most practical and economical is the solar water disinfection (SODIS) system, developed and promoted by the Swiss Federal Institute for Environmental Science and Technology. It consists of placing low turbidity water in clear plastic bottles after shaking it to increase oxygenation and exposing the bottles to the sun, usually by placing them on roofs. Exposure times vary from 6 to 48 hours depending on the intensity of sunlight. Like filters and boiling, solar disinfection does not provide residual protection against recontamination. However, recontamination is unlikely, if the bottles are only used for water treating and storage purposes, because water is consumed directly from the small, narrow-necked bottles (with caps) in which it is treated. SODIS has been proven to inactivate bacteria (97%) and viruses (99%) and only affects the taste minimally (UNICEF, 2008; Lantagne et al., 2006).

2.4.2 Safe storage

Safe household water management means maintaining or improving the microbiological quality of the water from its initial source through collecting, transporting and storing in the home (Bloomfield, 2003). Safe storage at home can be provided my means of protected containers that restrict physical access prior to actual use of the water. These can be vessels with a narrow mouth or opening and a hard cover, lid or cap (Mintz et al., 2001). Another option is a container with a wide-mouth that has a hard cover and spigot. In the ideal case water does not come in contact with hands and other helping devices such as cups or ladles and is served directly from the storage vessel. In the less ideal case tools such as ladles or cups with a handle are used. Tools which do not possess any handles increase the risk of hands coming into contact with the water are the least ideal method to avoid (re-) contamination (Murcott, 2006; Hernández, 2007). Furthermore, additional factors such as water temperature, airborne

particulate concentrations, and storage time might also influence the quality of stored water (Murcott, 2006).

2.5 Water supply and quality in India, Uttar Pradesh, and Lucknow

India has by far the worst records regarding diarrhoeal diseases and documented 212.000 deaths caused by diarrhoea in children under five in 2010 (Liu et al., 2012). In total 10.9 million diarrhoea morbidity cases were reported in India in 2007. Two years later, in 2009, the value even increased to 11.9 million reported cases (NHP, 2008; NHP, 2010).

Groundwater and surface water are the two main sources for water consumption in India. The country is highly suffering from groundwater depletion and pollution and governmental failures to ensure secure reliable and safe water supplies (Briscoe, 2005; Brick et al., 2004; Firth et al., 2010). The available infrastructure is too swamped to deal with the large amount of sewage produced by the Indian cities. 90% of India's 20 million m^3 produced sewage a day mixes with groundwater and surface water (Chaudhary et al., 2002). Only 20% of the available supplies meet health and safety regulations (Jha, 2001). Connected to goal number 7, target 10, of the MDGs "halve, by 2015, the proportion of people without sustainable access to safe water and basic sanitation", various initiatives are currently being implemented on a large scale in India to deal with these issues (MoDWS 2011; GOI, 2010; RGNDWM, 2010; Black et al., 2003; Esrey et al., 1991). India will probably meet drinking water supply goals, while failing to realise the goals related to improved sanitation (WHO & UNICEF, 2010). However, although 88% of people living in India have access to improved water supply, only 22% of the population owns household taps. Most of the people still have to collect water from an open collective source, transport it, and store it at home (WHO & UNICEF, 2010). The high risk of post contamination associated with this, encourages the usage of point-of-use (POU) water treatment and safe storage techniques at household level (Wright et al., 2004; Clasen et al., 2007; Sobsey 2008; Quick et al., 2002). HWTS is much faster and more affordable compared to the planning effort, installation and delivery of piped community water supplies (Clasen & Rosa, 2010; Nath et al., 2006). Even tapped water in urban areas cannot always be regarded as a safe source due to insufficient treatments or seasonal microbial contamination resulting from system failures in the distribution (Clasen & Rosa, 2010; Nath et al., 2006).

Water quality and safe water supply will become an even more pressing issue for India in light of climate change and socio-economic developments (CPCB, 2008). HWTS methods already are and will be the best short- to midterm solutions for ensuring safe drinking water quality for India's major population at risk until a protected piped community supply will be made available or another effective innovation will emerge (Kang et al., 2001). It is also questionable if the state of a safe piped line for everyone will ever be reached, considering the slowly depleting water resources, combined with an increase in wastage that occurs once water is fairly available to humans.

The field work of this study was conducted in Lucknow (see figure 2 below), the capital city of UP, with a population of 2.8 million people and an area of 310 sq. km (Census, 2011). The water situation in Lucknow is similar to the one described above for India in general (CPCB, 2007). The city is experiencing enormously decreasing ground water tables, forcing local authorities to switch to surface sources. The only surface source the city has is the Gomti river (Shivani, 2011). Over 330 million litres of wastewater finds its way into the river through 28 drains every day (CDP, 2006; CPCB, 2007). The wastewater includes industrial effluent, domestic waste, sewage, and medicinal waste. Although these drains are treated they still carry highly contaminated water (Mishra & Mishra, 2008). However, before the river water is supplied to the residents of Lucknow it is treated again. The average duration of water supply is around two hours per day. As consumers are aware of the high Gomti river pollution, they often distrust water from the river and prefer ground water sources (CDP, 2006). Ground water sources can, however, also be contaminated since sewerage facilities are not available everywhere in Lucknow. Hence the wastewater infiltrates the ground and hereby pollutes the groundwater as well (CPCB, 2007).

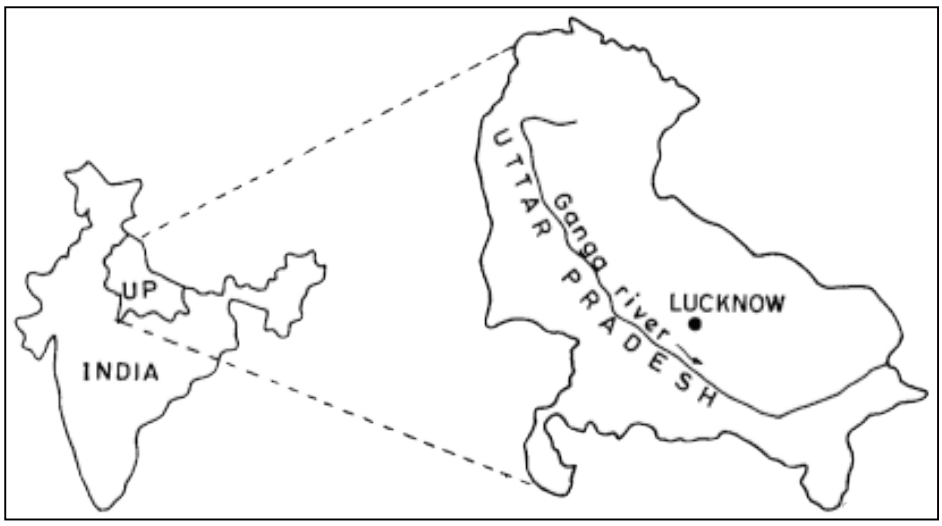

Figure 2: The study was conducted in Lucknow, the capital city of Uttar Pradesh, India.
Source: Shaban & Dikshit (2001)p. 569

Approximately 63.2% of Uttar Pradesh urban population obtain their drinking water from ground water resources, and 32.2 from piped supplies (see table 2 below). Only 12.9% of Uttar Pradesh urban population treat their water in order to make it safe to drink. The most common method is filtering (approximately 3.2%) and the second common boiling (approximately 2.8%) (IIPS, 2008).

Table 2: Drinking water characteristics among the population in Uttar Pradesh. Source: IIPS, 2008, p.34

	Urban %	Rural %	Total %
Source of drinking water			
Improved source*	98.5	92.1	93.7
Piped water into dwelling/yard/plot	32.2	1.2	9
Public tap/stand	2.7	0.8	1.3
Tube well or borehole	63.2	89.8	83.1
Other improved source	0.5	0.3	0.4
Non-improved source	1.4	7.8	6.2
Other source	0.1	0	0
Missing	0	0.1	0.1
Total	100	100	100
Water treatment prior to drinking			
Boil	2.8	0.4	1
Strain through a cloth	1.7	0.7	0.9
Use ceramic, sand or other water filter	3.2	0.1	0.9
Other treatment	5.2	1.1	2.1
No treatment	87.4	97.8	95.2

Note: *An improved source of drinking water includes, in addition to water piped into the dwelling, yard or plot, water available from a public tap or standpipe, a tube well or borehole, a protected dug well, a protected spring, and rainwater. Additionally, households that drink bottled water are defined as having an improved source of water only if the source of water they use for cooking and/or hand washing is from an improved source

3. Theoretical Framework

It is important to examine first which determinants and variables have already been investigated by different studies in general and which variables lacked sufficient attention in order to decide which factors should be added to the theoretical behaviour change model for the purpose of this research. Hence, in the first step a systematic literature review was conducted to get an overview of determinants that have been investigated and seem to be influential. After this a general overview of behavioural theories and the main constructs relevant for preventive and interpersonal behaviour are given. These theoretical constructs are used in the final step to structure the results from the literature review in order to present in an integrated theoretical framework for treating water. Finally, the integrated theoretical framework is applied to guide the research objectives.

3.1 Research methods and description of the results

3.1.1 Search strategy

A systematic literature review was conducted in December, 2011, including search terms such as HWTS, determinants, factors, beliefs, and terms related to different water treatment methods and different study types (see Appendix A for exact search syntax). Following databases were included: *Communication & Mass Media Complete, SocINDEX, MEDLINE, EconLit, Psychology and Behavioral Sciences Collection, PsycARTICLES, PsycINFO, GreenFILE,* and *CAB Abstracts*. The search was restricted to only abstracts and studies published in between 1990-2011. It yielded 1902 hits in total. All the titles of these papers were scanned through in the first step. Papers already indicating with their titles a focus on high-income countries and bottled water consumption or emergency situations were obviated. In the second stage the abstracts of the 44 remaining studies were examined and promising appearing papers with the same criteria as for the titles were assembled for the next step. Also papers only looking at water supply interventions or assessing only risk perceptions, while not explicitly including behavioural performances were excluded. This selection of 30 publications was then fully read. Additional exclusion criteria to the one mentioned above were reviews and too vague studies with respect to socio-psychological variables. For example, two studies only analysed which promotion interventions were the most effective to encourage household water hygiene practises, but did not analyse which socio-psychological determinants were the most influential in the behaviour change process. At the end 25 studies remained. References of these studies and of the two excluded reviews were also browsed through for additional relevant publications for this research. The rule of thumb for including studies in this review was that they are capable of providing influencing factors for household water hygiene practises. Although arsenic filters do not have any influence on preventing diarrhoea, they were still included in this review as these studies also give useful information on what variables determine water treatment behaviour in general. The final literature review resulted in 31 papers.

3.1.2 Description of studies

For a detailed description of the papers included, see the table in the Appendix B. Three studies are of qualitative (in depth interviews and focus group discussions) and 26 of quantitative (all based on surveys) origin, the remaining two applied mixed methods. Twenty-three studies applied a cross-sectional research design and six a longitudinal design. Two studies did not use a very clear approach and therefore fall in between a retrospective and cross-sectional design. The studies were conducted in 18 different countries, all low-income countries. Twelve studies were conducted in sub-Saharan Africa, nine in Latin America, four in Southeast Asia, two in South Asia, one in China, one in Russia, and one in Egypt. One study focused on three different countries together: Ethiopia, Haiti, and Pakistan. All studies

were published between 1994 and 2011. The majority of the studies – 25 studies – were published after 2006. The sample size of qualitative studies ranged from 34 to 109, of the quantitative studies the sample size ranged from 81 to 878. However, the majority of these studies included a sample size larger than 300. The sample sizes of the mixed studies were 1768 and 21 972. The studies covered all kind of treatment methods: SODIS, boiling, chlorination, filtration and letting water stand still (i.e. wait for a while until bigger particles in the water float to the ground of the storage vessel). In all of the studies, except of one study applying secondary data, the number of females interviewed outweighed the number of males, as they are as primary caretakers responsible for household tasks such as preparing food and beverages.

3.1.3 Data abstraction

For each factor associated with water hygiene practices, information is provided on the study type they were investigated in – qualitative (focus group discussions (FGD) or in depth interviews) or quantitative surveys (analytical or descriptive) – and on significant results. Results have been classified as significant whenever $p \leq 0.05$. Not all quantitative studies carried out a p-value significance analysis. These will be named descriptive studies in this review. Such descriptive quantitative studies will always be mentioned separately from studies that applied a significance test; as such an approach is a weaker scientific method for presenting relationships compared to studies that mention the significance. At the end of this review a synopsis of the results can be found in a table format including information on the strengths of the evidence for each determinants (see table 3).

3.1.4 Organising the results

The initial listing of the determinants that came to the fore from this research resulted in almost 120 variables. Structuring and organizing them was not always straightforward. Reasons for this were the applications of different definitions for similar determinants (e.g. costs, affordability, willingness to pay, cost-benefit weightings), different words for potentially identical factors (e.g. improved safety versus improved health), different meanings of the same expression (e.g. costs can be a hindering as well as a supporting factor, or with social norms sometimes injunctive norms were meant and in other cases descriptive norms), aggregations of different determinants to one factor in one study whereas in other studies they were kept as single determinants (for example in some cases worth spending time, effort and money in water treatment methods were categorised as instrumental attitudes or evaluation beliefs and in others they were handled individually), different scales for one category (e.g. child present in household < 2 years, child present <5 years, babies present, children present between 10-14), or of unclear definitions (e.g. outcome expectancy could be related to improved health, clean water, improved smell, etc. after purification).

According to Bartholomew et al. (2006) determinants influencing individual behaviour can originate from different hierarchical levels, namely the individual, interpersonal, organizational, community, societal, or supranational level. They can include biological, psychological, behavioural, physical, social, and cultural aspects of the individuals and their environment and build a complex embedded system of vertical and horizontal relations. Factors emerging from higher levels can influence lower-order systems and vice versa. The authors have named this construct the *ecological model* and explain that behaviour is not just influenced by the individual itself but by its entire environment. For example an individual who smokes might have difficulties to quit with that habit as many close friends of him smoke as well (interpersonal and individual level). If there are many individuals smoking in a country the government might perceive smoking as a high risk behaviour causing lung cancer in a large amount of its population and therefore take action against it by increasing the taxes on cigarettes or banning smoking within public rooms/buildings. These regulations then can have an effect on individuals to stop with the risk behaviour. More awareness on a policy level can also influence society and society again individuals. The factors influencing water hygiene identified in the literature review have been organised along the lines of the ecological model.

3.2 Determinants from the literature review

All levels from the ecological model except of the organisational level could be applied to the determinants from the literature review (see figure 3 below). The overview of the determinants will start from the individual level and move to higher order systems.

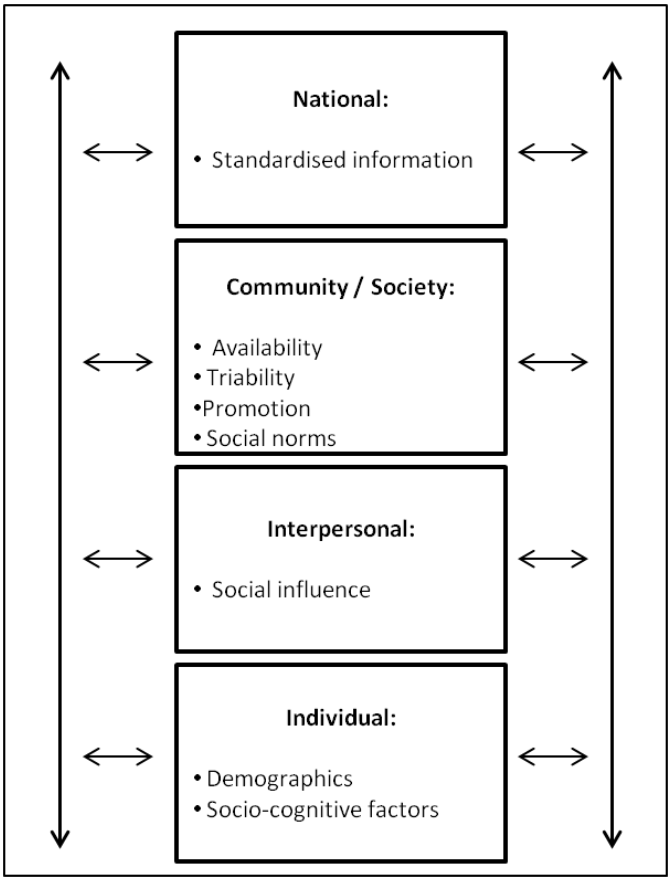

Figure 3: Ecological model applied to structure the determinants

3.2.1 Individual level factors

The determinants in this category have been clustered into a demographic, personality traits and a socio-cognitive section. The demographic section contains socio-economic factors as well as several household characteristics. The personality traits part consists of different hygienic measures. The socio-cognitive section includes the majority of determinants identified in the literature search. "*Social cognition is concerned with how individuals make sense of social situations. The approach focuses on individual cognitions or thoughts as processes which intervene between observable stimuli and responses in specific real world situations"* (Conner & Norman 2005, p.5). The determinants related to socio-cognition deal with different beliefs, outcome expectations, knowledge and awareness levels, attitudes, skills and confidence levels, which influence the reality perception, the way of processing information and the motivational development of individuals.

Demographic variables

Ethnicity

Three quantitative surveys explored the relation between ethnicity and uptake of water treatment behaviour (Nagata et al., 2011; Prihartono et al., 1994; Figueroa & Hulme, 2008). All studies found a

statistically significant relationship between ethnicity and treating water with chlorine or boiling water. Banjarnese people were for example in a study in Indonesia four times more likely to drink unboiled water compared to non-banjarnese people (Prihartono et al., 1994).

Education

Several quantitative surveys studied the relationship of education and household water treatment. Four publications considered the relation with literacy and three of them found a positive significant link (Nagata et al., 2011; Prihartono et al., 1994; Faye et al., 2011). The study that only made use of descriptive statistics claims it did not find any associations between literacy of the female household head and self-reported use of a chlorine solution (Ram et al., 2007). Six out of 11 studies found a positive significant correlation with years of education/schooling and water treatment behaviours (Nagata et al., 2011; Tamas & Mosler, 2011; Yang et al., 2009; Prihartono et al., 1994; Wright & Gundry, 2009; Freeman et al., 2009). Two of the studies that did not find a significant p-value state that an explanation for this outcome might be that their sample was very similar and did not show sufficient demographic variance (Altherr et al., 2008; Mäusezahl et al., 2009).

Monthly household income

Ten quantitative studies investigated the linkage between performing water treatment practises and wealth or monthly income. Six of these surveys found a positive significant relation supported by statistical analytical methods between these two variables. This link suggests that poor households are less likely to treat water compared to households with a higher income (Larson & Gnedenko, 1998; Yang et al., 2009; Wright & Gundry, 2009; Prihartono et al., 1994; Faye et al., 2011; Freeman et al., 2009).

Electricity

For some purification methods access to electricity is a prerequisite. One out of two quantitative studies found a positive significant relation between having access to electricity and boiling their water (Sakisaka et al., 2002).

Water source of household

Seven quantitative surveys investigated if water treatment is related to different water sources. Five quantitative studies revealed a significant correlation between different types of water supply sources and water treatment uptake (for example tube well, tap water, surface water, different supply stations) (Tobias & Berg, 2011; Mäusezahl et al., 2009; Wright & Gundry, 2009; Faye et al., 2011; Larson & Gnedenko, 1998).

Age of child(ren) at home

Four quantitative surveys and one qualitative study examine the correlation of different age groups of children – babies, < 2, < 5, > 5, 10 – 14 – present at home and water treatment behaviour of female care takers. Only having children below the age of two and children between 10 and 14 year in a household showed a positive significant relation with water treatment adherence (Mäusezahl et al., 2009, Sakisaka et al., 2002). In-depth interviews from a qualitative study also revealed having babies present at home was positively associated with boiling water at home in Pakistan (Figueroa & Hulme, 2008).

Household members' health status

One qualitative study discovered by means of focus group discussions that continuous water treatment at home was inherited after a serious water borne disease caught a family member in Pakistan and as well in Haiti (Figueroa & Hulme 2008). In the descriptive quantitative study of Aini et al. (2007), 9% of filter users also gave the same reasoning for purchasing a water filter. Another focus group discussion pointed out that having a sick child present at home was related to treating water (Escobedoa et al., 2011). Households having at least one stunted or wasted child below the age of five at home were examined by two quantitative surveys. One of them found a positive significant relation with the stunted type of malnourishment (Mäusezahl et al., 2009) and the second one with the other type (Christen et al., 2011). Diarrhoea incidence and prevalence, and cough prevalence in children below five was also tested by the latter study, but no significant correlation could be proven.

Other

Several studies looked at one of the following socio-economic characteristics, but found no significant relationship with these factors and water treatment: Age of household members, bicycle, radio, gas cooker, television, number of rooms, solar panel, different job types, unemployment, animals present in the kitchen, number of family members, and household water consumption per day (Mosler & Kraemer, 2011; Altherr et al., 2008; Mäusezahl et al., 2009; Christen et al., 2011; Blanton et al., 2010).

Hygienic practises

Being interested in synergy effects of domestic and personal hygienic measures on water hygiene practises five quantitative studies examined aspects such as presence of soap, latrine ownership, cash spending on other hygienic products, clean house environment or actual hand-washing and their connection to treating water. Two quantitative surveys out of three found a positive significant association with hand-washing behaviour (Mäusezahl et al., 2009; Figueroa & Hulme, 2008). One quantitative paper out of two found a statistical significant linkage with latrine ownership (Christen et al., 2011) and another one with cash spending on household cleaning detergents and water treatment

(DuBois et al., 2010). No significant association with *soap present in the kitchen*, *clean house environment*, and *faecal contamination of housing environment* that were tested once by quantitative studies could be found (Christen et al., 2011; Mäusezahl et al., 2009).

Socio-cognitive variables

Knowledge

Understanding the causes of diarrhoea: 16 research papers studied the link between knowing what causes diarrhoea and treating water. Two of these studies applied qualitative in-depth interviews, one focus group discussions and another one in-depth interviews and focus group discussions. The remaining 12 were of quantitative origin. Two of the quantitative surveys included lay and false beliefs about diarrhoea. Lay ideas about causes of diarrhoea did not proof to be significant to not treat water (Graf et al., 2007). False believes such as "child can get sick if he/she returns to drinking purified water after drinking untreated water" showed to be influential as 142 mothers (42% of non-boilers) gave this as a reason for no longer boiling water (McLennan 2000, p. 17). However, no significance analysis was conducted for this survey. Next to the four qualitative studies (in-depth interviews and focus group discussions), one out of two quantitative studies found a positive significant relationship between biomedical knowledge of the causes of diarrhoea (Graf et al., 2007) and five out of six surveys discovered a significant positive relationship between knowing that contaminated water can cause diarrhoea and treatment methods (Graf et al., 2007; Kraemer & Mosler, 2011 b; Kraemer & Mosler, 2010; DuBois et al., 2010; Figueroa & Hulme, 2008). Another descriptive quantitative study solely stated that "perceived need for water treatment to prevent diarrhoea" was a contributing factor amongst the 58 chlorine users (in total 173 households surveyed) without specifically mentioning how many of the actual chlorine users gave that particular statement (Makutsa et al., 2001).

Knowledge about drinking water quality: The relation between knowing that the water is contaminated, or distrust the water quality and applying purifying techniques has revealed five positive significant results out of five quantitative studies (Tobias & Berg, 2011; Nagata et al., 2011; Kraemer & Mosler, 2010; Larson & Gnedenko, 1998). One study that only applied descriptive quantitative methods found that most of the people who were unsatisfied with their water quality (86 out of 100) took additional measures to improve the household water quality (85% used domestic filters, 41% boiled water, and 17% bought bottled water) (Aini et al., 2007). Two in-depth interviews found a positive association with particular occasions like specific seasons or epidemics and water treatment behaviour. Mothers for example knew that water is likely to be unsafe in rainy seasons (Wood et al., 2011; Figueroa & Hulme, 2008).

Awareness of water treatment products: Three quantitative surveys and one qualitative study explored if there is any positive relation between knowing about the existence of household water

treatment products and their application. All three quantitative studies found a significant association next to the positive relation in the qualitative in-depth interviews (Wood et al., 2011; Faye et al., 2011; Figueroa & Hulme, 2008; Blanton et al., 2010).

Proper knowledge of the method: One quantitative study investigated the relation of applying chlorine tablets and knowing what chlorine does and found a positive significant relation (McLennan, 2000). Three out of four quantitative interviews found a positive significant relationship between knowing how to use the method correctly, what it does and actual uptake of the technology (Graf et al., 2007; Altherr et al., 2008; Blanton et al., 2010). Also one qualitative study found a link by means of in-depth interviews (Wood et al., 2011).

Risk awareness

The perceived risk of diarrhoea depends on the perceived vulnerability – how likely it is to catch the disease – and the perceived severity of diarrhoea – how bad/serious is it to have the illness. Three quantitative researches analysed the first variable and four the latter. Two studies depict a significant association with perceived vulnerability (Mosler & Kraemer, 2011; Heri & Mosler, 2008) and three with perceived severity (Mosler & Kraemer, 2011; Heri & Mosler, 2008; DuBois et al., 2010).

Attitudes, outcome expectancies, affective beliefs

Attitude towards the product or method: Attitude towards the method, trust in the product, and the perceived value and relevance of it can influence the decision to adopt water treatment actions. Seven quantitative surveys tested these attitudinal components. Three of these studies found a positive significant relation - people with positive attitudes were more likely to treat their water, and people who distrusted for example chemicals were reluctant to apply this method (Altherr et al., 2008; Kraemer & Mosler, 2010; Figueroa & Hulme, 2008). Furthermore, four qualitative studies (in-depth interview and focus group discussions) reported a positive linkage as well (Wood et al., 2011; De Ver Dye et al., 2011; Hanchett et al., 2002; Figueroa & Hulme, 2008). One of the descriptive quantitative studies claims that "interest in chemical disinfection" was a contributing factor for starting treating water with chlorine (Makutsa et al., 2001, p.1572). However, no significant analysis was performed in this study. Also 85% of filter users in a quantitative study in Nepal, which only applied descriptive statistics, said they would recommend the filters to others, indicating a positive attitude towards the products (Ngai et al., 2007). One qualitative study revealed in in-depth interviews and focus group discussions that people were reluctant to treat their water with chemicals as they valued natural water greatly (Figueroa & Hulme 2008). Four qualitative studies mention that evaluation beliefs such as if it is worth investing time and effort in treating water can predict adherence of purifying water (Wood et al., 2011; Escobedoa et al., 2011; Hanchett et al., 2002; Figueroa & Hulme, 2008). All the five quantitative studies investigating the

same and the compatibility of treating water with other work pattern confirm the relation of such positive attitudes with actual purifying behaviour by means of significance tests (Mosler & Kraemer, 2011; Kraemer & Mosler, 2011 b; Heri & Mosler, 2008; Kraemer & Mosler, 2010; Tamas & Mosler, 2011).

Cost: The interpretation of costs is a little complicated. As on one hand costs can be interpreted as evaluation beliefs, meaning if it is worth spending money on water treatment, but on the other hand costs can also be a barrier in that sense that someone might believe that treating water is worth the money, but does not own the money to purchase those products. To keep things simple and as it was not always clear how to interpret costs in various studies (as evaluation beliefs or an economic barrier) both aspects about costs are summarised in the following. Three out of four quantitative studies investigating the relation between costs and household water treatment found an inverse significant relation between the two factors especially amongst the poor (Tobias & Berg, 2011; DuBois et al., 2010; McLennan, 2000). One qualitative study also suggests costs as a barrier to invest in water treatment products, next to a descriptive quantitative study, which stated that 17% of 60 discontinuers gave costs as a reason for discontinuing with water treatment (Figueroa & Hulme, 2008; Ram et al., 2007). Two other descriptive studies also argue that willingness to pay and affordability played an important role for the uptake of household water treatment methods (Aini et al., 2007; Makutsa et al., 2001). However, costs do not always have to be a hindering factor. One quantitative and another qualitative in-depth interview showed that realisation of saving costs (e.g. for treatment) on a long term basis with home water treatment practises is related to sustained water treatment behaviour (Heri & Mosler, 2008; De Ver Dye et al., 2011). The quantitative study confirmed the inverse significant relationship between cost and water treatment. However, in this case a perceived low cost lead to sustained behaviour, whereas the other studies concluded that the perceived high cost lead to omission.

Positive outcome expectancies: Sensual experiences - like taste, smell, and visual appearance - improved social status, and perception of improved health or safety after treatment can positively affect sustained behaviour. Finding different benefits associated with the treatment of water is crucial as several studies - especially hygiene oriented health studies - showed that positive health outcomes are often not sufficient to trigger behavioural change and additional convincing reasons are needed (Figueroa & Kincaid, 2010). Nonetheless, the feeling of improved health after treatment of family members was investigated by 12 studies. Six out of seven of the quantitative surveys found a significant positive relation with water treatment and believes that purifying water improves health (Mosler & Kraemer, 2011; Tobias & Berg, 2011; Kraemer & Mosler, 2011 b; Kraemer & Mosler, 2010; Tamas & Mosler, 2011; DuBois et al., 2010). Three quantitative studies that only applied descriptive methods to depict these relationships and one qualitative study (in-depth interview) also confirm this positive association. 99 % (out of 150), 67% (out of 85), and 72% (out of 1074) of water treatment users gave

health reasons for their sustained usage in the quantitative descriptive studies (Wood et al., 2011; Fiore et al., 2009; Aini et al., 2007; Ngai et al., 2007).

Regarding the sensuality of treating water, most of the studies focused on the taste after treatment. All four quantitative studies could illustrate a positive relation between improved/good taste after treatment and actual treatment (Tobias & Berg, 2011; Heri & Mosler, 2008; Tamas & Mosler, 2011). None of these studies however, focused on chlorine taste, which, as can be seen below, usually has an inverse relation to water treatment. Three descriptive quantitative studies also confirm that improved taste after treatment can be important motivators to treat water with filters. 100%, 75% and 95% respectively gave improved taste as a reason for treating water (Fiore et al., 2009; Aini et al., 2007; Ngai et al., 2007). One qualitative study (in-depth interviews) demonstrated that clarity of water after treatment is a reason for people to treat their water (Figueroa & Hulme, 2008). One quantitative survey found a positive significant relationship between turbid water and the application of a flocculent-disinfectant product. However this relationship was only observable for a short-term behavioural change. After some time flocculent-disinfectant product users of this longitudinal study changed to a chlorine product, which is cheaper and did not address turbidity (DuBois et al., 2010). Improved appearance and odour after treatment was inspected by two descriptive studies and these factors showed to be an important factor to treat water with filters. Reasons given for using filters were improved colour by 93% and 91% of the respondents and improved smell by 81% and 92% respectively (Aini et al., 2007; Ngai et al., 2007). The results of one qualitative in-depth interview and one quantitative study defined *improved cleanness/quality* after treatment as a determinant. What exactly is meant with this formulation though is not very straightforward. It could stand for improved transparency, taste, smell, etc. The quantitative survey found a positive significant relation with this factor (Altherr et al., 2008; De Ver Dye et al., 2011). Furthermore, one out of two quantitative surveys showed a positive statistically significant relation between the importance of clean water for a person and SODIS application (Tamas & Mosler 2011).

Finally owing a filter can be accompanied by experiencing an enhanced social status and in this manner influence treating water. This was demonstrated by one descriptive quantitative study and one qualitative in-depth interview (Aini et al., 2007; Figueroa & Hulme, 2008). However, the study of Fiore et al. (2009) presents arguments that owing a filter does not automatically mean water is regularly or - in some extreme cases - at all treated, if other motivating reasons next to the improved social status are lacking. Nearly all participants in their study stated that they use and like the filter because it improved their health status and the taste of the water (see above). However, this result is unlikely as 26% of the filtered water contained even a higher level of contamination than the untreated source water and 27% did not have any reductions in E. coli counts. Fiore et al. (2009) gave as a possible explanation that filter ownership was associated with a higher social status and the interviewees did not want to lose their

filters which were distributed free of costs by giving honest answers. It is also very well possible that respondents gave inaccurate answers for purpose of secondary gains.

Negative outcome expectancies: Negative associations with water treatment other than cost and time related arguments focus on sensual perceptions and health concerns just like the benefits described above. Two qualitative studies (focus group discussions and in-depth interviews) discovered that treating water with chemicals for example was associated with negative health concerns and therefore water treatment behaviour restrained (Escobedoa et al., 2011; Figueroa & Hulme, 2008). In one of these in-depth interviews also the perceived negative health consequences of interrupting the behaviour was associated with never starting with the behaviour. People feared they would not always be capable of treating their water and drinking untreated water in between would make them even more vulnerable to falling sick (Figueroa & Hulme, 2008). One quantitative study revealed a significant relationship with perceived adulterated water taste after its treatment and discontinuing the behaviour (Nagata et al., 2011). 18% of non-chlorine users in another quantitative study where for this part no significance analysis was made also gave taste as a reason for not chlorinating their water (McLennan 2000). Also the focus group discussions, in-depth interviews and quantitative descriptive part of Figueroa & Hulme (2008) confirmed this relation. The same study also found a negative association with the smell of chlorinated water and continuous water purification by means of the same research methods. Two qualitative studies (focus group discussions and in-depth interviews) further showed that the sensation of lack of control of external factors and a low efficacy feeling of preventing diarrhoea because of other transmission pathways negatively related with regularly treating water at home (Escobedoa et al., 2011; Figueroa & Hulme, 2008). Also 10% of mothers in McLennan's (2000) study said they stopped boiling water because the child will anyways drink untreated water elsewhere.

Affective believes regarding the water treatment behaviour: Feeling good about treating water or experiencing some kind of dissonance when forgetting or not being able to purify water was examined in seven quantitative studies. Five out of six found a positive significant relationship with affective believes and treating water (Mosler & Kraemer, 2011; Tobias & Berg, 2011; Kraemer & Mosler, 2010; Tamas & Mosler, 2011). One study also demonstrated that the emergence of tension when not performing the behaviour of interest seemed to have a positive significant effect on treating water (Tamas & Mosler, 2011). Kraemer & Mosler (2011 b) suggest as treating water at home appears to be a highly gendered matter it would be interesting to include in future research the influence of females' feeling of responsibility of family's health on the usage of household water treatment products.

Self-confidence and habit

Self-efficacy to use the method: All three quantitative studies which looked at self-efficacy found a positive significant relationship with the interviewee's ability believes to perform the water treatment

behaviour correctly and actual behaviour (Tobias & Berg, 2011; Figueroa & Hulme, 2008; Mosler & Kraemer, 2011). De Ver Dye et al. (2011) confirm this association with their qualitative in-depth interviews. One can argue that the perceived difficulty of using a method is as well connected to self-efficacy believes. Two out of four quantitative studies found inverse significant associations with perceived difficulty to apply a method and actual application (Tamas & Mosler, 2011; Figueroa & Hulme, 2008). Two qualitative in-depth interviews showed as well the link to perceived difficulty and applying a purification method (De Ver Dye et al., 2011; Figueroa & Hulme, 2008). In the quantitative study of Ngai et al. (2007) 86% of the user of a filter judged the perceived difficulty of using it as low. However, no significance analysis was conducted for this measure. Ease in using the product was also mentioned by a descriptive study as a contributing factor for applying chlorine (Makutsa et al., 2001).

Habits: Habit for treating water and getting used to the changed taste after treatment by certain methods is a very important factor for sustained behaviour over time. Variables such as remembering and getting reminded are supportive in developing a habit and ensuring maintenance. If people keep on forgetting to treat water, a habit will never be developed and successful sustained behaviour certainly not reached. Five out of six quantitative studies (Mosler & Kraemer, 2011; Tobias & Berg, 2011; Kraemer & Mosler, 2010; Tamas & Mosler, 2011) and one qualitative study in form of in-depth interviews (Figueroa & Hulme, 2008) found a positive (significant) relationship between remembering and regular water treatment. Two quantitative studies assessing directly habit development of different user types (such as of regular users, discontinuers, irregular users) in longitudinal studies confirmed the significant association between habit and treating water (Kraemer & Mosler, 2011 b; Tamas & Mosler, 2011). Two qualitative studies also suggest that getting used to the changed taste after treatment effects the sustained uptake of methods (Wood et al., 2011; Figueroa & Hulme, 2008).

3.2.2 Interpersonal Level

Social influence plays a major role on the interpersonal level. However, not all social influences take place alone on the interpersonal level. They can also act on an organisational, community, or society level as for social norms for instance. All determinants described below can be regarded as a part of social influences. No other factors appeared to be suitable for this category.

Social Influence

The influence of the promoters' persuasiveness (e.g., the credibility and kindness of the promoters) on water treatment during an intervention was tested by one quantitative and qualitative study (in-depth interview). It had a positive influence according to the qualitative study (Wood et al., 2011). This relation also proved to be significant according to the quantitative study (Mosler & Kraemer, 2011).

In one qualitative study (in-depth interviews) women complained that they do not get any support offered from household members for treating water, which forms an extra task for them. In addition their spouses are not very concerned about water contamination or think it is the governments' duty to provide safe drinking water to their inhabitants (Figueroa & Hulme, 2008). Two quantitative studies found a significant relationship with treating water with SODIS and the number of females present at home after an intervention. The studies do not try to explain this correlation (Christen et al., 2011; Figueroa & Hulme, 2008). However, this could be related to a better division of tasks and responsibilities, or a better awareness and an increased talking frequency amongst each other about water treatment methods. Talking about and recommending water treatment options to others can have a self-persuasive effect, act as a social incentive, or a reminder and thus have a positive impact on habit and behaviour (Mosler & Kraemer, 2011).

One study conducted in Africa tested the influence of school children on their caretakers after taking part in a promotional intervention on water treatment and provision of free trying examples during the beginning. The results showed a significant effect on sustained behaviour change (Blanton et al., 2010). Another study, already mentioned above, showed that mothers living in a household with children present aged between 10 and 14 are also significantly more likely to treat their water. The authors suggest in the discussion that these might as well have been the influence of children's knowledge about hygienic measures from school (Mäusezahl et al., 2009).

3.2.3 Community and society level

Community and society level were clustered together as it is difficult to draw clear lines between them with respect to social influences. In many cases determinants can be attributed to either one of them. However, the determinants *availability, attendance at promotional activities, possibility of free trial* and *local preferences* can be referred to the community level solely.

Availability

Two interviews out of four quantitative surveys found a positive significant association between regular product availability and their usage (Heri & Mosler, 2008; DuBois et al., 2010). One other descriptive study states that the availability of treatment tools is an important requirement for regular usage, but the authors do not provide any numeric evidence to underlie their statement (Makutsa et al., 2001). Two qualitative studies (in-depth interviews) also mention interviewees complaining about products or parts of them not being available as a reason for discontinuing or never starting with water treatment in rural settings (Escobedoa et al., 2011; Figueroa & Hulme, 2008).

Free trial

One quality study argues that the possibility to try a water treatment product for free for a certain period of time convinced female caretakers of the benefits of the products and thus leads them to purchase the product (Wood et al., 2011). Another quantitative study claims the same. However, it does not present any kind of quantitative relationship for this proposition and just uses it as a very likely explanation in the discussion, derived from the diffusion of innovations theory by Rogers (1995), for the success of the school campaign (Blanton et al., 2010).

Social norms

Often descriptive and injunctive norms are jointly expressed by the terms social norms or normative beliefs. Descriptive norms usually indicate perceptions about which behaviours are typically performed, whereas injunctive norms point out perceptions about which behaviour are ought to be done, meaning which behaviours are typically approved or disapproved. Descriptive norms were analysed by six studies, and five of them found a significant relationship with adopting water treatment behaviours (Mosler & Kraemer, 2011; Tobias & Berg, 2011; Altherr et al., 2008; Heri & Mosler, 2008; Tamas & Mosler, 2011). Injunctive norms were tested by seven quantitative surveys, and three qualitative studies (in-depth interviews) (Wood et al., 2011; Escobedoa et al., 2011; Figueroa & Hulme, 2008). Five quantitative studies found a significant linkage with water treatment (Mosler & Kraemer, 2011; Tobias & Berg, 2011; Graf et al., 2007; Kraemer & Mosler, 2011 c; Kraemer & Mosler, 2010). Heri & Mosler (2008) also examined if the motivation to comply with social networks has any influence on purification behaviour next to the perceived social norms. However, they were unsuccessful in showing a significant relationship between these two variables.

Attendance at several promotional activities

Four quantitative studies looked at the relation between how often someone attended community educational promotions and water treatment behaviour. Three of them found a significant result (Heri & Mosler, 2008; Kraemer & Mosler, 2011 b; Christen et al., 2011). Also one qualitative study (55 in-depth interviews) reports that the number of home visits of health workers had a positive effect on the usage and later purchase of filters in Malawi (Wood et al., 2011). However, one has to be cautious interpreting results where the attendance was “voluntary”, as people who pursue a health oriented life or for whom hygiene in general is important are more willing to attend these events, but on the other hand they might as well anyways be more likely to take up water purification methods at home. Another way of interpreting the influence of promotions could be as injunctive norms, as health promotions or campaigns tend to tell us what we should be doing according to some experts.

3.2.4 National Level

Under this category only one subgroup, *standardised information,* was identified.

Standardised information

One qualitative study argues that more promotional efforts and standardised and clear information on a wide basis are needed in order to diffuse the technology, given the fact how less people knew about the condition of their water quality and (correct) water treatment practises in their study (Figueroa & Hulme 2008). Boiling (39%) and cloth filter (35%) were the most known methods, followed by a commercial chlorine product (8.7%) amongst 1500 interviewees in Pakistan. However, cloth filters are not considered to be a reliable method to eliminate microbes.

3.3 Overview of the outcome of the literature research

The systematic literature review on determinants influencing water treatment practises was performed to get an insight into why some people treat water regularly whereas others restrain from this behaviour. Several studies conducted in low-income countries were found which investigated different predictors of various water treatment methods. Most of the factors could be categorised into demographic, knowledge and attitude variables and focused on personal or interpersonal influences. As the literature research revealed many different behavioural determinants for water treatment by different study types a summary table is provided below (see table 3). The amount and potency of evidence on which basis the explanatory power of the variables can be judged vary for the determinants. The resulting determinants have been assessed according to:

i) how often they were found to be significant in the quantitative studies they were analysed in relatively (second column)
ii) the relative strength of the research designs of significant and insignificant results (third column)
iii) the percentage of descriptive quantitative studies examining the influence (fourth column),
iv) and the fraction of qualitative studies reporting a relation (fifth column).

Regarding the relative strength of the research design (ii), studies that performed quantitative analysis used either a longitudinal or cross-sectional design. Longitudinal designs can be regarded as a stronger method compared to cross-sectional designs (Webb & Bain, 2011). For each factor it was reported whether the research design of the significant or in-significant results were stronger. With respect to qualitative studies no difference between FGDs and in-depth interviews is made. Both study types made use of a big sample sizes, and both types of studies have their own advantages and disadvantages. In general quantitative studies performing a significance test can be regarded as delivering a better approach to present evidence compared to descriptive quantitative or qualitative

studies. Interestingly in this overview, determinants that scored high with respect to descriptive quantitative or qualitative percentages also always achieved high marks on significance levels. Based on these four criteria, parameters providing the strongest evidence have been shaded in table 3. Following determinants can be regarded as of having some importance: ethnicity, water source of household, different knowledge aspects, perceived risk of diarrhoea, various attitudinal variables, self-efficacy to use the method, other hygienic measures, social influence and norms, and how often people participated in promotions/repeated house visits. The evidence base for education and monthly income was not very straight forward, as significant results out-weighted non-significant results slightly in their occurrence, but the insignificant results applied a stronger research method. Different hygienic measures, such as a clean house, and animals and soap present in the kitchen, etc. did not seem to be influential. However, as synergy effects of hand-washing, and latrine ownership and its usage on water treatment were defined as a knowledge gap in the literature they were examined separately, and although rarely studied, they seemed to be influential.

Table 3: Summary overview of literature review and influential determinants

	Determinants	significant (relative)	Strength of research design	quantitative descriptive (relative)	qualitative (relative)
Personal level factors					
Demographics	**Ethnicity**	100.0%	All sig.	0.0%	0.0%
	Education of water treating person	60.0%	Insig. stronger	20.0%	0.0%
	Monthly household income/wealth	60.0%	Insig. stronger	0.0%	0.0%
	Electricity	50.0%	equal	0.0%	0.0%
	Water source of household	71.4%	Insig. stronger (a bit)	0.0%	0.0%
	Age child	40.0%	Insig. stronger	0.0%	25.0%
	Household members' health status	40.0%	Insig. stronger	20.0%	50.0%
	Other	0.0%	All in-sig.	0.0%	0.0%
Knowledge	**Understanding the causes of diarrhoea**	75.0%	Sig. stronger	40.0%	100.0%
	Knowledge about drinking water quality	100.0%	All sig.	20.0%	50.0%
	Executive knowledge and functional knowledge	80.0%	Sig. stronger	20.0%	33.3%
	Awareness of water treatment methods/products	100.0%	All sig.	0.0%	33.3%
Risk awareness	**Perceived risk of diarrhoea**	71.4%	Sig. stronger	0.0%	0.0%
Attitude	**Attitude towards the method (incl. time & effort)**	75.0%	Sig. stronger	40.0%	100.0%
	Cost	80.0%	Sig. stronger	60.0%	50.0%
	Positive outcome expectancies (incl. health impact, sensuality, social status)	94.1%	Sig. stronger	60.0%	50.0%
	Negative outcome expectancies/disadvantages	100.0%	All sig.	33.3%	50.0%
	Affective beliefs towards water treatment	85.7%	Sig. stronger	0.0%	0.0%
Self-efficacy	**Self-efficacy to use the method**	71.4%	Sig. stronger (a bit)	40.0%	50.0%
Habit	**Habit and remembering**	87.5%	Sig. stronger	0.0%	50.0%
Hygienic measures	**Personality trait (hygienic personality):**	44.4%	similar	0.0%	25.0%
	hand washing with soap	*100.0%*	All sig.	0.0%	0.0%
	latrine ownership	*50.0%*	Sig. stronger	0.0%	0.0%
	cash spending on other hygiene products	100.0%	All sig.	0.0%	0.0%
Interpersonal level factors					
Social influence	**Social influence (interpersonal level)**	100.0%	All sig.	20.0%	50.0%
Community / society level factors					
Availability	Availability	60.0%	Insig. stronger (a bit)	20.0%	50.0%
Triability	Triability	0.0%	Not assessed	0.0%	33.3%
Promotion	**How often participated in promotions/repeated house visits**	75.0%	Sig. stronger	0.0%	33.3%
Social norms	**Social norms (community, society level)**	69.2%	Sig. stronger	0.0%	75.0%
National / district level factors					
Information	Standardised information	0.0%	Not assessed	0.0%	25.0%

Note: sig = significant; insig = insignificant

strongest negative evidence

strongest positive evidence

3.4 Integrative behaviour change models

Besides empirical evidence from previous studies about the topic at hand, theories from behavioural science can be helpful to explain behaviour. Behavioural theories provide a structured logical framework for influential determinants, which can be used for developing interventions and changing behaviour. To better understand how and why individuals engage in healthy or preventive behaviour and refrain from risky behaviour several health behaviour models have been developed since the 1950s. The pioneering work from Hochbaum (1958) and Rosenstock (1960) to understand why individuals engaged or did not engage in tuberculosis screening programme and related work led to the development of the Health Belief Model, one of the oldest model in health psychology (Champion & Skinner, 2008). Especially in the past 25 years many models have emerged which can be applied to health related behaviours and which have been empirically tested. Since then value expectancy theories, which include the Health Belief Model and the Theory of Planned Behaviour, an extension of the Theory of Reasoned Action, by Fishbein and Ajzen (1975) matured (Rimer, 2008; Conner & Norman, 2005). Overall there exist many different behaviour theories today with different foci. Some of them concentrate more on intra-person factors such as the Health Belief Model or Theory of Planned Behaviour and others focus more on environmental aspects such as the Social Cognitive Theory. As both perspectives are important and one theory is often not sufficient to explain complex behaviours, it is becoming a norm nowadays to combine different theories for health behaviour interventions (Rimer, 2008). Moreover, as there is considerable overlap between different behaviour theories, behavioural science researchers have developed integrated social cognition models including important constructs from different theories (Conner & Norman 2005; Glanz et al., 2008; Fishbein, 2000). In the following one such integrated model will be introduced and its main constructs explained. In addition, two other important constructs from different theories will be described, which are not part of the original integrated model.

One famous integrated model was developed by five major behavioural science theorists during a workshop organised by the National Institute of Mental Health for HIV preventive promotions (Conner & Norman, 2005; Bartholomew et al., 2006; Fishbein, 1995). They identified in total eight variables, based on five theories[2], which should account for most of the variance in any behaviour. These factors were split into two sets. Three of them are viewed as *necessary* and *sufficient* determinants of behaviour and constitute the first set. For behaviour to occur an individual must (i) have a strong intention to perform the behaviour, (ii) have the necessary skills to perform the behaviour and (iii) experience an absence of environmental constraints that could prevent behavioural performance. The

[2] The Health Belief Model, the Social Cognitive Theory, the Theory of Reasoned action, the Theory of Self-Regulation and Self-control, and the Theory of Subjective Culture and interpersonal Relations

remaining five variables from the second set are supposed to influence the strength and direction of intention. Intention can be seen as a mediating factor between motivational variables and behaviour and hence as an immediate antecedent of action. The variables leading to an intention are (Bartholomew et al., 2006):

(i) The instrumental attitude component: The beliefs about the positive and negative consequences of behaviour, weighting its advantages and disadvantages.

(ii) The affective attitude component: The emotional or affective response towards performing the behaviour. A person with a strong negative emotional reaction is less likely to perform a behaviour compared to a person with a positive reaction.

(iii) Norms: The individual perceives the normative pressure to perform the behaviour to be greater than not to perform the behaviour.

(iv) Self-identity: The person's feeling that the behaviour is consistent with his or her self-image and personal norms.

(v) Self-efficacy: The person's perception and confidence of being able to perform and control the behaviour even in light of difficult circumstances.

Fishbein, one of the researchers involved in the development of the integrated model, stresses the point that attitudes, perceived social norms and self-efficacy are all "*functions of underlying beliefs—about the outcomes of performing the behaviour in question, about the normative proscriptions and/or behaviours of specific referents and about specific barriers to behavioural performance*". The more one evaluates the benefits to outweigh the disadvantages, feels the social pressure and has the motivation to comply with it, and the stronger the belief in one's ability to perform the behaviour despite specific barriers the stronger will be the intention to perform the behaviour (Fishbein, 2000, p. 275-276).

The construct of norms for the integrated model was taken from the Theory of Reasoned Action and are defined as injunctive norms. The injunctive norm indicates beliefs about the normative expectations of other people, meaning a person's belief about what others think one should do and what is typically approved or disapproved. Fishbein (2007) later remarked that this definition from the Theory of Reasoned Action might not capture the normative influence sufficiently. The descriptive norm, a perception of what others in a social network are actually doing, may also be important in capturing part of the normative beliefs. Descriptive norms comprise "the strong social identity in certain cultures which, according to some theorists, is an indicator of normative influence" (Montano & Kasprzyk, 2008, p. 79). Furthermore, one can learn from others by observing what role models around one do according to the Social Cognitive Theory and in this manner others can have an influence on one's perception and behaviour (Bartholomew et al., 2006; McAlister et al., 2008). Under conditions of uncertainty, such as low-efficacy or when information and experience is lacking, people look at others, and hereby get

influenced as they want to do things right. This can lead to an attitude change, by accepting others ideas as correct (Bartholomew et al., 2006).

One aspect for which the integrated model has been criticised for is that it does not incorporate risk perceptions, a construct composed out of susceptibility and severity of a disease, from the Health Belief Model (Conner & Norman, 2005; Becker, 1974). Risk perception can be seen as a form of attitude towards the disease and lead to a motivation to take preventive measures against the disease. Perceived susceptibility seems to be a stronger predictor of preventive health behaviour than severity according to empirical data (Brewer & Barbara, 2008). In order to be motivated to take preventive actions against the perceived risk the person must believe that the behaviour of interest is effective to avert the disease. This behavioural belief, targeted towards a goal, is called response-efficacy (Casey et al., 2009). Response-efficacy can influence the formation of an attitude and might be a necessary belief for undertaking preventive behaviours but may not be sufficient for engaging in them (Casey et al., 2009).

In order to maintain the behaviour that has to be performed regularly a habit formation is needed. Habitual behaviours are performed automatically, without much cognitive efforts and no strong conscience intentional processing takes place (Montano & Kasprzyk, 2008). Whereas habits can support that the behaviour is performed regularly, old habits can also be a hindering factor for developing new regular behaviours. This occurs in cases for example where someone lacks skills or abilities like self-regulation and action control over the new behaviour (Verplanken & Aarts, 1999).

Finally, external factors such as demographic variables, personality traits and other individual differences can influence behaviour indirectly. They are regarded as distal background factors affecting motivational beliefs, which mediate their effect on intentions and behavioural performance. It is acknowledged that such background factors can give important information on antecedents of behavioural, normative and self-efficacy beliefs. Different background factors such as a different cultural setting can influence the impacts of motivational factors, which again can influence the formation of intentions (Fishbein, 2000).

3.5 Integrated theoretical framework

In this section insights from the theoretical constructs from different behaviour theories and findings from the literature on water treatment are applied to present an integrated theoretical framework. Figure 4 below summarises the integrated theoretical framework for water treatment. This integrated framework is expected to explain variations between followers and non-followers of water treatment practises. It is believed that the influence of different background factors from the literature review on intention and actual performance is interceded by motivational determinants. Motivational determinants can be influenced by beliefs such as drinking untreated water is unhealthy (vulnerability),

treating water can improve health (instrumental attitude), and taste (affection) positively, expectations from doctors (injunctive norms), learning from neighbours (descriptive norms), beliefs of being a good care taker when treating water (self-image), being capable of treating water (self-efficacy). The influence of different motivational factors can be very diverse. For example a positive attitude in terms of positive outcome expectancies such as improved health can have a higher influence on a positive intention than social pressures perceived from the personal social network. Although the influence of motivational factors can differ amongst individuals it is also very well possible that a similar pattern stands out between them in a population. These motivational variables are supposed to be mediated by intention to treat water. The likelihood of treating water is supposed to be high when the intention is strong and no environmental constraints (e.g. availability of treatment products) exist and the person possess the right executive knowledge and skills. Finally, for sustained users habit or automatic behaviour is important to perform the behaviour regularly. Automatic behaviour can decrease the effects of intention on behaviour.

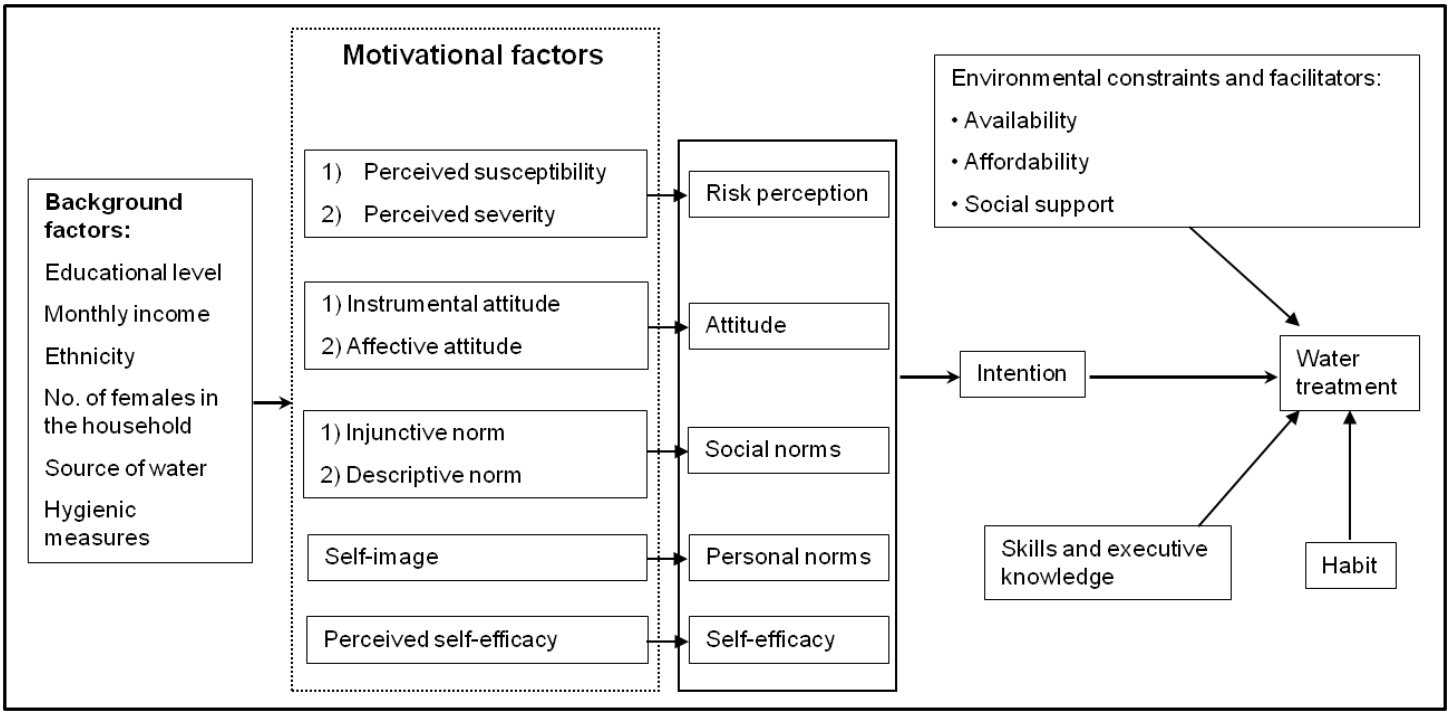

Figure 4: Explanatory model for water treatment

Only few studies were found in the literature that used a logical model to explain water treatment behaviour. However, none of them were conducted in India. To the authors knowledge no study has applied an a-priori defined theoretical framework based on empirical findings and behavioural theories to explain water treatment.

3.6 Study objectives

Resulting from the integrated theoretical framework following research questions can be formulated:

1) Which determinants resulting from the theoretical framework are the most powerful to explain different users and non-users of household water treatment methods?
    a. Which background factors (educational level, monthly income, ethnicity, number of females in the household, water source, and hygienic measures) influence motivation, intention and water treatment?
    b. Which motivational factors (risk perception, attitudes, social norms, personal norms and self-efficacy) influence intention and water treatment most?
    c. To what extent does intention influence water treatment?
    d. And which post-intentional factors (environmental constraints, skills, and habit) additionally explain water treatment?

In order to minimise diarrhoea incidences not only simply following HWTS methods are important, but also the correct application is crucial to experience their full health benefits. This leads to the second research question:

2) What is the effect of applied water hygiene practises on the drinking water quality?
    a. What is the effect of water treatment on the drinking water quality when controlling for its source contamination?
    b. What is the effect of different storing methods on the drinking water quality (covered vs. non covered, small vs. big mouth, age of water in the storage vessel?)?
    c. What was the effect of serving tools on water quality (directly pouring water into the glass, and using tools with and without handles attached to it)?

4. Methods

This chapter aims at describing the methods applied to answer the research questions posed in the previous chapter. The research setting, study population, measures, research procedures and statistical analysis techniques will be discussed below.

4.1 Setting

In order to better understand the institutional context in which the water hygiene practises take place, the point of views of local influential key stakeholders on HWTS were assessed by means of short semi-structured interviews (see Appendix C for interviews). Stakeholders interviewed were employees of governmental local water bodies, a member of the State Urban Development Agency (SUDA) of Uttar Pradesh, a manager of a governmental hospital, and the director of a local non-governmental organisation (NGO). The interviews revealed that the quality of piped in water cannot always be trusted

in slum areas, where illegal connections often contain leakages, and therefore potentially cause water contamination. Despite these facts, the different governmental sectors are not doing anything to inform individuals about the risks of drinking untreated water. Even though some of them acknowledged that more has to be done in direction of public awareness, concerted efforts on a large scale are currently lacking. NGOs are regarded as the key supportive agents to promote household water treatment and safe storage practises, as they are able to directly interact with communities. However, NGOs depend largely on the concepts of social marketing for promoting HWTS and hence on local partnerships such as with the private commercial and financing sector to ensure that individuals continuously get the appropriate and affordable products. This makes it sometimes difficult for NGOs to keep their neutral image.

This research was conducted with the support of a NGO called "Pratinidhi" based in Lucknow. Pratinidhi is very active in HWTS and hygiene promotions and works together closely with large organisations like the United States Agency for International Development (USAID) and PATH (an international non-profit organization focussing on health issues). For its HWTS projects in the past, Pratinidihi sub-divided the city into five major zones (north, south, east, west and central). This study was conducted in two districts in the Eastern zone of the city, where poverty is prevalent and where Pratinidhi found the source water of the inhabitants to be contaminated regularly. The two study districts are Luvkush Nagar (near Kukrail flyover) and Jugouli (near Lekhraj busstop) (see figure 5). About 5270 people live in Luvkush Nagar and approximately 4650 in Jugouli.

Pratinidhi conducted a large water treatment promotion campaign in these districts over two years ago and every six months educational sessions about hygiene practises took place. The last time the inhabitants from these districts experienced an educational session was over eight months ago. Part of these campaigns included social marketing strategies, where different treatment products from different manufactures were offered to the population. Furthermore, as they belonged to the lower income class, Pratinidhi offered them attractive credits through a micro finance scheme. During this intervention some households also received free filters from the manufacturer Tata. For a more detailed description of the intervention see Appendix D.

Figure 5: Luvekush Nagar and Jugouli, the two study areas in Lucknow. Source: Google maps

It was important that the study population experienced an intervention that addressed the need to treat the drinking water in that particular area, including proofs about the water contamination and information about different water treatment options. Otherwise there would have been the risk of too many people not being aware of the poor water quality and of methods to improve the quality of their drinking water (Figueroa, 2012). It is difficult to measure attitudinal beliefs of water treatment products or why people do not use certain products if they do not know about the existence of such products. However, in order to minimise the short term behavioural effects many interventions have, a study population was selected which did not experience any intervention in the recent past (at least six months).

4.2 Study Population

For the purpose of this study a convenience sample was chosen. No special requirements had to be fulfilled for the inclusion or exclusion of participants. The two districts included in this study were divided further into four to five blocks. Individuals from all these different blocks were included in the

study to ensure a more even representation of people living in different parts of these areas. The person usually responsible for water treatment and preparing and serving food and beverages in the household was interviewed.

4.3 Measures

For answering research question number 1a-d a structured quantitative questionnaire was developed, assessing the different concepts of the theoretical framework. For answering research question 2a-d a structured questionnaire with observational elements was applied and water samples were collected and tested for contamination levels. The research design of this study was cross-sectional, meaning that all the data was collected from individuals at one point of time. This section is going to elaborate in detail on these different measures.

4.3.1 Questionnaire

All items from the theoretical framework were tested using a 5-Point Likert scale, with background factors and water treatment being the exceptions. Most answer categories of those scales ranged from 1- Totally disagree to 5- Totally agree. Exceptions are always mentioned below in brackets. The reliability of the scales was assessed using Cronbach's alpha. Items that used reversed scales were recoded (1 --> 5; 2 --> 4; 3 --> 3; 4 -->; 5 --> 1). An item was deleted from a scale if the Cronbach's alpha was below 0.80 and item removal would result in a relevant increase (≥.01). A value around at least .7 is usually considered to indicate acceptable internal consistency reliability. Mean scores were computed for items combined in one scale. Table 4 below summarises the outcome of the reliability analysis of the final scales.

Table 4: The Cronbach's α of scales

Scale	No. of Items	Cronbach's α (N)
Vulnerability	3	.81 (130)
Attitude	13	.80 (130)
Injunctive Norms	3	.59 (130)
Descriptive Norms	4	.85 (130)
Personal Norms	4	.51 (130)
Self-Efficacy	5	.75 (130)
Intention	3	.91 (130)
Skills	4	.52 (130)
Barrier	5	.57 (130)
Habit	4	.83 (130)

Background factors were measured with several different items. *Number of females present in the household* was measured with two questions. 1) How many girls below 14 years live in your household? 2) How many females above 14 live in your household? As belonging to different *ethnicity groups* was not directly applicable for this study, people were asked about their religion and castes. 1) What is your religion? [Islam, Hinduism, Christian, Sikhism, Others] 2) What is your caste? [Scheduled caste, Scheduled tribes, Other backward class, General, None]. The following question was related to the *source of water*: 1) What is currently your main source of drinking water? [Piped water into dwelling, private borehole, public tap, hand pump]. All *Hygienic measures* were assessed with the three individual questions. 1) For what did you use hand washing soap yesterday? [For nothing, washing my hands after defecating, washing my hands before preparing food, washing hands before eating, other]. 2) Do you have a toilet facility at home? [No, Yes] 3) Do you make use of a special detergent for cleaning (for example your floor)? [No, Yes]. *Educational level* was measured by asking: Until which grade did you study [0-15]? *Monthly income* was inquired with the question: What is the income of your entire household [number in Rupees].

Other demographic variables such as age, gender and number of household members, income level, house type, occupation and educational level were also included in the questionnaire.

Vulnerability/susceptibility was measured with three items. 1) I believe the water from my main source is safe to drink untreated 2) Whenever water is clear it is safe to drink 3) Water only needs to be treated when it looks dirty. The Cronbach's α for this scale was .81.

Severity consisted of the following three items: 1) Diarrhoea is something very common. It is nothing to worry about 2) If my child has diarrhoea very often this is not good 3) If you contracted diarrhoea, how severely would that impact your life? [not bad at all / very bad]. The reliability of this scale scored only .21. Therefore, severity as a subscale of the risk scale had to be omitted.

Instrumental attitude was assessed with eight different questions. 1) It is worth to invest money in water treatment. 2) It is worth to invest time in water treatment 3) Treated water is safer to drink compared to untreated water. 4) Treating water does not help to improve health outcomes. 5) I cannot prevent someone from falling sick by treating water. It is God who decides about who falls sick and who remains healthy. 6) Chemicals that are used to treat water are unhealthy to consume. 7) Do you believe it is bad or good to treat water? [very bad / very good] And 8) Do you believe it is good or bad to drink untreated water? [very bad / very good]. The Cronbach's α for this scale resulted in .63. Deleting item number 6 resulted in a higher reliability score with .66. Therefore item 6 was removed from the subscale.

Affective attitude was measured with six questions. 1) Always treating water is a hassle. 2) Drinking untreated water is disgusting 3) I feel sorry whenever offering someone else untreated water. 4) Treated water smells better than untreated water. 5) How does it feel like treating water for the entire household? [very unenjoyable / very enjoyable] 6) How do you perceive the taste of treated water [very bad / very good]. The reliability of this scale was .75. As attitude is comprised of both an affective and instrumental dimension, the affective and instrumental scales were assessed together. Since the combined items revealed a higher Cronbach's α score .80, the scales were combined in one attitude scale. Item 6 was also removed from this scale, as that step improved the reliability.

Injunctive norms were measured with four items. 1) Do your household members expect you to treat water? [not at all / very much] 2) Does your doctor expect you to treat water? 3) How often are you told by NGOs or other promotion activities to treat your water? [never / always] 4) What would others (such as your neighbours, friends, relatives) think of you if you were not treating water [very bad / very good]. For each of these items the motivation to comply with these norms was measured with four motivational items respectively. 1) I do what my household members expect me to do. 2) When it comes to health matters I want to do what my doctors says with respect to water. 3) How often are you motivated to listen to what the staff from the NGOs or promotions tell you to do? [never / always]. And finally 4) It matters to me what others (such as my neighbours, friends, relatives) think about me if I do not treat water. The matching pair items were combined to a new item by multiplying them with each other. The reliability scale was .58. Removing item four from the scale resulted in a higher score with .59.

Descriptive norms were assessed with four items as well and the answer categories for all the four items ranged from none to everybody on a five point scale. 1) How many people do you know in this community who do not treat their water? 2) Do any of your neighbours treat water? 3) Do any of your relatives treat water? 4) Do any of your friends treat water? All of these items were multiplied with one general motivational item: Seeing many others treating water would be a reason for me to treat water as well. The reliability of the scale was .85. Desriptive and injunctive norms was not combined to one scale, the social norm scale, as the Cronbach's α of the combined items was lower than the reliability score of the descriptive norm scale of its own.

Personal norms were measured with following four questions: 1) Hygienic people treat their water. 2) People who care about their family treat their water 3) It is my duty to take care of my family's health by providing them with clean water 4) If the government fails to supply us with safe drinking water it is my responsibility to provide clean drinking water to my household members by treating water. The Cronbach's α was .51.

Self-efficacy consisted of initially six items. 1) I feel capable of always treating water even if I am busy 2) I am confident that if I wanted to I could treat water. 3) Treating water daily for the entire

household is difficult for me 4) Whether I treat water is entirely up to me. 5) How confident are you to be able to treat water when you are short of money? [very unconfident / very confident] 6) How confident are you to treat water if someone important to you is not in favour of treating water? [very unconfident / very confident]. The reliability analysis resulted in .74. Deleting item number 2 resulted in a higher reliability score with .75.

Intention to treat water was measured with three items. Following remark was made before asking every item: *Please, when answering this question also keep challenging situations in your mind, for example when there is lack of money, time, availability and motivation.* 1) I intend to always treat water in the coming month no matter if the water appears to be clean or dirty. 2) How often do you expect to treat water in the coming month [never/ always] 3) How often do you plan to treat water in the coming month [never/ always]. The Cronbach's α was .91.

Skills and executive knowledge were assessed with following four items: 1) I make sure whenever I am about to run out of stock of the things I need for treating water I buy or order a new load so that there is no interruption in the water treatment process 2) I make sure whenever treated water is almost finished, I treat more water in time. 3) Do other tasks hinder you from treating water? 4) I know how to treat water. The reliability score resulted in .52 for this scale.

Barriers/facilitators were assessed with five items. 1) I know where to get the tools for water treatment 2) My household members (would) give me a hand with treating water if I needed their help 3) I am unable to treat water because it is too expensive 4) In case I forget treating water my household members remind me. And 5) Getting the tools needed for water treatment is fairly easy for me. The reliability of this scale was .57.

Habit was measured with five item questions. 1) Treating water is a habit for me. 2) I have a fixed way of treating water 3) Looking at tomorrow, I exactly know when I will be treating water. 4) How easy is it for you to remember treating water [very difficult / very easy]. 5) It is a common thing that people intend to treat water, but forget to do so. How often does that happen to you? (or could happen to you) [never / always]. The Cronbach's α resulted in .83.

Behaviour/ action water treatment was measured in three ways. 1) How often do you treat water in general? [never, rarely, sometimes, often, always] 2) Do you currently have treated water available for taking a sample? [No, Yes], 3a) How often did you collect drinking water in the past three days? [number] b) How often did you treat water in the past three days? [number] The initial idea was to combine the items of the latter two questions into one ratio measure: *number of times water was treated / number of times drinking water was collected*. The outcome would have been a continuous variable ranging from 0 (never treated in last 3 days) to 1 (always treated in last 3 days). However, as the size of containers in which people collected their water and treated their water differed, this measure

did not reflect an appropriate continuous scale anymore for identifying individuals who always treated water. Therefore, it was decided to drop this item to measure behaviour.

To make it easier for the interviewee to understand the five point answer scales and the fine differences between the different answer categories, diagram charts were developed. Different colours and sizes of circles illustrated the degree of agreement or disagreements that could be chosen to answer the questions (see questionnaire in the Appendix F).

People were asked *if and how they treat water* with following question: 1) What do you currently mainly do to make water safer to drink? [Boil, Add chlorine tablets, Strain it through a cloth, Let it stand and settle, Filter, Solar disinfection, Phitkari/Alum, Nothing, Don't Know].

Following *storage* related questions were asked or observed during the interview based on the checklist of Hernandez (2007) and Murcott (2006): 1) How do you store your drinking water (*also have a personal look at the storage vessel*) [Clay pot, Plastic bucket, Plastic bottle, Steel bucket, Filter, Vessel with a tap, Other). 2) Do the vessels have a narrow mouth or a wide mouth? [Narrow mouth, Wide mouth] 3) How do you get water out of the drinking container? [Glass / cup with handle, Ladle, Pour into drinking glass/cup directly, Tap, Any device without a handle] 4) How old is the water in the storage container? [number in days].

4.3.2 Water quality tests

For assessing the water quality two water tests were performed using the drinking water testing kit from TERI. Those two tests were 1) a residual chlorine test and 2) a total coliform test by means of H2S test stripes. Whenever possible, water samples from the source and the vessel water was stored in was collected.

Each time an interviewee claimed to have used chlorine as a treatment method during the interview, a chlorine residual test was performed, which tests if free chlorine (chlorine residuals) is present in the water sample. An outcome showing that at least 0.2 mg/l chlorine is present in a free form, indicates that enough chlorine is available for disinfection and that no microbes are present in the water (TERI, 2005). For testing for residual chlorine, a test tube, a dropper and Ortho-toluidine reagent was used. A 10 ml water sample was collected in the test tube and 10 drops of Ortho-toluidine solution was added with the dropper. Then it was checked if the colour of the sample changed to at least a medium yellow shade, which indicates a minimum amount of 0.2 mg/l of free chlorine present in the sample (see Appendix E for colour shading scheme). The same test was performed in cases where people obtained their drinking water from household taps as a source. This was done because water delivered through governmental pipes is treated with chlorine and samples should indicate some free chlorine present in the water to ensure safe water quality. Only when the colour of the water did not turn yellow after the chlorine test was performed, another sample was taken for a total coliform test.

The second method adopted for testing the water quality was a total coliform test. This test is an indicator test, which simply states if any kind of coliform is present in the water sample (presence-absence test, P-A test). Coliform bacteria present in drinking water are a good indicator for the presence of pathogenic bacteria that pose health risks and are therefore a useful indicator of treatment efficiency and microbial water quality (Ramteke et al., 1994). According to the WHO guidelines drinking water should not contain any of those coliforms (WHO, 1997). The P-A test is an inexpensive method when resources are limited for a rapid qualitative detection of bacterial indicators of faecal pollution and comparable to alternatives such at the multiple tube fermentation (MPN) and membrane filtration (MF) procedure. Statistical analysis of performed tests showed a 91.31 - 94.7% sensitivity and a 89.1 - 93.9% specificity in detecting total coliform (Pathak & Gopal, 2005; Sobsey & Pfaender, 2002). Moreover, this simple test could be performed by the interviewers themselves and no laboratory environment is needed. However, this P-A test is not able to distinguish between different coliform types. So it is not possible to detect if E. coli bacteria caused the contamination of the water. E. coli is regarded as the most reliable indicator of faecal contamination and total coliforms as the least reliable indicator for this purpose (Sobsey & Pfaender, 2002); Rompre et al., 2002). This limits the applicability of this test as a reliable indicator for faecal pollution specifically.

The water quality testing kit from TERI contained testing bottles with hydrogen sulphide (H2S) paper-stripes in them, which is the medium needed to test for the presence of coliform bacteria. In cases where water was not treated with chlorine or the tap water did not turn yellow after performing the chlorine test, the H2S test was performed. The procedure for taking the water samples and the precautinary steps undertaken were as follows:

1) On every sample bottle the same number was noted down as on the questionnaire. Furthermore, it was always noted if the sample was taken from a source or storage vessel.
2) For each sample a new pair of gloves was worn.
3) Hands were sterilised with ethanol prior to taking the sample.
4) In cases where water samples were taken from metallic taps or handpumps, their mouths were heated up with a lighter for four seconds and hereafter disinfected with ethanol and a piece of cotton as far as possible. In cases where the taps were made of plastic the opening was only cleaned with ethanol. After the ethanol dried up and water ran through the tap for four seconds,the sample was taken.
5) The sealed lid of the H2S bottles were opened carefully without touching the inside of the bottle or lid.
6) The sample bottle was filled directly from the drinking water source until the 50ml mark. In cases where this was not possible, a sterile pipette was used to get the water from the storage container into the testing bottle.

7) The lid was carefully closed and the sample bottle was placed in an incubator with the temperature set on 35 degrees in the evening, after the field work was terminated for the day[3].
8) The colour of the sample was checked after 48 hours. If it turned black the test confirmed the presence of coliform bacteria. If the sample remained unchanged the test indicated that no contaminating bacteria were present.

4.4 Procedure for conducting the quantitative interviews

As a starting point a draft questionnaire was developed in agreement with the local NGO and pre-tested in the field with nine individuals before the actual study started. The main focus lay on the comprehensibility of the questions and the diagrams with the scales, the duration of the survey and the sequence of different sections in the questionnaire. During the testing phase the author was always accompanied by a female member of the NGO. Based on the experience of the pre-test the length of the questionnaire was adapted, so that it could be handled in maximum 30 minutes, questions and words were reframed and general explanations for the whole questionnaire and process were added. The interviews were conducted in Hindi by the author and an additional person who was trained by the author for this purpose.

The data collection took place every day between the month of April and May 2012, from late mornings until early evenings. The data collection consisted of three elements: 1) questions 2) observations and 3) collecting water samples for water quality tests. At the beginning of the survey the interviewers introduced themselves and the purpose of the study was explained to the household head. The participation was voluntary. All participants were assured confidentiality and that their participation or answers would not have any effect on their water supply or quality. At the end of the interview the participants were handed over German candies as a small reward for taking part in the survey and they were offered to get informed about the result of the water test if wished.

4.5 Statistical analysis

The statistical analyses were all performed using IBM SPSS Statistics version 19.0. The following section will explain which steps were taken and which choices were made before the main statistical analysis was performed.

[3] After the sample is taken it should be kept in a warm place (around 34-42 degree celcius). Carrying around the bottles for several hours during the day should not have a negative effect as the temperature in Lucknow was usually around 33-40 degrees during day time.

4.5.1 Checking data for errors and interview bias

Simultaneously to entering the data into SPSS categorical / nominal variables were coded and dummy variables were created for categorical variables with more than two categories. After the recoding, the data was checked and corrected for typing errors and the data distributions were explored. The data was also checked for the occurrence of interview bias, since two interviewers had obtained the information. The only variable where some bias might have occurred was for the severity measurement. The Cronbach's α for the severity scale differed substantially for both interviewers (.368 vs. -.233). Moreover, the t-statistics for the combined severity variable was significantly different for both interviewers. However, this scale was dropped from the analysis anyway as the Cronbach's α was too low and both individual Cronbach's α scores were too low to be included in the analysis independently from each other. Therefore the interview bias detected here should not influence the outcome of the main analysis. Other random interviewer effects seemed to have no influence on the outcomes of the analyses.

4.5.2 Bivariate /correlation and multivariate analyses

In total three regression models are used along the logical model of this study. The first one is a hierarchal linear regression and explains intention to treat water. The second model is a hierarchal logistic regression, as the outcome variable, water treatment, is dichotomous (yes/no). In order to decide which measure to apply for actual water treatment from the ones assessed with the questionnaire, the best predictor for water quality was used. This best predictor was determined with a logistic regression with source quality as a control variable and the stored water contamination as the dependent variable (yes/no). The outcome was that the measure based on self-report if the stored water had been treated (yes/no) was the best predictor for stored water quality. This logistic model was also used as a basis for the third hierarchal regression in which, next to water treatment behaviour, it was also assessed if certain water management behaviours influenced the stored water quality.

All the underlying assumptions for the linear and logistic regression were fulfilled. The cook's distance test was applied to check for influential cases and the presence of outliers was tested with standardised residuals. No influential case or outlier could be detected.

In order to check which background factors to control for in the hierarchal regression models in the first step, a correlation analysis was performed with all background factors for the dependent variables. To limit the number of variables in the bivariate analyses only background variables showing a correlation with p-value below 0.1 with its dependent variable were in included in the relevant regression analyses in step 1. To further reduce the number of background variables in the model, only significant variables in this step 1 were retained. Limiting the number of background variables in the models was necessary because they contained too many predictors in relation to the sample size of the

study. Including too many background factors with no significant influence on the dependents decreases the power of the models (Field, 2009). Finally, in order to control all the models for the same background variables, any variable that was retained at step 1 in one of the regression models, was also included in the other models. These results and the theoretical framework informed which variables to include in which step into the hierarchal regression models. For calculating the correlations the Kendall's tau-b test was chosen, because that is the best alternative to opt for with nonparametric data and a large number of tied ranks (Field, 2009).

5. Results

5.1 Description of the Study Population

5.1.1 Demographics

Table 5 below summarises the demographics of the study population. Usually women were responsible for management of water in the household. Therefore the percentage of females interviewed (97.7%) outweighs the percentage of males interviewed (2.3%) by far. The average age of people interviewed was 33 years and a large part of the interviewees were between 21 and 30. Usually the daughter in law in the family was interviewed, who in a traditional Indian household is responsible for the household tasks. The majority of the females interviewed were housewives (68.5%) or were working in family owned small shops (14.6%). 52% of the households had between 1.000 and 5.000 rupees available as monthly income and 28% between 5.001 and 10.000 Rupees. 31.5% of the study population was uneducated. However, 48.5% visited school at least until the sixth grade. The average household consisted of six people and most of the people lived in families with three to five members. The majority of the people were Hindus (88.5%). Most individuals could either be classified belonging to the Scheduled Caste (34.6%) or the General class (33.8%).

Table 5: Demographics of study population

Variable	N	Percentage	Mean (SD)
Gender:	***130***	*100*	
Female	127	97.7	
Male	3	2.3	
Age:	***130***	100	32.53 (10.65)
16-20	9	6.9	
21-25	33	25.4	
26-30	33	25.4	
31-40	27	20.8	
41-50	19	14.6	
51-60	6	4.6	
61-70	3	2.3	
Household income (Rupees):	***127***	*100*	5603 (4420)
<1000	10	7.9	
1.000-5.000	66	52	
5.001-10.000	36	28.3	
10.001-15.000	11	8.7	
15.001-25.000	4	3.1	
Occupation:	***130***	*100*	
Own business	19	14.6	
Governmental job	7	5.4	
Private job	15	11.5	
Jobless / housewife	89	68.5	
Education:	***130***	*100*	5.3 years (5.09)
No education	41	31.5	
1st until 5th	26	20	
6th until 10th	34	26.2	
High school (10th-12th)	17	13.1	
Higher education (13th-15th)	12	9.2	
Household size:	***130***	*100*	5.85
<2	6	4.6	
3 -5	70	53.8	
6-9	39	30	
10-21	15	11.5	
House type:	***130***	*100*	
Plastic / Metallic / Cloth	17	13.1	
Bricks	35	26.9	
Cement	78	60.0	
Religion:	***130***	*100*	
Hindu	115	88.5	
Muslim	13	10.0	
Sikh	2	1.5	
Caste (from low to high):	***130***	*100*	
Scheduled Caste (SC)	7	5.4	
Scheduled Tribe (ST)	45	34.6	
Other Backward Class (OBC)	32	24.6	
General (GEN)	44	33.8	
None (Sikh)	2	1.5	

5.1.2 Water treatment and storage related descriptive statistics

The main source for getting drinking water in the two study districts was from household taps (58.5%). The second most popular source was water from the hand pumps (33.10%). 29.81% of the 104 samples taken from the sources were contaminated and 47.90% of the 119 storage samples taken were contaminated. 32.30% (42 people) of the people interviewed claimed to have treated water available at the time point of the interview. The most prevalent treatment method was boiling (26.2%) and filtering (26.9%). 30.8% did not apply and kind of treatment method at any time. At the time point of the interview however, the 42 treated samples available were mostly filtered water samples (76.1%). 69.69% of the people did not have any treated water available at the time of the interview. In total 21.4% of the allegedly treated samples were contaminated.

Table 6: Main water source and treatment types in study

Variable	N	Percentage
Source:	***130***	*100.00*
Private tap	76	58.50
Private borehole	3	2.30
Public tap	8	6.20
Hand pump	43	33.10
Applied treatment types in general:	***130***	*100.00*
Non-treaters	40	30.80
Straining through a cloth	5	3.80
Boiling	34	26.20
Chlorine	16	12.30
Filter	35	26.90
Treatment types at the day of the interview:	***130***	*100.00*
Treated water available at interview:	42 (130)	32.30
Boiling	4 (42)	9.52
Chlorine	6 (42)	14.29
Filter	32 (42)	76.19
Not treated	88 (130)	67.69
Water contamination results:		
Contaminated source samples	31 (104)	29.81
Contaminated storage samples	57 (119)	47.90
Contaminated treated samples	9 (42)	21.43

Regarding how people stored their drinking water, following summaries can be presented (see table 7 below). The most common method to store water was in bottles (40.8%). People cooled water in the refrigerators and plastic bottles were the most convenient way to store water in a fridge. Otherwise water was usually stored in large plastic (20%) or steel buckets (17.7%). To get water out of the main storage vessel, individuals to a large extent directly poured water into the drinking device or used a tap

attached to the storage vessel (60%). These methods are the safest way of serving water. 26.9% used a device that had a handle (second safest option) and another 26.9% made use of tools without any handle to get their water out of their bigger storage vessels (unsafe option). 86.90% had fully covered their storage vessel with a hard cover and 56.20% used vessels with a narrow mouth.

Table 7: Household water management

Variable	N	Percentage
Handling water:	***130***	*100.00*
spigot/directly	60.00	46.2
handle/ladle	35.00	26.9
without handle	35.00	26.9
Specification storage vessel:	***130***	*100.00*
Claypot	10	7.7
Plastic bucket	26	20.0
Bottle	53	40.8
Steel bucket	23	17.7
Filter	11	8.5
Vessel with tap and lid	7	5.4
Covered	113	86.90
Narrow mouth vs. big mouth	73	56.20

Finally, regarding the hygienic measures, 50% of the people washed their hands at critical moments important for positive health outcomes[4], 81.50% had a toilet facility on their premises and 63.10 % used a special detergent for cleaning their house.

5.2 Correlations

In the following section, three correlation tables are presented. In the first one background factors correlating with one of the dependent variables (intention, water treatment and stored water contamination) are presented (see table 8). The second correlation table informs which conceptual factors other than the background variables from the theoretical framework correlate with intention and water treatment (see table 9). The third correlation table depicts which variables correlate with stored water contamination (table 10).

[4] For the statistical analysis a person had to state that she/he washed her/his hands after defecating and at least before preparing food or before eating. These are the most critical moments according to WHO to wash hands in order to reduce diarrhoea incidences.

5.2.1 Background factors correlating with intention, water treatment and stored water quality

Several background factors correlated with intention to treat water. More years of education and a higher monthly income positively correlated with higher intention to treat water. Being in the Scheduled Tribes caste (ST), using pipe water as the main drinking source, washing hands at critical times, having a toilet at home and using a special detergent for cleaning the house were also positively related with higher intention to treat water. Being part of the Other Backward Classes (OBC) and using water from hand pumps had a negative correlation with intention to treat water. No other background factors correlated with intention significantly.

Just as with intention, more years of education and a higher monthly income had a positive relation with water treatment. Coming from a ST caste, using piped tap water, washing hands at critical times, having a toilet at home and applying a special cleaning detergent were also positively correlated with treating water. None of the other background factors correlated with water treatment.

More years of education and a higher monthly income negatively correlated with stored water contamination and being a Muslim positively correlated with bad stored water quality.

Table 8: Background factors correlating with intention, water treatment and contaminated stored water

Variables		1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intention	Correlation Coefficient	1	.607***	-.218***	.291***	.264***	.014	.171**	-.163**	.224***	-.190**	.224***	.277***	.369***
	N	130	130	119	130	127	130	130	130	130	130	130	130	130
2. Water treatment	Correlation Coefficient	.607***	1	-.347***	.290***	.230***	-.066	.189**	-.089	.221**	-.171	.197**	.244***	.324***
	N	130	130	119	130	127	130	130	130	130	130	130	130	130
3. Storage contamination	Correlation Coefficient	-.218***	-.347***	1	-.058**	-.177**	.159*	.029	-.035	.061	-.058	-.076	-.130	-.172
	N	119	119	119	119	116	119	119	119	119	119	119	119	119
4. Years of education	Correlation Coefficient				1	.334**	-.187*	-.017	-.095	.205**	-.146	.020	.238**	.125
5. Monthly income	Correlation Coefficient					1	-.162*	.088	-.063	.216**	-.153*	.020	.378**	.288**
6. Muslim	Correlation Coefficient						1	-.027	-.131	.159	-.125	.128	-.106	-.064
7. Scheduled tribes	Correlation Coefficient							1	-.416**	.004	-.099	-.016	.054	.188*
8. Other backward classes	Correlation Coefficient								1	.001	.016	-.036	-.096	-.155
9. Piped water	Correlation Coefficient									1	-.748**	.077	.109	.175*
10. Hand pump	Correlation Coefficient										1	-.082	-.045	-.140
11. Washing hands	Correlation Coefficient											1	.079	.159
12. Toilet at home	Correlation Coefficient												1	.170
13. Special detergent used	Correlation Coefficient													1

Note: Kendall's tau b. Cases are excluded pairwise. *** Correlation is significant at the 0.01 level (2-tailed); ** Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at < 0.1 level (2-tailed). None of the dependent variables significantly correlated with girls under 15, females above 14, number of females in HH, Hindu, Sikh, Scheduled caste, General caste, no caste, public tank, private borehole

5.2.2 Socio-cognitive and post-intentional factors correlating with intention and water treatment

All motivational factors positively correlated with intention (table 9). Feeling more vulnerable, having more positive behavioural beliefs and affections towards water treatment, experiencing higher social pressure (descriptive and injunctive norms), higher personal norms, and having higher self-efficacy scores, all correlated positively with higher intention to treat water. The relation of these factors with water treatment was the same. They all positively correlated with treating water. Additionally, intention itself and all post-intentional factors, namely skills, barrier/facilitators and habit, had a significant positive relationship with water treatment.

5.2.3 Factors correlating with stored water contamination

Directly pouring water in from a storage vessel into a drinking device, covering the storage vessel and water that was claimed to have been treated correlated positively with water contamination, meaning that these factors had a positive relationship with safe water (see table 10 below). Using a helping device that has no handle attached to it (e.g. a bowl or drinking glass) and the quality of the water source, positively correlated with storage contamination, meaning they negatively influenced the stored water quality. All other factors, namely using pouring devices with handles, the size of the opening of the storage vessels, and how old the stored water was, did not correlate significantly with the quality of the stored water.

5.3 Regressions

In the following section the results of the three hierarchal multivariate regressions from the logical framework will be explained. The only background factors which remained significant when entering all correlating factors ($p<.1$) in the first step of the regressions in each of the three models were years of education, washing hands at critical times, having a toilet in the house and using a special cleaning soap (all hygienic measures). Thus, these factors are used as control factors for all three regressions. All other background factors initially correlating with the dependent variables in the bivariate analyses were not significant ($p>.1$).

Table 9: Socio-cognitive and post-intentional factors correlating with intention and water treatment

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Vulnerability	1										
2. Attitude	.533**	1									
3. Descript. norms	.248**	.232**	1								
4. Injunctive norms	.464**	.497**	.222**	1							
5. Personal norms	.313**	.295**	.137*	.298**	1						
6. Self-efficacy	.360**	.460**	.196**	.409**	.275**	1					
7. Skills	.310**	.446**	.171**	.376**	.282**	.435**	1				
8. Barrier/ facilitators	.350**	.402**	.189**	.497**	.196**	.379**	.377**	1			
9. Habit	.445**	.555**	.251**	.490**	.312**	.512**	.450**	.449**	1		
10. Intention	.582**	.640**	.294**	.549**	.346**	.534**	.467**	.456**	.649**	1	
11. Water treatment	.477**	.495**	.218**	.430**	.270**	.405**	.397**	.368**	.545**	.607**	1

Note: Kendall's tau b Correlations. Cases are exluded pairwise. N=130** Correlation is significant at the 0.01 level (2-tailed); * Correlation: is significant at the 0.05 level (2-tailed).

Table 10: Factors correlating with stored water contamination

Variables	1	2	3	4	5	6	7	8	9
1. Ladle / Device with handle	1								
2. Device without handle	-.368**	1							
3. Tap/directly poured in	-.551**	-.573**	1						
4. Covered vessel (vs. open)	.023	-.117	.084	1					
5. Big mouth (vs. small mouth)	.391**	.250**	-.569**	-.209*	1				
6. How old water in vessel	-.100	-.009	.096	.143	-.118	1			
7. Source contamination	-.085	-.057	.126	-.032	-.043	.044	1		
8. Water treatment	-.374**	-.244**	.548**	.122	-.378**	.161	.263**	1	
9. Storage contamination	.082	.287**	-.333**	-.185*	.121	-.110	.276**	-.347**	1
Sample size	119	119	119	119	119	118	103	119	119

Note: Kendall's tau b. Cases are excluded pair wise. ** Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed).

5.3.1 Predictors of intention

The results of the linear stepwise regression with intention as dependent variable can be found in table 11 below. In the first step the background factors, education, and all three hygienic measures were entered. Having obtained a higher education, washing hands at critical times, owning a toilet and applying a special cleaning detergent for the house correlated positively with higher intention to treat water. This first step explains already 33.22% variance in intention. In the second step all motivational factors were entered together into the model. Washing hands at critical moments is the only background factor that remained significant. In addition vulnerability, attitude, injunctive norms and self-efficacy correlated with intention significantly. Higher scores in these motivational factors positively correlated with higher intentional levels to treat water. The beta values suggest that the influence of attitude and vulnerability on intention is the highest. The motivational factors not correlating significantly with intention were personal norms and descriptive norms. This second step explained 43.77% additional variation in intention, which was a significant improvement of the model. In total this model explained 77.00% of the variation in intention to treat water.

Table 11: Linear regression with intention as dependent variable

	Step 1			Step 2		
Determinants	**B**	**SE B**	**β**	**B**	**SE B**	**β**
(Constant)	1.73	0.28		-1.75	0.58	
Background factors:						
Years of education	0.08	0.02	0.27**	0.01	0.01	0.05
Washing hands at critical times	0.45	0.21	0.16*	0.28	0.13	0.10*
Toilet at home	0.62	0.28	0.17*	-0.01	0.18	0.00
Special Detergent used	0.98	0.22	0.33***	0.07	0.16	0.02
Motivational factors:						
Vulnerability	-	-	-	0.20	0.06	0.24**
Attitude	-	-	-	0.58	0.14	0.31***
Descriptive norms	-	-	-	0.01	0.01	0.05
Injunctive norms	-	-	-	0.05	0.02	0.20**
Personal norms	-	-	-	0.05	0.16	0.02
Self-efficacy	-	-	-	0.27	0.08	0.20**

Note: R^2 = .332 for Step 1 (p <.001) ; ΔR^2 = .438 for Step 2 (p <.001). R^2 adjusted for model=.751

* p <.05(two-tailed); ** p <.01(two-tailed); *** p <.001 (two-tailed). N= 130. Exclude cases list wise.

5.3.2 Predictors of water treatment

In the first step the background factors were entered (see table 12 below). Years of education and using a special detergent had a positive significant relation with water treatment. Washing hands at

critical times and owning a toilet did not significantly correlate with water treatment, but were approximating the p-value significance level of .05 with p-values of .088 and .075 respectively. With each increase in one year education the odds of treating water increased by 1.05 (5%) and people who used a cleaning detergent compared to someone who did not had a 1.71 higher odds to treat water. The model chi square (=34.403) was significant ($p < .001$ with $df = 4$). The Nagelkerke's R^2 for this step was .325.

In the second block the motivational factors were entered. No background variable was significant anymore. Vulnerability and attitude had a significant positive regression coefficient for water treatment, meaning that individuals with more positive attitudes and a higher sense of vulnerability were more likely to treat water. With each unit of increase in the explanatory variables, vulnerability and attitude, the odds of treating water increased by 13% and 22% respectively. Descriptive, injunctive and personal norms, and self-efficacy were not significant independent predictors in the model. The model chi square (75.534) for this second step was significant as well ($p < .001$ with $df = 10$). The Nagelkerke's R^2 for this step was .583.

In the next block intention was included as a predictor. All background factors remained insignificant. Intention was the only predictor that had a significant correlation with water treatment. People with a higher intention were more likely to treat water. An increase of one unit in intention resulted in a 3.06 times higher odds ratio to treat water. This means that someone who scored a five on the intention scale had a 15.3 higher odds ratio for treating water compared to someone who did not intend to treat water. None of the motivational factors correlated significantly with water treatment in this step anymore. The chi square of the model (=87.817, $p < .001$ with $df = 11$) was significant again, with a Nagelkerke's R^2 of .655.

In the final step the post-intentional factors, skills, barriers / facilitators, and habit, were added. None of the variables in this last step were significant. Intention remained the only significant predictor in the model and all other predictors stayed insignificant individual predictors of water treatment in this model. The correlation was positive again. An individual had a 75% higher odds for treating water for each unit increase in intention. The chi square value of the model (=92.206, $p < .001$ with $df = 14$) was significant and a variation of 68.7 % in water treatment could be explained (Nagelkerke's R^2 .687). The Hosmer and Lemoshow tests were not significant at any step of this regression, indicating a well-fitting model (Field, 2009). However, although the model was significant, this last step did not add any predictive power to the model, compared to the previous step, as the step and block chi squares were not significant.

Table 12: Logistic regression with water treatment as dependent variable

	Step 1					Step 2					Step 3					Step 4				
Determinants	**B**	**SE B**	**Odds**	**Lower**	**Upper**	**B**	**SE B**	**Odds**	**Lower**	**Upper**	**B**	**SE B**	**Odds**	**Lower**	**Upper**	**B**	**SE B**	**Odds**	**Lower**	**Upper**
(Constant)	-3.394	.966				-7.20	2.64				-9.203	4.023				-10.324	4.257			
Background factors:																				
Years of education	0.13**	0.04	1.14	1.05	1.25	0.10*	0.06	1.10	0.98	1.23	.071	.065	1.074	.945	1.220	0.07	0.07	1.07	0.93	1.24
Washing hands	0.74*	0.44	2.10	0.89	4.94	0.66	0.57	1.93	0.64	5.85	-.132	.693	.877	.225	3.408	-0.07	0.73	0.93	0.22	3.89
Toilet at home	1.44*	0.81	4.22	0.86	20.62	0.87	0.99	2.39	0.34	16.75	.694	1.096	2.002	.234	17.137	1.07	1.15	2.92	0.31	27.63
Special detergent used	1.56**	0.52	4.77	1.71	13.30	0.34	0.72	1.41	0.34	5.80	.505	.807	1.657	.341	8.051	0.66	0.85	1.93	0.36	10.24
Motivational factors:																				
Vulnerability	-	-		-	-	0.36**	0.22	1.44	1.13	11.90	-0.17	0.30	0.84	0.46	1.53	-0.14	0.30	0.87	0.48	1.56
Attitude	-	-		-	-	1.32**	0.61	3.32	1.22	10.37	0.90	0.69	2.47	0.65	9.47	0.49	0.73	1.63	0.39	6.76
Descriptive norms	-	-		-	-	0.04	0.06	1.04	0.93	1.16	0.04	0.06	1.04	0.92	1.18	0.04	0.07	1.04	0.91	1.18
Injunctive norms	-	-		-	-	0.12	0.09	1.13	0.94	1.36	0.07	0.11	1.08	0.87	1.33	0.09	0.12	1.09	0.86	1.38
Personal norms	-	-		-	-	0.83	0.88	2.29	0.41	12.76	0.36	0.95	1.43	0.22	9.28	0.36	0.98	1.43	0.21	9.72
Self-efficacy	-	-		-	-	0.59	0.44	1.80	0.76	4.29	-0.15	0.57	0.86	0.28	2.62	-0.4776	0.62	0.62	0.18	2.09
Intention:																				
Intention	-	-		-	-	-	-		-	-	1.12**	0.69	3.06	1.90	8.67	0.56**	0.76	1.75	1.29	9.61
Post-intentional factors																				
Skills	-	-		-	-	-	-		-	-	-	-		-	-	0.98	0.72	2.66	0.64	10.96
Barriers / facilitators	-	-		-	-	-	-		-	-	-	-		-	-	-0.14	0.55	0.87	0.30	2.57
Habit	-	-		-	-	-	-		-	-	-	-		-	-	0.77	0.64	2.15	0.62	7.51
Model statistics																				
	Value	**Sign.**				**Value**	**Sign.**				**Value**	**Sign.**				**Value**	**Sign.**			
Model Chi-square	34.403	.000				73.534	.000				87.817	.000				92.206	.000			
Cox & Snell R^2	.233	-				.402	-				.485	-				.502	-			
Nagelkerke R^2	.325	-				.593	-				.655	-				.687	-			
Hosmer & Lemeshow Test	7.122	.416				3.395	.832				2.401	.866				1.231	.970			

Note:* p <.1(two-tailed) ** p <.05(two-tailed) . N=130. No case was excluded

5.3.3 Predictors of stored water contamination

The third model was used to answer the second research question if water treatment has a positive effect on water quality. The sample size decreased for this analysis from 130 to 103, because it was not always possible to collect source water during the interviews, as people did not have running water available 24/7 or people did not have any stored water available at the time of the interview.

In the first step of the regression the four background factors and source contamination were entered as control factors. Source contamination was the only significant predictor in explaining the water quality of the stored water[1]. Their relation was positive, meaning that water that was contaminated already at its source was more likely to be also contaminated at point of use at home. Stored water being contaminated was 4.26 times more likely if the water was already contaminated at its source. The chi square model was significant (=16.969, p =.05 with df = 5) and the Nagelkerke's R^2 was .201.

In the second step water treatment was added as a predictor. Source contamination remained significant and water treatment had a significant negative relationship with the stored water quality. This means water which was treated was less likely to be contaminated. If someone treated water the odds of the water being contaminated decreased by 8.3 times. However, if the source water was contaminated the odds that the stored water would be contaminated as well was 11.16 times higher. The chi square model was significant (=27.942, p <.001 with df = 6) and the Nagelkerke's R^2 increased to .319. After this step it was also checked if there is an interaction effect between source water contamination and water treatment. However, the interaction effect was not significant.

In the last step other factors potentially influencing water quality were entered all together. These included the kind of device used to get water out from the main storage vessel and if the storage vessel was covered or not. Source water quality and correct water treatment kept being significant predictors and they retained their initial direction of relationship with the stored water quality. From the newly entered factors, only water served with a pouring device that did not have a handle proofed to be a significant predictor. Using such a device had a significant positive correlation coefficient for predicting stored water contamination. The odds for contaminated stored was 5.17 times higher using such a device to serve water compared to if water was served directly from the storing vessel and 11.30 times higher if the was already contaminated at its source. Treating water decreased the odds for the water to be contaminated by 6.25 times compared to when it was not treated. The model chi square of this last step again was significant (=37.294, p <.001 with df = 9)

[1] None of the background factors were also significant without entering source contamination into the model.

with a Nagelkerke's R^2 of .407. The Hosmer and Lemoshow test were not significant at any step of this regression, indicating a good fit of the model after each step.

Table 13: Regression water quality

	Step 1					Step 2					Step 3				
Variables	**B**	**SE B**	**Odds**	**Lower**	**Upper**	**B**	**SE B**	**Odds**	**Lower**	**Upper**	**B**	**SE B**	**Odds**	**Lower**	**Upper**
Constant	0.39	0.14				0.44	0.21				0.62	0.29			
Years of education	-0.06	0.05	0.94	0.86	1.03	-0.01	0.05	0.99	0.90	1.10	-0.02	0.06	0.98	0.88	1.10
Washing hands	-0.38	0.44	0.68	0.29	1.62	-0.18	0.47	0.84	0.33	2.11	-0.55	0.52	0.58	0.21	1.61
Toilet at home	-0.95	0.61	0.39	0.12	1.26	-0.84	0.62	0.43	0.13	1.45	-0.62	0.67	0.54	0.15	2.00
Special detergent used	-0.36	0.47	0.70	0.28	1.76	-0.14	0.50	0.87	0.33	2.30	-0.03	0.53	0.97	0.34	2.74
Source contamination	1.45	0.50	4.26	1.96	12.07	2.41**	0.67	11.16	2.98	14.78	2.52**	0.71	12.48	4.13	19.71
Treated water	-	-	-	-	-	-2.11*	0.71	0.12	0.03	0.50	-1.79*	0.75	0.16	0.05	0.69
Device with handle / ladle ++	-	-	-	-	-	-	-	-	-	-	0.60	0.68	1.82	0.48	6.93
Device without handle ++	-	-	-	-	-	-	-	-	-	-	1.64*	0.68	5.17	1.37	17.47
Covered vessel (vs. open vessel)	-	-	-	-	-	-	-	-	-	-	-1.03	0.67	0.36	0.10	1.34
Model statistics															
	Value	**Sign.**				**Value**	**Sign.**				**Value**	**Sign.**			
Model Chi-square	16.969	.005				27.942	.000				37.294	.000			
Cox & Snell R^2	.152					.238					.304				
Nagelkerke R^2	.204					.319					.407				
Hosmer & Lemeshow Test	8.354	.400				6.172	.628				5.333	.722			

Note:* p <.05 (two-tailed); ** p <.01 (two-tailed). N=103. Exclude cases listwise.

++ directly poured out of the main storage vessel was the baseline

6. Discussion and conclusion

In this last chapter of the study, the main results are summarised, interpreted and compared with previous studies. Based on this analysis recommendations for practise and future research were made. Before an overall conclusion was drawn the strength and weaknesses of this research were discussed.

6.1 Summary of the results

The first objective of this study was to understand which personal and interpersonal factors predict water treatment. For this purpose an extensive literature review was conducted and the results were integrated in a theoretical framework of behavioural change theories. In order to test the influence of background factors, motivational factors, and intention on water treatment, a questionnaire was performed in a poor, water contaminated area in Lucknow, India. The hierarchal linear regression revealed that washing hands with soap at critical times, higher perception of vulnerability, positive attitudes, higher social pressure emerging from injunctive norms and higher self-confidence influenced more positive intentions to treat water significantly. The model had a good explanatory power for explaining variances in intention. The hierarchal logistic regression with water treatment as the dependent outcome showed that intention to treat water was the only significant predictor from the conceptual framework. Being able to explain 68% of variances in water treatment the model had a satisfactory predictive power.

The second objective of this study was to investigate what the effect of applied water hygiene practices are on drinking water quality. These HWTS methods can reduce the incidence rate of diarrhoea dramatically, which is one of the leading death causes of child mortality under five. In particular the interest was if water treatment had a positive effect on water quality. Of the supposedly treated water samples 78.56% indicated good water quality. A logistic regression showed that water treatment, water serving practises, and source contamination significantly affected stored water quality. Having a contaminated source and serving water with a device which does not have any handle attached to it, which therefore increases the risk of hands getting into contact with the stored water, positively correlated with contaminated stored water quality. Treating water had a significant negative relation with bad water quality.

6.2 Theoretical implications

6.2.1 Determinants influencing intention and water treatment

It was hypothesised that the background factors ethnicity, number of females in the household, the main drinking water source, educational level, monthly income and hygienic measures influence

water treatment indirectly (research question 1 a). According to the theory of planned behaviour these measures are supposed to be mediated by motivational factors. This hypothesis had to be tested for both models, for the one analysing intention to treat water and for the one analysing water treatment. Monthly income, all different castes and all water type of sources were not significant predictors in any of the regression models, although they correlated with one of the dependant variables in the bi-variate correlation analyses. The reason behind this is most likely that these factors have a spurious relationship with intention and water treatment. In order to keep the predictive power of the regression models high these factors were excluded from the regression models. No other study was found which included castes in their analysis, so no comparison can be made with this outcome. There are two other studies in which the source of water did not have a significant independent role in multivariate analyses and where only household characteristics or demographics were included (Christen et al., 2011 and DuBois et al., 2010). Moreover, in two out of five studies where a significant relationship with the source and water treatment was found the interpretation of the results is questionable. In one of the study the application of arsenic filter was analysed and it was found that groundwater as the main source predicted water treatment with this particular method in Vietnam. This result is not very surprising. The application of arsenic filters only makes sense for groundwater sources as usually only groundwater is contaminated with arsenic. The other questionable relation was found with applying water settlement as a method for groundwater sources in Egypt (Wright & Gundry, 2009). The authors argue that the relationship was only marginally and not very plausible, as the source was an improved groundwater source where actually no need exists to treat it with a settlement technique and suggest that confounding might have caused this outcome. In another study where a significant relation was found with a river in Moscow as the source water, only bivariate correlations were applied and the influence of the source water was not tested in a multivariate analysis (Larson & Gnedenko, 1998). The number of females present in the household and different religious backgrounds were the only factors that neither showed any relation in the bivariate nor in the multivariate analysis. The influence of number of women present in the household was tested by two studies and both studies revealed this outcome in multivariate analysis for SODIS use in Bolivia and the application of a chlorine mixture in Pakistan (Christen et al., 2011; Figueroa & Hulme, 2008). The outcome in this study might have been affected by the classification of women and girls. Women were defined to be females older than 14 as in the study of Christen et al. (2011). In the other study it was not clear how and if the group of women were categorised by age as well. Defining 'women' based on a different age class might have influenced this non-significant outcome. Also clustering all females together into one group did not show any significant results. The study conducted in Pakistan also found out that Hindus were more likely to treat water compared to Muslims. This relation could also not be confirmed by this study. A reason

for this might be that the number of Muslims included in this sample (13 individuals) was too small to detect a significant difference between different religions. However it could also imply that there was truly no relation between religion and water treatment behaviour.

Years of education, and all hygienic measures were the only background factors that were included in both regressions as control factors. All of them correlated with intention to treat water in the first step, but all factors were mediated by the motivational factors as hypothesised in the theoretical framework, the only exception being hand washing at critical times. This means that washing hands at critical times explained some unique variance that the motivational factors missed to capture for predicting intention. In the only study where hand-washing with soap was found to be significant, washing hands with soap was mediated by motivational factors (Figueroa & Hulme, 2008). However, in this study the dependent outcome was not intention but water treatment itself. One reason for why hand-washing at critical time had a direct influence on intention in this study might be that the population experienced educational interventions where hand-washing and water treatment were both together promoted. So, females might acknowledge the importance of both hygiene practises at the same time. If washing hands with soap at critical times is adapted, individuals might also be more likely see the need of treating water (or vice versa). For the second regression model, which explained water treatment, all background factors were, just like for intention, significant predictors in the first block of the regression. But all background factors were fully reflected by the underlying beliefs as hypothesised in the integrated model. In the study of Figueroa & Hulme (2008) the effect of the background factors - years of education, owning a regular latrine and having hand-washing soap available - were also mediated through motivational factors. No other study included demographics or background factors in their behavioural theoretical framework.

As described in the previous section, most background factors were mediated through motivational factors. Research question 1 b dealt with the influence of motivational factors on intention and water treatment. Descriptive and personal norms did not have a significant relationship with intention, although they were correlating with intention to treat water directly in the bivariate analyses. These two factors were most likely confounded by other motivational determinants in the regression. The influence of descriptive norms on intention was studied by one cross-sectional study and no influence was found as well (Heri & Mosler, 2008). The influence of personal norms has not been investigated by any other research. According to the theory of planned behaviour not all determinants have to necessarily predict intention significantly together. The developers of the theory rather argue that some of the motivational factors have more and others have less effect on certain intentions and that this can differ for different populations and cultures

(Fishbein, 2000). Regarding the descriptive norms many females also stated that they do not have any friends since they got married or they do not know what their neighbours do as they do not have contact with outsiders. People did not seem to have a strong social network within their neighbourhood or community. The model was able to explain 77% of variance in intention. The R^2 adjusted of the model predicting intention was 75.1%, which was higher than in two other comparable studies with adjusted R^2 of 61.7% and 69% (Altherr et al., 2008; Heri & Mosler, 2008). Positive behavioural beliefs and affection and higher feeling of susceptibility influenced water treatment as the motivational factors directly before including intention to the model. This means that all the remaining motivational factors were confounded by these two variables. Neither social nor personal norms nor self-efficacy beliefs influenced water treatment significantly. The results of other studies on this matter are very diverse. The study of Altherr et al. (2008) found similar results, although their conceptualisation of the determinants differed to some extent from this study. In their logistic regression also neither self-efficacy, nor subjective norms were significant predictors. Attitude, and conviction and beliefs (more knowledge aspects) were significant predictors in their cross-sectional research. However, in a different study (Figueroa & Hulme, 2008) for example descriptive norms and beliefs and values (more attitudinal components and risk perceptions) were significantly influential. In a third study attitudinal, risk aspects, barriers, and descriptive norms were the influential predictors (Heri & Mosler, 2008). And in yet another research social norms and a higher risk perception and better knowledge of proper handling of water were significant (Graf et al., 2008). Although the results are different in every study, a pattern is visible that attitudinal components and risk perceptions play an important role in influencing water treatment, which is a result confirmed by this study as well. One reason why particularly these two motivational factors were significant could be linked to the intervention the population experienced in the past (see Appendix D), which was strongly built on the logic that individuals have to be made aware of the contamination of their drinking water and the risks connected to it. On the other side the intervention provided these individuals with a promising solution to the "threat" of dirty drinking water and therefore worked on building a positive attitude in the intervention population.

Whereas the previous paragraph describes the effect of motivational factors on water treatment and intention, this goal of this section is to describe the influence of intention on water treatment (research question 1 c). After entering intention to the model, no other predictors were significant in explaining water treatment, except of intention itself. This means that attitude and vulnerability were mediated by intention to treat water and intention alone was able to predict water. This result is in line with theoretical assumptions that all motivational factors should be mediated by intention. It is impossible to compare the outcomes with other studies as hardly any

study included intention to treat water in their model and usually predictors are just compared directly with water treatment in their regression analysis. However, intentions are handled as the most proximal upon behaviour and are able to explain 28% of variance in behaviour on average (Webb & Sheeran 2006). The high influence of intention on this result might be an outcome of a very good measure of intention. Also the fact that a cross-sectional study was performed might have influenced this result. Intention tends to have a higher impact on behaviour in these kind of studies compared to in longitudinal studies.

Research question 1 d describes the last step in the regression model and includes the effect of post-intentional factors. Including these factors to the model did not change the role of intention as the solely significant predictor in the whole model. None of the post-intentional factors and the entire step itself added any predictive power to the model. Post-intentional factors can, but do not have to have an effect on behaviour. It was still a surprising result that habit did not have a significant influence on water treatment. The factor was strongly correlated with water treatment in the bivariate analysis (second highest correlation after intention to treat water) and the influence of habit has been proven in several other studies (Heri & Mosler, 2008; Kraemer & Mosler, 2010; Kraemer & Mosler, 2011; Tamas & Mosler, 2011). However, as previously mentioned none of these studies included intention in their model assessment as predictor for water treatment, so a direct comparison is not possible. However, it is noteworthy that intention and habit correlated strongly with each other and the relation was significant. The similarity between the two variables could explain why habit did not have an influence on water treatment in the model. In essence, this means that for most interviewees, habit corresponded to their intention. Other studies which applied a different conceptual framework for example found out that a strong habit strongly predicted intention to treat water (Kraemer & Mosler, 2010; Heri & Mosler, 2008). The effect of habit, barriers, and skills was confounded or mediated by the other factors in the model. It could be interpreted that individuals who intended to treat water were to some extent also people who did not experience any barriers, had the right skills and a habit to treat water. The model was able to explain 68.7% variance in water treatment. Compared to other models predicting water treatment, this model performs reasonably well. Other studies using regressions were able to predict 42% (Nagelkerke's R^2), 68% (R^2 adjusted), 70% (Nagelkerke's R^2) and 86.3% of variance (Figueroa & Hulme, 2008; Heri & Mosler, 2008; Kraemer & Mosler, 2010; Altherr et al., 2008).

To give a short summary on research question 1: Motivational determinants mediate all background factors and the measure of intention successfully mediates motivational determinants and becomes the only predictor in an integrated model, which predicts water treatment significantly. None of the post-intentional factors influenced water treatment. As measures of intention and its influence on water treatment have not been adopted in previous research, the results are difficult to

compare to previous findings. Intention to treat water on the other hand is positively influenced by washing hands at critical times, a feeling of higher vulnerability, positive attitudes and affections, higher injunctive norms and higher self-efficacy.

6.2.2 The effect of applied water hygiene practices on water quality

In order to obtain safe drinking water, it is important that water purification is performed adequately, and that recontamination does not occur. The second research question therefore deals with the effect of applied water hygiene practises on the drinking water quality. The water quality tests revealed that 29.81% of source, 47.90% of the stored and 21.4% of the treated water was contaminated. Next to the fact that water cannot always be regarded safe from its source, the results also suggest that although water quality might have been save at its initial source it can deteriorate at its POU. Increased post-source contamination through the process of collecting, transporting and storing water has been proven by many different studies (Oswald et al., 2007; Murcott, 2006; Trevett et al., 2005: Nath et al., 2006; Clasen & Bastable, 2003). That 21.4% of the supposedly treated water was contaminated could depend on several factors. Either people gave socially desirable answers, treated their water wrongly, or recontamination during unsafe storage practises after treatment occurred. Another possible reason could be that the water test created false positives results. In 2.28% of cases P-A tests can create false positives results, meaning that it indicates that the water was contaminated although it was not (Ramteke et al. 1994).

In order to investigate the effect of water treatment on water quality when controlling for its source contamination, a multivariate logistic regression was performed (research question 2 a). None of the background factors emerging as controls from the other two regression models and none of the initially significant descriptive in the bivariate analysis significantly explained water treatment in the regression. The background factors initially correlating with water treatment were confounded by other factors. It was checked with an interaction product if the impact of the source water contamination on stored water quality depended on water treatment. This was not the case. There are several reasons for this unexpected outcome. Amongst others, it could be that the sample size was too small to depict this fine relation, or that after treatment contamination took place or that people gave socially desirable answers that they treated water, but actually had not. Source contamination had the biggest influence on stored water quality. However, the logistic regression did show that water treatment on its own had an impact on improved water quality, when controlling for source contamination.

Next to water treatment, water quality could also be affected by different storing methods (research question 2 b). Bi-variate correlations showed that the size of the opening of the storage

vessel and how many days ago the water was stored in the storage vessel did not affect the quality of the stored water. Therefore these factors were excluded from the regression analysis. The small effect of covering the storage vessels in the bivariate analysis was confounded by other factors and did not have a significant effect in the logistic regression. Moreover this variable did not show much variance amongst the population (out of 130 individuals only 17 did not cover their vessels). That the time how long the water was already stored for in the storage vessel did not affect water quality in this study might be explained due to the fact that water was usually not stored longer than a day in a household and hence this measure did not show much variance. Water was not scarce in the neighbourhood this study was conducted in. People were able to get fresh water every day and usually also believed that water older than a day should be thrown away. Trevett et al. (2004) who analysed what causes water contamination from its source to its consumption also did not find any significant relation with the time water was stored, the size of the opening of the storage vessels and with covered versus non-covered containers. In their study source contamination was the only significant predictor, and they did not include water treatment in their analysis.

The last research question (2 c) deals with the effects of helping tools on water quality. The results of this study imply that helping tools which have no handle are the most risky devices to introduce recontamination of water. This corresponds well with Murcott (2006), who suggested in a conference background paper on HWTS that this specific method to serve water is the riskiest for recontamination. Devices which had a handle connected to it so that direct contact with hands and water could be avoided did not have a significant negative influence on water quality compared to the method where no helping devices were needed. The effect that stored water quality deteriorates when using serving tools compared to directly pouring water into the drinking glass has been shown by several other studies (Mintz et al., 1995; Quick et al., 1996; Roberts et al., 2001; Trevett et al., 2005). However, no study was found which distinguished between the different devices types to get water out of the storage vessel.

The final outcome of the logistic regression showed that source contamination, treating water, using a device with no handles to get water out compared to directly pouring water into a glass all significantly predicted stored water quality. However, the most important finding of this analysis was that treating water had a positive effect on stored water quality. After source quality, water treatment had the second biggest influence on water quality. The results show that people who treated their water significantly increased the chances of their water not being contaminated at the point of consumption. This means that people who treat their water benefit from its health implications and a possible reduction in occurrence of diarrhoea, as long as no other critical pathways exist.

6.3 Practical implications

Officials from local governmental water bodies argued in the interviews that there is no need to be worried about water quality at its source. However, 29.81% of the water samples collected in this study indicated water contamination. Even though the governmental water bodies did acknowledge that water quality in slum areas might be a problem, such remarks from the governmental water sector, which assure safe water quality, can be misleading for the end-consumer.

Most users applied filters for treating their water, none applied SODIS, and hardly anybody used chlorine, the cheapest methods to treat water. However, these more affordable methods lack the "aspirational" appeal associated with filters, and very often do not improve the taste or aesthetics of their water. The large number of filter users might be explained by the fact that several individuals received a filter for free during a promotion campaign of a filter manufacturer. Approximately 18.75 to 31.2% of the filter users got their filter for free.

As the research showed that water treatment had a positive effect on the drinking water, it is worth to address this behaviour in intervention strategies. The results of this research show that the integrated theoretical framework developed and applied in this study was able to explain a large amount of variation in intention to treat water and in water treatment itself. By finding the most critical theory based determinants of current and intended use of water treatment methods, the results can guide the development of more effective intervention strategies. Intention was the only significant predictor for water treatment. Therefore it is very important to look at what influences a positive intention to treat water in order to get current non-users to start treating their water. Positive attitude towards water treatment and a higher feeling of vulnerability were the most influential factors for higher intentions to treat water. This means that campaigns should focus on the positive effects of water treatment, such as improved safety and saving costs, but also use emotional components like how good it feels to treat water for the entire family or how disgusting it is to drink untreated water. Another important point interventions should focus is on the perceived vulnerability of drinking untreated water. It is essential that people understand and believe that their water is unsafe to drink untreated and that when water looks clean/clear it does not automatically mean that it is safe to drink. Several individuals in this study for example stated that they would never drink unsafe or dirty water, but also do not see the need to treat their water when it looks clean. They claimed whenever it looks dirty or smells badly they do not drink it and collect water from a different source. Two additional socio-cognitive factors a promotion campaign could focus on are injunctive norms and self-efficacy beliefs. People stated in this study that they mainly heard from HWTS from their doctors and promotions campaigns. With the injunctive norm determinant the influence of NGOs and doctors on individuals were explored. So for example if campaigns were

conducted by NGOs which have a very good reputation amongst the intervention population and included trustworthy practitioners in their promotion this could have a positive effect on the perceived injunctive norms. Finally, if people are assured that it is possible to treat water regardless of time and money constraints and that it is something very simple to do, their self-efficacy might increase, which in turn leads to a higher intention to treat water.

Some attention should also be put on the fact that although the influence of higher education and sanitary and cleaning hygiene were mediated by the motivational factors, they still influence the development of intention indirectly. Furthermore, there was even a direct unmediated influence of hand-washing practices on intention. This suggests that people with lower educational levels and lower hygienic practices need a different or a more elaborated intervention compared to people with the opposite attributes. These people might need more explanation on the impact of unhygienic practices and need to be more sensitised for it. Even though interventions cannot affect the educational level of people, they can influence and change the hygiene oriented lifestyle of people. So one strategy could be to influence different hygienic aspects one by one or to develop interventions that address multiple aspects together. Very interestingly all of the hygienic practices, except when people use a special cleaning detergent, also have a positive effect on diarrhoea reduction. Therefore interventions should be developed in such a way that synergy effects on these critical behaviours can be achieved.

However, it is difficult to tackle all these different determinants discussed here with one single intervention. As a first step, this research shows that attitude and vulnerability are the most important factors to start with, as these factors were both predicting intention and treatment (before including intention to the water treatment regression model) in the two regression models and the influence of these two motivational factors was the highest on intention.

Another aspect that should be kept in mind when developing intervention strategies is the influence of habit on regular and continuous water treatment. A campaign might successfully influence a high intention development, but if a person's habit does not adapt accordingly this could potentially hinder the translation of intention into sustained behaviour. Therefore campaigns might also incorporate in their (long-term) strategies some effective and regular reminders to treat water in order to make the behaviour more salient.

Finally, this research showed that safe water quality does not only depend on the initial source quality and purifying it, but that also safe handling practises can prevent contamination of water post-collection. Intervention strategies focusing on HWTS should pay attention to the fact that people do not apply tools without any handles attached to it to serve water.

6.4 Limitations of this study

There are in total five bigger weaknesses in this study, against which the results have to be reflected. First, the cross-sectional nature of this study does not allow interpreting the relations found in this study as a causal link. The way in which the directions of the effects were interpreted in this study are merely theory-based. Strictly seen a prospective study would be needed to assure that, for example, intention caused water treatment and not vice versa. A longitudinal approach would also help to see if the influence of intention (and the factors which determine intention on the other hand) are stabile over time and not only the mere reflection of one time point.

Second, there are two issues with the measure of actual behaviour. First, the outcome of the dependent variable was measured with a dichotomous scale. A continuous outcome scale is the better option because the effect of variations in the determinants, which were all except of the background factors measured with a continuous scale, can directly be linked to different levels of treatment behaviours. This allows a finer measure of if different levels of motivational factors influence not just water treatment alone, but also a higher amount of water treated (or more often treated). A continuous scale was initially planned in this research, but the measure failed to work out. A better way of conceptualising this measure could be to measure in litres how much drinking water was collected and how many litres of this water were treated within, for example, the past three days (going back longer in time will be difficult as people will have difficulties to remember). Second, a small error was introduced to the measure in that sense that people who stated that they actually had treated water on the interview day, but it was finished at the time point of the interview, are regarded as non-treaters in this study. However, these cases did not occur often and formed exceptions. Hence, the effect of the error should be negligible for the outcome of this study.

Third, the determinants from the theoretical framework were not tested with a validated scale, as for this research topic such scales do not exist yet. Thus the scales were self-constructed with the help of some example questions on this topic in the literature. Furthermore, the underlying beliefs could not be elicited before developing a questionnaire. This resulted in a low reliability for several scales and the severity measure was even so inconsistent that it had to be omitted from the analysis. Therefore risk or threat perception, which consists of vulnerability and severity together, could not be applied in this study. Furthermore, the analysis was conducted with injunctive norms, personal norms, barriers and skills, which did not have a reliable Cronbach's alpha. Conducting the study with reliable measures might result in different outcomes, which would lead to a different focus for interventions.

Fourth, the sample size was not large enough to detect small-effect sizes of the determinants in all three regression models and for the water treatment regression the sample size was even barely enough to detect medium-size effects, as not enough water samples could be gathered (Field, 2009). Thus, to identify small-effect sizes and to increase the power of the model a study with a much larger study sample would be required.

Fifth, the measure if someone washed their hands at critical times could not be assessed in an objective way, and participants were only asked to state when they had washed their hands on the previous day. This question is very prone to socially desirable responses. It could be that people only answered in this manner because they knew they should be washing their hands at certain moments rather then also really doing it. Therefore, the interpretation of its meaning in this study should be handled cautiously.

However, this research did not only have limitations, but also some strengths against which the research can be weighed. The research is based on a thorough literature review, resulting in a comprehensive theoretical framework. The questionnaire, based on this theoretical framework, was pre-tested before it was applied in the field. The results of the research were statistically significant and were able to explain a decent proportion of variation in intention and water treatment. Based on these results, conclusions could be drawn regarding future water treatment interventions. Furthermore, this research applied an objective water quality measure and a validated behavioural measure (i.e., the best measure for predicting water quality) for its main analysis.

6.5 Future research

Future research on behavioural aspects of HWTS could focus on following aspects. One research gap that could be captured with future research is to apply more theoretical concepts that focus on behaviour and the process behind it rather than just focussing on background variables or on one or two determinants picked from theories. Furthermore, concepts are needed which can be compared to each other and a common understanding of the interpretation of the different determinants from theories is required. Along with these aspects it would be very beneficial to develop reliable scales and validate them for future research. As only very few studies applied logical models to understand treatment behaviour, and furthermore interpreted the determinants and their conceptualisation substantially different from each other, it was not possible to verify and directly compare the results of this study with other scholars. Therefore, a more coherent and guided research approach, as in the field of HIV for example for condom use, would be beneficial to understand the processes behind the uptake of water treatment behaviour.

Furthermore, in this research water treatment behaviour in general was measured. The outcome was not further split into the method types. However, reasons and underlying beliefs can differ for applying different method types. For example an attitude towards chlorine could be that water does not taste afterwards anymore, but for filter the opposite would be the case. Studies that take these different methods into consideration together with studies focussing on user preferences could guide developers and manufactures of these products.

Although many scholars in the field of HWTS acknowledge safe water storage as an important measure for protecting it from recontamination, no study was found which explicitly focussed on explicatory determinants for safe storage behaviour. Water hygiene practises and their benefits depend on both water treatment and safe management of water. Therefore it would be beneficial to incorporate more post water collection behaviour in studies. The challenge is here to find a good concept and measures for safe water management as it depends on a chain of different behaviours, which might be difficult to capture within the framework of a single research.

Finally, investigating why key players influential and important for the diffusion of HWTS do not support its large scale uptake could proof to be very beneficial in finding ways to persuade them to support the diffusion of crucial water hygiene practises. For example in this research some short qualitative reviews with governmental officials revealed that their emphasis lies on conventional improvements in water supplied and in engineered solutions. To a large part they believed that there is a key role for NGOs to promote HWTS. These findings suggest that HWTS needs to be advocated more strongly on a policy level. Policy makers should be made aware of the cost-effectiveness and the gained health improvements

6.6 Conclusion

Although HWTS seem to be promising and convincing solutions to make water potable and reduce diarrhoea incidences and other drinking water related diseases, the diffusion of water hygiene practises has neither reached large scales yet in India nor globally. Understanding factors influencing behaviour are crucial in determining, explaining and predicting up-take and sustainable adoption of HWTS. Furthermore, understanding the reasons behind acceptance, compliance and adoption could help to develop customised promotion strategies and increase product enhancement and development. Even though the body of knowledge on these subjects increased over the past few years, it remains incomplete. This research focuses on this issue and aims to increase understanding of which personal and interpersonal factors predict water treatment, in order to provide guidance for the development of interventions to increase the diffusion of HWTS.

One of the objectives of this study is to investigate what the effects of applied water hygiene practices are on drinking water quality. Using an objective measure for water quality and a pre-tested questionnaire, this research showed that water serving practises and water treatment were influential in determining water quality when controlled for source water quality. Next to measuring if water treatment had an effect on improved water quality, an integrated theoretical framework was developed a priori to assess what determinants predict water treatment behaviour itself. The results show that the framework and the underlying theories are able to explain a large variance in water treatment behaviour. Furthermore, this research revealed that intention was the only influential predictor of water treatment. Hence, it is important for campaigns to focus on which determinants influence positive intentions to treat water. This research showed that intention is directly positively influenced by washing hands at critical times, a feeling of higher vulnerability, positive attitudes and affections, higher injunctive norms and higher self-efficacy. Hence all the factors should be addressed in promotional campaigns. The results also imply that potential synergy effects with other hygiene behaviours could be achieved. This means that people who are, for example, more open for washing their hands at critical times or for having a toilet in their house are also more open to treat water. In dealing with reducing incidences of diarrhoea, next to water treatment, personal hygiene and sanitation facilities are also important aspects and therefore reaching such synergy effects could be very important. Intervention campaigns should try to focus on all three aspects in order to address all critical pathways causing diarrhoea. Successful interventions would hold the promise to save many lives.

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Appendix A Search syntax for the literature review

((AB ((((determinant*) OR (factor*) OR (behaviour*) OR (behaviour*) OR (correlate*) OR (barrier*) OR (background) OR (knowledge) OR (socio-economic) OR (reason*) OR (predict*) OR (explanation*) OR (belief*) OR (facilitat*) OR (explain*) OR (attitude) OR (motivat*)) AND ((water treatment) OR (treatment of water) OR (filter) OR (POU) OR (HWTS) OR (HWT) OR (chlor*) OR (SODIS) OR (Cloth*) OR (boil*) OR (water storage) OR (flocculation) OR (purif*)) AND ((Water)) AND ((interview) OR (qualitative) OR (survey) OR (field study) OR (quantitative) OR (questionnaire))))))

Appendix B Overview of literature review

Table A.1: Overview of literature review

Authors	Sample size	Research design	Country and setting	Study type	Means of data collection	Treatment method
Mosler & Kraemer 2011	694	longitudinal	Zimbabwe, urban	quantitative	interviews	SODIS
Tobias & Berg 2011	319	cross-sectional	Vietnam, rural	quantitative	survey	arsenic filters
Graf et al., 2007	500	cross-sectional	Kenya, urban slum	quantitative	survey	SODIS
Nagata et al., 2011	201	cross-sectional	Guatemala, urban	quantitative	semi-structured interviews	chlorine
Wood et al., 2011	55	retrospective -cross-sectional	Malawi, urban and rural	qualitatitive	in-depth interviews	chlorine
Altherr et al., 2008	81	cross-sectional	Nicaragua, rural	quantitative	interviews	SODIS
Heri & Mosler 2008	644	cross-sectional	Bolivia peri-urban and rural	quantitative	survey	SODIS
Kraemer & Mosler 2011	514	longitudinal	Zimbabwe, urban	quantitative	interviews	SODIS
Kraemer & Mosler 2010	878	cross-sectional	Zimbabwe,urban	quantitative	interview	SODIS
Mäusezahl et al., 2009	241	cross-sectional	Bolivia, urban	quantitative	survey	SODIS
Christen et al., 2011	216	longitudinal	Bolivia, urban	quantitative	survey and protocol observations	SODIS
Tamas & Mosler 2011	369	longitudinal	Bolivia peri-urban and rural	quantitative	interviews	SODIS
De Ver Dye et al., 2011	34	cross-sectional	Kenya, rural	qualitatitive	in-depth interviews	filters
Fiore et al., 2009	199	cross-sectional	Nicaragua, rural	quantitative	questionnaire & water quality test	bio-sand filters
Larson & Gnedenko 1998	615	cross-sectional	Russia, urban	quantitative	telephone survey	boiling, filter, settle water, bottled water
Escobedoa et al., 2011	109	cross-sectional	Cuba, urban	qualitatitive	FGD	boiling
Sakisaka et al., 2002	206	cross-sectional	Philippines, rural	quantitative	survey	boiling
Yang et al., 2009	600	cross-sectional	China, rural	quantitative	survey	boiling
Wright & Gundry 2009	21 972	cross-sectional	Egypt national	quantitative	secondar source: data already available from a national survey	boiling, chlorine, cloth, settle water, home filters, solar desinfection
Hanchett et al., 2002	694 surveys, 138 FGD	cross-sectional	Banglasdesh, urban	mixed	quantitative questionnaire and FGD	arsenic filters

Aini et al., 2007	100	cross-sectional	Malaysia, urban	quantitative	survey	filters, boiling and botteled water
Prihartono et al., 1994	400	cross-sectional	Indonesia, rural and urban slum	quantitative	survey	boiling
Faye et al., 2011	312	cross-sectional	Senegal, rural	quantitative	interviews	chlorine
Makutsa et al., 2001	173	cross-sectional	Kenya, rural	quantitative	short questionnaire	chlorine, boiling, storage clay pots
Ngai et al., 2007	1000	retrospective -cross-sectional	Nepal, rural	quantitative	survey	arsenic filters
DuBois et al., 2010	297	longitudinal	Kenya, rural	quantitative	interviews	chlorine,flocculent-disinfectant product
Figueroa & Hulme 2008	84 &100 in-depth interviews; 84 FGD, 1500 surveys	cross-sectional	Pakistan, Haihiti peri urban and rural	mixed	in depth interview, focus group discussion, survey	chlorine, boiling
Freeman et al., 2009	487	cross-sectional	Kenya, rural	quantitative	survey and water quality tests	chlorine
McLennan 2000	582	cross-sectional	Dominican Republic, peri-urban	quantitative	survey	boiling
Blanton et al., 2010	413	longitudinal	Kenya, rural	quantitative	survey	chlorine
Ram et al., 2007	242	cross-sectional	Madagascar, rural	quantitative	survey	chlorine

Appendix C Semi-structured interviews and institutional context

In order to better understand the institutional context in which the water hygiene practises take place, the point of views of local influential key stakeholder on HWTS was assessed by means of short semi-structured interviews

Reluctance on a policy level to adopt HWTS as a solution to water problems might be one reason why HWTS did not reach a large scale application yet as officials tend to focus on engineered solutions (Clasen 2009). Governmental and local institutional supports are important for the diffusion of HWST. Such institutions have an influence on what people think they should be doing (Figueroa & Kincaid 2008). Therefore it is also interesting to see local bodies' perspective on HWTS as a solution to the safe water quality problems. Stakeholders interviewed were employees of governmental local water bodies, a member of the State Urban Development Agency (SUDA) of Uttar Pradesh, a manager of a governmental hospital and the director of the local NGO Pratinidhi. The interviews contained following key questions:

1) Their view on the necessity to treat water on a household level
2) Do they support the uptake of HWTS on a large scale and are supportive in promoting it?
3) Is there any evidence of concerted efforts amongst these different bodies to promote HWTS?

For the qualitative stakeholder interviews, the author was always accompanied by a member of Pratinidhi. The NGO usually fixed the appointments before visiting the stakeholder in their offices in Luncknow.

Institutional context

Additionally to the quantitative interviews five short qualitative interviews were conducted with local governmental officials from water bodies (UP Jal Nigham, State Water & Sanitation Mission and the Third Water Connection, a water treatment plant in Lucknow), the State Urban Development Agency (SUDA) and from a governmental hospital close to one of the slums. The individuals interviewed owned influential positions within their organizations and wished to remain anonymous. Finally, also the director of Pratinidhi was interviewed upon his opinion on HTWS to also get the viewpoint of a stakeholder from the non-governmental sector and who is highly active in promoting HWTS.

Governmental water bodies

The three interviews conducted with the governmental water bodies showed that the local authorities consider the water they provide to the end user to be of good quality. They do however, recognise that in some slum areas of Lucknow water quality might be an issue, mostly due to connection and pipe problems related to illegal access to water supplies prevalent in those areas.

These illegal connections often contain leakages, potentially causing water contamination. Bacteria or flies sitting on the openings of water taps might also cause some contamination at the endpoint according to them. Otherwise they considered the water provided from the treatment plants to be safe. Two interviewees did not consider it necessary to treat water again at household level. One interviewee refused to comment on this issue. When one of the officials was confronted with a recent newspaper article which reported contaminated water supplies in some parts of Lucknow, he replied that people from the media sometimes lie when they talk about water contamination and that rich people generally do not trust the public system and consider their costly filters installed at home as a status symbol. They also claimed that people only treat water at home for their own satisfaction. All interviewees identified slums as the major problematic areas, not just because of the illegal water supply connections, but also because of all the dirt around those areas. More work according to them should be done under public awareness to inform and educate people about the health risks of an unhygienic environment. However, the interviewees saw greater issues with ensuring regular water availability and were concerned about the growing ground water depletion. Therefore they want to mainly focus in future on opportunities on how to extract more water from surface water sources to lower the pressure on ground water tables. Ensuring safe water quality with surface water resources is always more challenging than with groundwater resources, as surface resources in and around Lucknow are heavily contaminated and need heavy treatments.

SUDA

The contact person from the State Urban Development Agency (SUDA) in Uttar Pradesh held the view point that the ground water resources are generally safe, and that the actual problem lies with surface water distributed through pipes. However, she also acknowledged all the efforts and resources invested by the government in the water supply infrastructure to already maintain the current status. The government has to continue with their efforts to ensure safe water quality, but also the consumer has to be made aware of their own responsibilities to treat their water, as safe water quality cannot always be guaranteed currently. People have to understand and realise that the water is not always safe to drink untreated. Therefore she claimed that massive large scale communication plans are needed and especially non-users need to be explained and persuaded again and again. For this purpose the government hands over all the responsibility towards NGOs, because they are the ones with the power to interact and are able to take actions on the grass root levels. Also according to SUDA people have to get more active in communities and report complaints more frequently and on a larger scale about their water quality, rather than just accepting it silently or complaining amongst each other. The government on the other hand needs to assess the water quality more frequently at endpoints and establish a well working monitoring system which also works well in practice and not just on paper.

Governmental hospital

Finally, another short interview was conducted with a manager of a governmental hospital close to the slum area. He claimed that water should always be treated on a household level as there is no guarantee that the supply water is always safe to drink. He found that there is a peak with patients suffering from diarrhoea during the months of May, June and July. During those months the hospital is also very active organizing health camps, distributing free chlorine tablets and informing people in general about health threats connected to water wherever epidemic outbreaks occur. However, according to the hospital these activities do not have a large (long-term) effect. According to him people living in the slum areas are to a large part uneducated, extremely busy struggling with daily life, do not have enough money and live in highly unhygienic conditions. He also claims that many just do not want to change and got used to their surroundings and way and condition of living. The manager also doubted its effectiveness in slum areas, where people live in unhygienic conditions and the chances of recontamination is very high and people tend to get sick through other critical pathways if not through water.

Pratinidhi

The director of the NGO Pratindidhi saw a strong need for water treatment on a household level and stated that the water quality from supply cannot be trusted. The government cannot and never will directly admit water quality issues and frequently state that the water which they distribute from their treatment plants is safe. According to him officials from the water sector believe that their duty ends here and what happens at the end point is not really of their concern. Therefore the director saw a crucial role of NGOs in supporting the upscale of HWTS through massive campaigns by raising awareness, but also finding suitable solutions for the people at risk. In order to be successful a strong partnership with the private (commercial) sector and micro finance institutes is needed, which assure that consumer needs are understood and affordability guaranteed.

Summary

From all the interviews it was noticed that concerted efforts to promote HWTS were not practised on an official governmental level. However, the contact person from SUDHA mentioned the need for it and that actions are required on multiple scales. The responses of the officials of the water bodies with those of SUDHA and the hospital is striking. Where the officials from the water bodies claim that there is no problem in water provision and that the main problem is solely caused by illegal piping and dirt around the opening of the water pipes, SUDA, the hospital manager and the director of Pratinidhi found that the water quality cannot always be guaranteed. The key influential role of promoting HWTS was seen within the NGO sector.

Appendix D Water treatment promotion campaign in Lucknow

The large water treatment promotion consisted of three major steps. In the first step water samples were collected from randomly selected households for a contamination test. In the second step people were sensitised to the importance of clean water consumptions and were presented the outcome of the simple water quality tests during a large public event. In the third step different water treatment options were presented to the communities. This step also included marketing and selling different filters and chlorine tablets to the inhabitants (a list with the products offered and their prices can be seen in the table D.1). Additionally, this last step involved follow up visits to households. People who purchased products were visited to make sure they were using the products in the correct manner or to provide them with replenishments of chlorine tablets or replacements of filter parts. Moreover, households that did not purchase any products were visited from door to door to make them aware of the various treatment products in more detail. As the population in these districts were from the lower income class, Pratinidhi offered them attractive credits through a micro finance scheme. This process was repeated every six to seven weeks for almost one and a half years. During this intervention some households also received free filters from the manufacturer Tata.

The second type of intervention the two districts experienced, were educational sessions about hygiene practises. These sessions were usually held in smaller groups of women. The districts were subdivided in smaller divisions and female household heads from the same area were invited at the educational meetings. The content of those sessions focused on different water treatment options, personal and water handling hygiene practises, and general recommendations on how to manage water borne diseases like diarrhoea and typhoid fever and child diseases. These educational sessions were last conducted eight months ago in the districts relevant for this study.

Table D.1 List of different filter types promoted during household water treatment promotion campaign in Lucknow.

Product Name	Company Name	Kind	Price (Rs.)	URL
Aquatabs	Medentech	Chlorine tablet	30.00	http://www.medentech.com/water-contamination-disinfection-products/aquatabs-water-purification-tablets.html
Pureit Classic	HUL	Filter	2,200.00	http://www.pureitwater.com/IN/pureit-classic
Pureit Classic 14L	HUL	Filter	1,200.00	http://www.pureitwater.com/IN/pureit-classic-14-litres
Water Guard	Usha Brita	Filter	2,499.00	http://www.ushabrita.com/2009/12/waterguard-20l.php
Zero B Shuraksha Plus	Ion Exchange	Filter	2,090.00	http://zerobonline.com/pro7.html
Tata Swach	Tata	Filter	1,199.00	http://www.tataswach.com/
Tata Swach Smart	Tata	Filter	899.00	http://www.tataswach.com/

Note: Websites last accessed on 02.08.2012

Appendix E Chlorine colouring scheme

Source: TERI (2005), p. 43

Appendix F Questionnaire

Questionnaire

Greetings,

My name is Tanya Singh. I am a student from the Netherlands and currently conducting a research for my studies in Lucknow. Is there someone in the household present who is responsible for handling and serving drinking water I could talk to?

(*If the responsible person is different from the person whom you just introduced yourself then repeat the short introduction. Otherwise continue with the part below*).

For my research I am interested in the opinion of people on household water hygiene practises in general, and in how people treat and store their water at home.

Your contribution to my research is very much appreciated. The interview will take approximately 30 minutes. Your participation is voluntary and will have no effect on the quality of your water supply. For the purpose of my study I will also need to take a water sample from your stored water. Would you be ready to take part in this questionnaire?

1) *No → Thank the person and move on*
2) *Yes → Proceed with the questionnaire*

Before we start I want to assure to you that all the information you will give here will not be shared with anybody else. The answers you give I will fill out on a paper, but your name will not be on it, so only I know that you have provided these answers. Also, for the usefulness of the interview, it is very important that you give honest answers to the questions. Please know that it does not matter for me which answer you give, and that different people give different answers to these questions and that is okay. There is no right and wrong for me in this case. I am only interested in your view point, beliefs, opinion and how you do things.

Do you have any questions so far?

Please, during the interview that I will start now, if anything is unclear always ask me and I will try to explain. You may refuse to answer any or all questions on the survey at any point of time.

A) Identification

NO.	QUESTION	CODING CATEGORIES	INSTRUCTIONS
	Questionnaire number		
01	Sex of respondent	Female …….. 1 Male …….. 2	
02	Date of Interview	____DAY ____MONTH _____ TIME	
03	Slum		

B) Socio-economic characteristics

NO.	QUESTION	CODING	INSTRUCTIONS
04	**OBSERVE:** What is the material of the house of the main living area?	Stone ……..1 Carton……..2 Bricks ……3 Cement……4 Plastic/metallic cover……5	

Let's first start with some of the characteristics of your family and the people living in your household			
05	How many people live permanently in your house?	***(Write down the number*)** _____	
06	How many of those are boys/males?	0-14:_____ 14-adult: _____	
07	And how many are girls/females?	0-14:_____ 14-adult: _____	
08	How old are you?	***(Write directly the age)*** _____	
10	What was the last grade of school that you completed? *(Write in the number.)*	Grade:_____	
11	What do you do?	Business ……..1 Government Service ……2 Private Service……..3 Jobless…… ……4	
12	What is the monthly family income *(write down number in rupees)*	_____Rupees	
13	What is your religion?	Hindu ……1 Muslim ……..2 Christian ……3 Sikh……4 Buddhism……5 Something else (specify) _____6 None…… 7	Q 15 Q 15 Q 16 Q 16 Q 16 Q 16 Q 16
14	What is your caste? (Hindus, Muslim)	Scheduled cast (SC) ……..1 Scheduled tribes (ST) ……..2 Other backward cast (OBC) ……3 General cast (GEN) ……4 None ……5	

C) Drinking Water Source

Now I would like to ask you questions about your drinking water source

NO.	QUESTIONS	CODING CATEGORIES	SKIP
16	What is currently your main source of drinking water?	PIPED WATER INTO DWELLING.....1 PIPED WATER FROM A NEIGHBOUR.....2 PIPED WATER INTO YARD/PLOT.....3 PUBLIC TAP/STANDPIPE.....4 WATER TANK (GOVERNMENTAL SUPPLY) .....5 HAND PUMP.....6 PRIVATE BOREHOLE .....7 BOTTLED WATER.....8 OTHER (SPECIFY) _____9	
17	How often do you collect and store drinking water?	1 x time/day ....1 2 x times/day ....2 3 x times/day ....3 4 x times/day ....4 5 x times/day ....5 More than 6 times ....6 Never. We just consume water directly from the tap 7	

D) Water Treatment

18	Do you know what families can do to make water better for drinking in the house? *(RECORD ALL MENTIONED)* *(And ask "anything else")*	Boil ....1 Add chlorine tablets (Aquatabs).....2 Strain it through a cloth.....3 Let it stand and settle.....4 Filter.....5 Solar disinfection .....6 Phitkari .....7 Nothing..... 8 Don't Know..... 9	Pottasium Aluminum Sulphate (Alum) = Phitkari
19	How often do you treat water which you collected for drinking purpose?	Never.....1 Rarely.....2 Sometimes.....3 Very often.....4 Always.....5	➔ 23 ➔ 25 ➔ 25 ➔ 25 ➔ 25
20	Have you ever treated water before?	No .....1 Yes 2	➔ Move to next section
21	What method dp you usually apply to make your water safer to drink?	Boil ....1 Add chlorine tablets (Aquatabs).....2 Strain it through a cloth.....3 Let it stand and settle.....4 Filter .....5 Solar disinfection.....6 Phitkari/Alum_____7 Nothing.....8 Don't Know.....9	

22	We all know that treating water can be a time consuming and costly task, which might not be always possible to do. How often did you manage to treat your collected drinking water in the past three days? *(Help remembering the person by asking how many times did you treat it today? And yesterday? And the day before that? And then count the numbers together)*	_____ Write down the number of times	

E) DETERMINANTS

In the following part of the survey I am going to ask you some questions about your opinion about water treatment. Every time I talk about treated water I mean boiled, chlorinated, filtered or for example water strained through a cloth. With untreated water I mean water which is consumed directly the way it comes from its source. Please keep in mind that there is no wrong and right. I am just interested in your attitude and opinions and will not judge what you say.

All the questions that I will ask now will be very short and specific. Some are not questions, but more statements. For each question or statement, there is a specific type of opinion that I am interested in, which I will read out aloud. I will also show you a picture of small and larger circles on which I will ask you to point out what answer best describes your opinion, feeling or your situation. The meaning of the categories is written above the circles. *(SHOW DIAGRAM)*

➔ Explain diagram B as an example

The red circles show that you disagree, with the biggest circle disagreeing most strongly. The green circles show that you agree, with the biggest circle agreeing most strongly. The blue dot in the middle means that you have no opinion.

Following questions and statements assess different aspects like your health beliefs, intention to treat water, your thoughts and confidence about water treatment and your perception of what others do and want you to do. Please when answering these questions keep in mind that there is no right or wrong. (**Show Diagram B**) You can answer all the upcoming questions with "totally disagree, disagree, neither disagree nor agree, agree and totally agree".

Show Diagram C). You can answer all the upcoming questions with "Very bad, bad, neither bad nor good, good, very good".

Q no	*Question*	*Totally disagree*	*Disagree*	*Neither disagree, nor agree*	*Agree*	*Totally agree*
RISK 1 VUL1	I believe the water from my main source is safe to drink untreated	1	2	3	4	5
INT1	*Please, when answering this question also keep challenging situations in your mind, for example when there is lack of money, time, availability and motivation.* I intend to always treat water in the coming month no matter if the water appears to be clean or dirty.	1	2	3	4	5
AT1	Treated water is safer to drink compared to untreated water.	1	2	3	4	5
MOT3	I worry about what others think about me if I do not treat water	1	2	3	4	5
SIDN5	If the government fails to supply us with safe drinking water it is my responsibility to provide clean drinking water to my household members by treating water.	1	2	3	4	5
AT6	Treating water does NOT help to improve health outcomes	1	2	3	4	5
SE2	I feel capable of always treating water even if I am busy	1	2	3	4	5
AT5	It is worth to invest time in water treatment	1	2	3	4	5
SIDN4	It is my duty to take care of my family's health by providing them with clean water	1	2	3	4	5
MOT4	Seeing many others treating water would be a reason for me to treat water as well	1	2	3	4	5

Q no	*Question*	*Very bad*	*Bad*	Neither bad, nor good	*Good*	*Very good*
INJN 4	What would others think of you if you were not treating water (like your neighbours, friends and relatives)?	1	2	3	4	5
AT7	Do you believe it is bad or good to treat water?	1	2	3	4	5
AT2	How do you perceive the taste of treated water?	1	2	3	4	5
AT8	Do you believe it is good or bad to drink untreated water?	1	2	3	4	5

(**Show Diagram E**). You can answer all the upcoming questions with "Very unenjoyable, unenjoyable, neither unenjoyable nor enjoyable, enjoyable, very enjoyable".

Q no	*Question*	*Very unenjoyable*	*Unenjoyable*	*Neither unenjoyable nor enjoyable*	*enjoyable*	*Very enjoyable*
AFF2	How does it feel like treating water for the entire household?	1	2	3	4	5

(**Show Diagram F**). You can answer all the upcoming questions with "not bad at all, very bad, a little bad, bad, very bad".

Q no	*Question*	*Not bad at all*	*Not bad*	*A little bad*	*Bad*	*Very bad*
RISK3	If you contracted diarrhoea, how severely would that impact your life?	1	2	3	4	5

(Show Diagram A). You can answer all the upcoming questions with "Never, seldom, sometimes, often, always".

Q no	*Question*	Never	*Seldom*	Sometimes	*Often*	*Always*
INT2	How often do you plan to treat water in the coming month (*Please, when answering this question also keep challenging situations in your mind, for example when there is lack of money, time, availability and motivation)*	1	2	3	4	5
INJN 3	How often are you told by NGOs or other promotion activities to treat your water?	1	2	3	4	5
MOT 1	How often are you motivated to listen to what these NGOs or promotion people tell to you?	1	2	3	4	5
INT3	How often do you expect to treat water in the coming month? ((*Please, when answering this question also keep challenging situations in your mind, for example when there is lack of money, time, availability and motivation)*	1	2	3	4	5
RISK	How often do you treat water in general?	1	2	3	4	5

(Show diagram D). You can answer all the upcoming questions with: Very confident, unconfident, neither unconfident nor confident, confident, very confident

Q no	*Question*	Very unconfident	*Unconfident*	Neither unconfident nor confident	*Confident*	*Very confident*
SE1	How confident are you to be able to treat water when you are short of money?	1	2	3	4	5
SE5	How confident are you to treat water if someone important to you is not in favour of treating water?	1	2	3	4	5

Following questions look at how many people you know who treat their water (**Show diagram AII**). You can answer the questions with "None, very few, several, many, everybody"

Q no	*Question*	*None*	*Very few*	*Several*	*Many*	*Everybody*
DIS2	Do any of your neighbours treat water?	1	2	3	4	5
DIS3	Do any of your relatives treat water?	1	2	3	4	5
DIS4	Do any of your friends treat water?	1	2	3	4	5
DIS1	How many people do you know in this community who do not treat their water?	1	2	3	4	5

(Show diagram B). You can answer with "Totally disagree, disagree, neither disagree nor agree, agree and totally agree".

Q no	*Question*	*Totally disagree*	*Disagree*	*Neither disagree, nor agree*	*Agree*	*Totally agree*
RISK4	Whenever water is clear it is safe to drink	1	2	3	4	5
AT4	It is worth to invest money in water treatment because for example of saved medical costs and more time to work?	1	2	3	4	5
RISk2	Diarrhoea is something very common. It is nothing to worry about.	1	2	3	4	5
AT3	Treated water smells better than untreated water	1	2	3	4	5
SE4	Treating water daily for the entire household is difficult for me	1	2	3	4	5
AFF3	Drinking untreated water is disgusting	1	2	3	4	5
SE4	Whether I treat water is entirely up to me	1	2	3	4	5
BAR3	I am unable to treat water because it is too expensive	1	2	3	4	5
SIDN2	Hygienic people treat their water	1	2	3	4	5
MOT2	When it comes to health matters I want to do what my doctors says with respect to water	1	2	3	4	5
MOT1	I do what my household members expect me to do.	1	2	3	4	5
AFF4	I feel sorry whenever offering someone else untreated water.	1	2	3	4	5
RISK5	If my child has diarrhoea very often this is not good	1	2	3	4	5
AFF1	Always treating water is a hassle	1	2	3	4	5
SIDN7	People who care about their family treat their water					
AT8	I cannot prevent someone from falling sick by treating water. It is God who decides about who falls sick and who remains healthy	1	2	3	4	5

AT9	Water only needs to be treated when it looks dirty	1	2	3	4	5
SE3	I am confident that if I wanted to I could treat water	1	2	3	4	5
BAR1	I know where to get the tools for water treatment	1	2	3	4	5
SC4	I know how to treat water	1	2	3	4	5
AT10	Chemicals which are used to treat water are unhealthy to consume	1	2	3	4	5

The coming two questions are about what other people think about water treatment. I will read out loudly the answer possibilities **(Show diagram G)**

Q no	*Question*	*Not at all*	*Not really*	*They have no opinion*	*A little bit*	*Very much*
INJN1	*Do your household members expect you to treat water?*	1	2	3	4	5
INJN2	*Does your doctor expect you to treat water?*	1	2	3	4	5

In case the interviewee does not treat water at all, tell him/her following: Following questions might be a little bit strange for you, as you do not treat water. But I have to ask these questions to everyone who participates in my survey. (Show diagram H)

Q no	*Question*	Very difficult	*Difficult*	*Neither difficult nor easy*	*Easy*	*Very easy*
HAB1	How easy is it for you to remember treating water	1	2	3	4	5

You can answer with "Totally disagree, disagree, neither disagree nor agree, agree and totally agree". **(Show diagram B)**

Q no	*Question*	*Totally disagree*	*Disagree*	*Neither disagree, nor agree*	*Agree*	*Totally agree*
HAB3	Treating water is a habit for me	1	2	3	4	5
HAB5	Looking at tomorrow I exactly know when I will be treating water	1	2	3	4	5
HAB4	I have a fixed way of treating water	1	2	3	4	5
BAR2	My household members (would) give me a hand with treating water if I needed their help	1	2	3	4	5
SK1	I make sure whenever I am about to run out of stock of the things I need for treating water I buy or order a new load so that there is no interruption in the water treatment process	1	2	3	4	5
SK2	I make sure whenever treated water is almost finished, I treat more water in time	1	2	3	4	5
BAR6	In case I forget treating water my household members remind me	1	2	3	4	5

BAR	Getting the tools needed for water treatment is fairly easy for me	1	2	3	4	5

Show Diagram A). You can answer all the upcoming questions with "Never, seldom, sometimes, often, always".

Q no	*Question*	Never	*Seldom*	Sometimes	*Often*	*Always*
SK3	Do other tasks hinder you from treating water?	1	2	3	4	5
HAB 2	It is a common thing that people intend to treat water, but forget to do so. How often does that happen to you? (or would happen to you)	1	2	3	4	5

F) Hygiene measures

In the following questions I will ask some general questions about hand washing and sanitation

23	When did you use hand washing soap yesterday?	For nothing……..1 WASHING MY HANDS AFTER DEFECATING ……2 WASHING MY HANDS BEFORE PREPARING FOOD……3 WASHING MY HANDS BEFORE EATING……4 OTHER……5	
24	Do you have a toilet facility at home?	No, we have to defecate somewhere outside …….1 Yes ……2	
25	Do you make use of a special detergent for cleaning (for example your floor)?	No ……1 Yes (which one)……..2 Sand mixed in oil……..3	

G) Storage

The next set of questions will address your storage behaviour.

26	(Only ask someone who treats water) Do you have treated water avaialble , from which I could take a sample?	No …… 1 Yes ……2 If yes, how did you treat the water? (Note down answer) _____	
27	(Only ask non-treaters) Do you currently have stored water available from which I could collect a sample?	No …… 1 Yes ……2	
28	How do you store drinking water ?	Clay pot ……1 Plastic bucket ……..2 Plastic bottle ……3 Steel bucket ……..4 Filter……5 Vessel with a tap……6 Other (Specify: _____)	
29	**OBSERVE:** Do the vessels have a narrow mouth or a closed mouth? Narrow mouth opening is 5 cm or less.	Narrow mouthed ……1 Wide mouthed ……2	
30	**OBSERVE:** ARE CONTAINERS COVERED?	Not covered ……1 Covered with hard cover……2 Half covered ……3 Covered with soft covers ……4	

31	How do you get water out of the drinking container?	Glass/cup with handle .....1 Ladle.....2 Pour into drinking glass/cup directly.....3 Tap .....4 Bowl, cup, glass without handle.....5 Other mechanism (specify)_____6	
32	How old is the water in the storage container?	0 day.....1 1 day.....2 2 days.....3 3 days.....4 Older than 3 days...5	
33	From which source did you collect drinking water the last time you collected water? (Try to get a sample from the original source)	PIPED WATER INTO DWELLING.....1 PIPED WATER FROM A NEIGHBOUR.....2 PIPED WATER INTO YARD/PLOT.....3 PUBLIC TAP/STANDPIPE.....4 WATER TANK (GOVERNMENTAL SUPPLY) .....5 HAND PUMP.....6 PRIVATE BOREHOLE .....7 BOTTLED WATER.....8 OTHER (SPECIFY) _____9	→
34	If source water is piped water into the dwelling ask if running water is available from which you could collect a sample	No ..... 1 Yes 2	

Thank you for taking part in my survey.

M) DIAGRAMS

DIAGRAM A

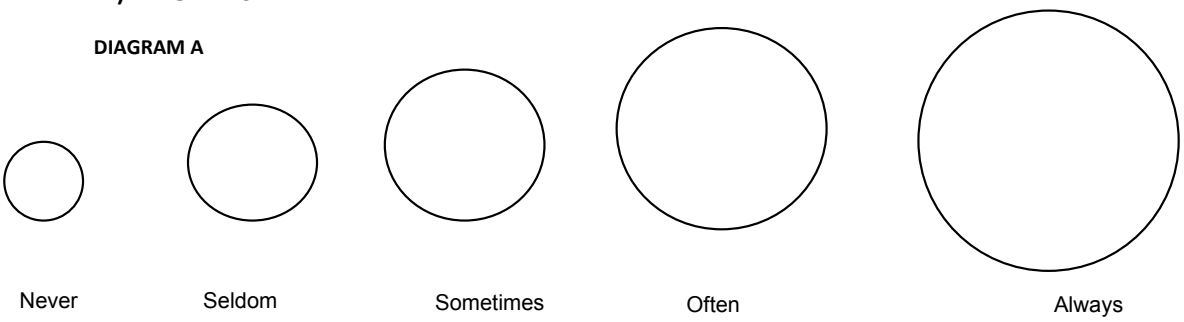


DIAGRAM A II

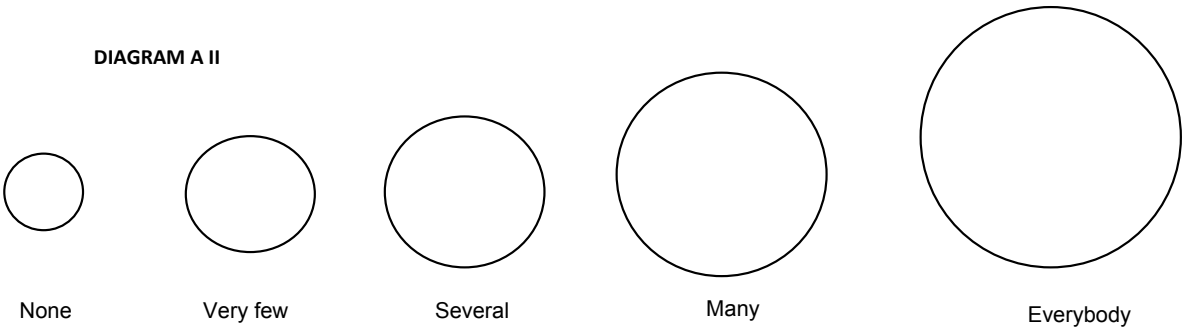


DIAGRAM B

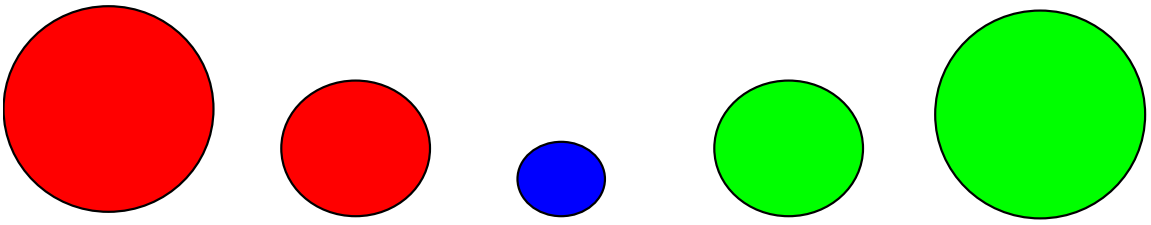
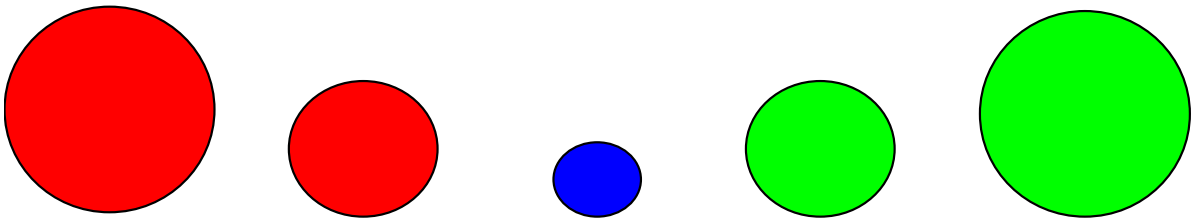
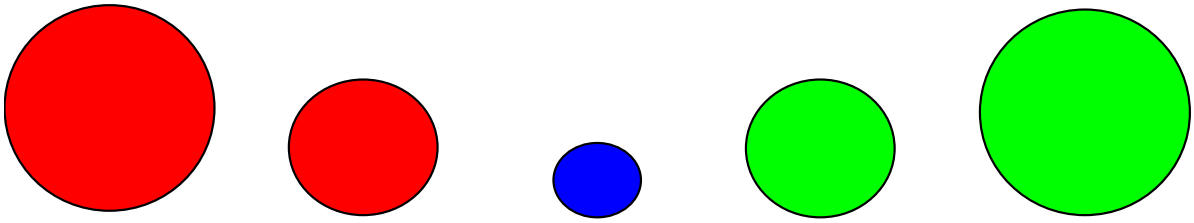


DIAGRAM C



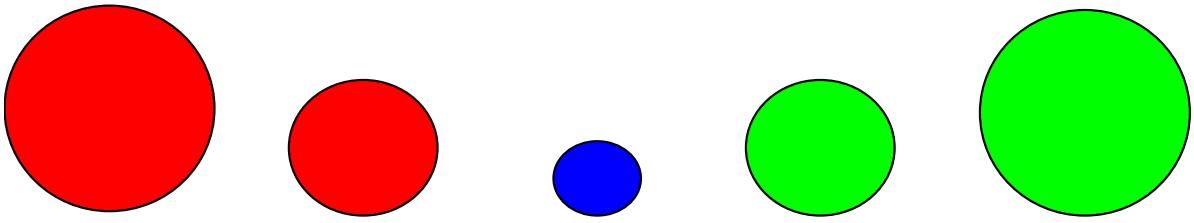
Very bad | Bad | Neither bad nor good No opinion | Good | Very good

DIAGRAM D



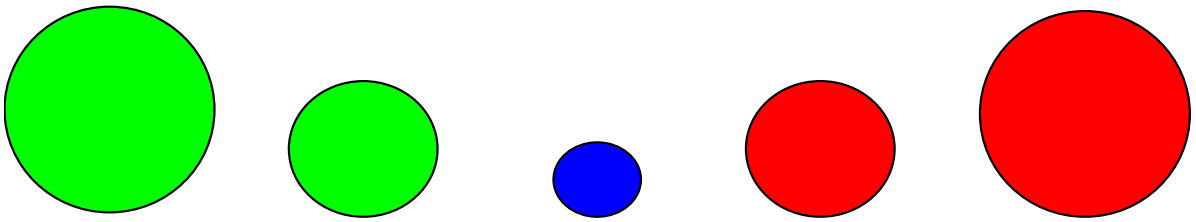
Very Unconfident | Unconfident | Neither unconfident nor confident | Confident | Very confident

DIAGRAM E



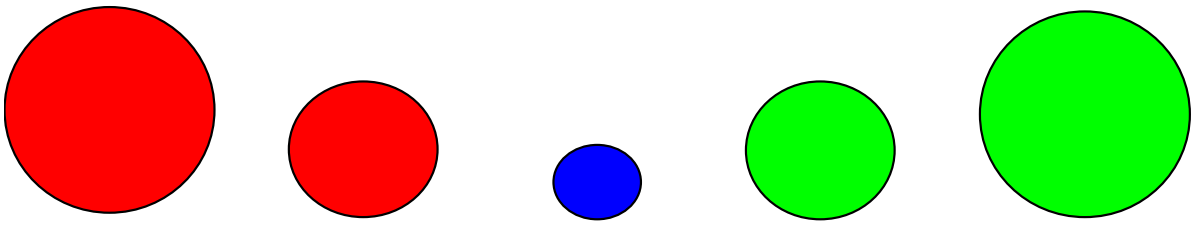
Very unenjoyable | Unenjoyable | Neither unenjoyable nor enjoyable | Enjoyable | Very enjoyable

DIAGRAM F



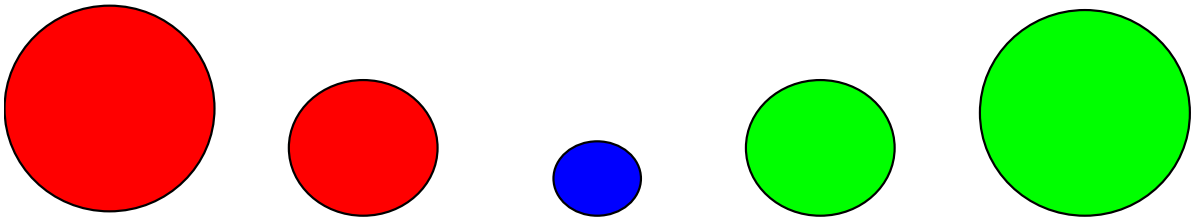
Not bad at all | Not bad | A little bad | Bad | Very Bad

DIAGRAM G



Not at all | Not really | No opinion | A little bit | Very much

DIAGRAM H



Very difficult | Difficult | Neither difficult nor easy | Easy | Very easy