Household perception and use of de-fluoridised water and hygiene behaviour in Naivasha, Kenya

Report for WSUP

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Executive Summary

Excessive amounts of fluoride pose a health risk to those relying on groundwater for drinking in 23 countries worldwide, including Kenya. Water and Sanitation for the Urban Poor (WSUP), a partnership between private sector organisations, civil society and academic institutions is working on a range of water supply issues in urban environments where significant population growth has occurred, often without a corresponding increase in basic services. One such example is the communities of Karagita and Mirera close to the town of Naivasha, Kenya. Since its' initial planning stage in 2006 the WSUP project has sought to find a sustainable solution to the dual problems of lack of affordable, reliable and safe water supply and high levels of fluoride in the groundwater above the safety guidelines set for drinking water by the WHO.

This study comprised of a rapid participatory assessment to explore the lower than expected sales of treated fluoride free water in the pilot project, despite the health risks. 53 semi-structured interviews were carried out, along with participant observation in order to identify water use and hygiene practices, specify the social and economic factors that shape these behaviours and assess the communities' understandings of the risk of fluorosis. Respondents often appeared to be opting for the cheaper options of untreated water and, whenever possible, collecting rain from their rooftops. Participants reported a number of factors affecting their water use, but the key finding was that use of treated water actually has less to do with economics but is instead dependent on individual awareness of fluoride and the health risks it poses.

The best way to increase the use of treated water in these communities is through an information campaign to disseminate and reinforce educational messages. In collaboration with respondents, some appropriate methods to increase community awareness were developed.

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KSH	Kenyan Shilling
UN	United Nations
USD	United States Dollar
WHO	World Health Organisation
WSUP	Water and Sanitation for the Urban Poor

1.Introduction

Despite impressive progress over the last 20 years there are still 920 million people globally living on less than a $1.25 a day (UN, 2010), many of whose limited resources are being stretched and their health suffering because they lack a safe, reliable, affordable water supply and adequate sanitation. The Millennium Development Goals (MDGs) were drawn up under the supervision of the UN to increase awareness of these issues and encourage investment to address them and many others that are blighting the lives of the world's poorest people. Due to improvements in water supply, recently reported in The Millennium Development Goals Report 2010, the often quoted estimate of 1.1 billion people without access to safe water may have to be recalculated and reduced. Safe water supply and sanitation are addressed in Goal 7 of the MDGs, 'Ensuring Environmental Sustainability' , but work toward achieving these goals has had a positive impact on combating other issues such as extreme poverty and hunger and high child mortality (Mwanza, 2003).

Guided by the aims of the MDGs Water and Sanitation for the Urban Poor (WSUP), a partnership between private organisations, civil society and academic institutions, has moved to address the issue of lack of access to water and sanitation in urban communities. WSUP is currently working in partnership with local service providers in Zambia, India, Mozambique, Madagascar, Ghana and Kenya.

In Kenya, where 41% of the population are not using improved drinking water sources (WHO 2008), WSUP have spent the last four years designing, trialling and implementing a project in communities surrounding the town of Naivasha located around 90KM Northwest of the capital Nairobi. The aim of which was to provide safe, reliable and affordable water to the growing populations of these areas.

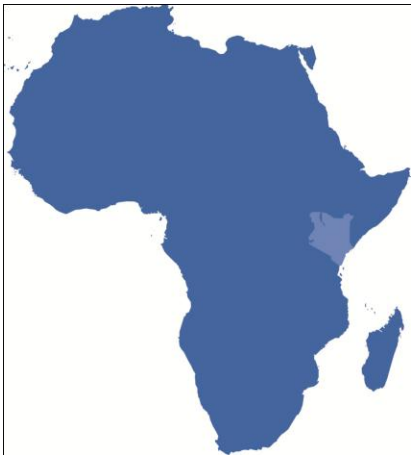


Figure 1: Map of Africa

Figure 2: Map of Kenya

The two adjoining communities that have been the focus of WSUP's work, Karagita and Mirera, are 7km from Naivasha and home to approximately 62,447 people (54,000 as of 2006 [Maina. 2006] with 3.7% annual population growth). The population is mainly made up

of low income economic migrants (67% of respondents in this study) who have been drawn to the area by the possibility of work on the numerous flower plantations and in the burgeoning geothermal and tourism industries.

Karagita and Mirera defy easy description, neither falling easily into the urban, peri-urban or rural category but encompassing all three. Karagita has the population density of an urban area but the surrounding flower plantations and farmland resemble a rural location, whilst Mirera's lower density and agricultural land makes it more similar to peri-urban and in parts rural areas. But the lack of basic services, substandard housing, overcrowding, poverty and unhealthy living conditions closely match the UN's (2003) definition of a 'slum'. Yet 'slums' or informal settlements are not homogenous they differ from place to place and there can be large variation within each settlement (Gilbert, 2007). One example being housing which is grouped in compounds of around 4 to 12 dwellings either constructed of mud and wood or concrete and brick with corrugated iron roofing.

Figure 3: Typical mud & wood dwelling

Figure 4: Typical concrete & brick dwelling

As in many other rapidly urbanising areas there is a need for adequate water supply, sanitation and waste disposal infrastructure. In this area most of the water consumed originates from boreholes accessing the groundwater supply although a number of people are supplementing this supply with harvested rainwater. Water quality tests of boreholes in this locality have found fluoride levels ranging from 6 to 25 mg l^{-1} (WSUP, 2008b). For this reason WSUP could not simply implement a water distribution system but had to incorporate fluoride filtration into the supply. Groundwater is filtered using bone char (processed and treated animal bones) lowering fluoride to safe levels.

Figure 5: WSUP Kiosk in use

WSUP have made water available from 8 kiosks in a pilot area of the project, approximately 8 hectors with a population of 6939 (6,000 as of 2006 [WSUP, 2008b], 3.7% annual pop.

growth) (WSUP, 2008b). Each kiosk sells both water treated for fluoride intended for drinking and cooking and untreated water acceptable for washing and hygiene purposes. The price of water at the kiosks reflects the treatment process and WSUP's aim to have a self sustaining project with untreated water for sale at 1Ksh (0.01USD) for 20l and treated water sold for 2Kshs (0.02USD) per 20l. But access to safe water does not necessarily result in consumption of safe water (Hoque & Sack, 1994) and sales of treated water have not met projected demand.

Many projects are unable to explain the deviation of actual outcomes from intended outcomes. Research in this field, discussed in detail in the literature review, has found that for newly implemented technologies to succeed they must match actual or perceived needs of prospective users. Interventions cannot be seen as simply technical projects; social, cultural and economic factors play key roles in how and why people use them. A Rapid Participator Assessment involving semi-structured Interviews and participant observation was used to investigate why purchased water at the kiosks has been lower than anticipated, outlining water use and hygiene practices and the economic factors that define these behaviours and to analyse the communities' understandings of the risk of fluorosis. The findings of which may have resonance not just for the pilot project but for similar defluoridisation projects WSUP are implementing in other communities such as Kamere and Kasarani.

2. Literature Review

This review introduces the research context and addresses three elements critical both to the implementation and use of water kiosks and to the improvement of hygiene practices. Themes running through each element are; how researchers across various disciplines have studied behaviour change, and how organisations have tried to harness or encourage those changes.

2.1 Adoption of new technology

In order to combat global challenges such as lack of access to safe water, a strong emphasis has been placed on the diffusion of new and presumably beneficial technologies (Sutton, 2008). Yet there are countless examples of abandoned pumps and broken down systems (Carter at al.1999); a shocking example is Nigeria, where less than 50% of rural hand pumps are fully functional (Amon & Odukuye, 2003). The study of the diffusion and adoption of new technologies can offer important insights into how these types of failure can be avoided. Diffusion has been defined as the communication of technologies, innovations and ideas to members of a social system that are considered or perceived to be new (Rogers, 1995). Many theorists across disciplines have settled on the model of the S-curve to represent diffusion.

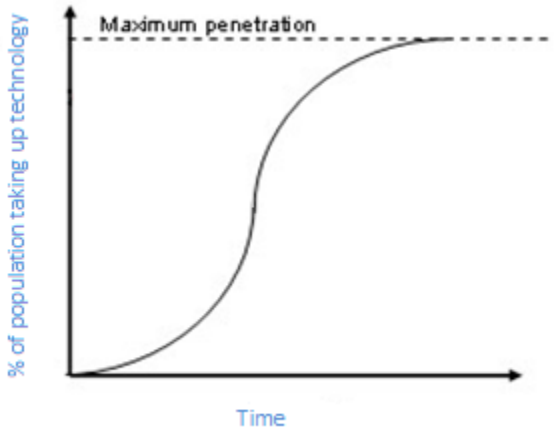


Figure 6: Example of the S-curve typical of the diffusion and uptake of new technology

The S-curve illustrates how diffusion of a technology through a group is initially slow (as indicated by the low rise of the curve) followed by a tipping point at the 10-25% adoption rate, leading to rapid adoption (and a rapid rise of the curve) until stabilising as the majority of potential adopters have done so (Jaffe et al, 2002).

Adopters can be grouped into five stages (Rogers. 1995), as shown below.

Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Innovators	Early Adopters	Early majority	Late Majority	Laggards

Figure 7: Rogers' stages of diffusion

Researchers have endeavoured to find out why it can take an unexpectedly long time for the people most likely to benefit to take up a new technology (Geroski, 2000). The epidemic model is one of two models explaining how technologies diffuse. It suggests that the spread of diffusion is proportional to the spread of relevant information (Geroski, 2000). Initially people are not aware of the technology, or of the advantages a technology offers, but through social interaction those who have tried the technology eventually spread this information, encouraging others to use it. The important role potentially played by community members or peers applies not just to the uptake of technology, but to other social phenomena, such as personal lifestyle or health decisions. Christiakis (2004) has illustrated that health behaviours such as weight loss can diffuse through close social networks and shown how negative health factors such as the risk of obesity can be increased if person has a friend, sibling or spouse who is overweight (Christakis & Fowler. 2007). The epidemic model has been criticised, however, for failing to address differing abilities to learn and differing degrees of risk aversion (Geroski, 2000). The second model, the probit model, posits that differing lengths of time taken for adoption are based on such individual differences, driven in turn by varying personal goals, needs and abilities (Geroski, 2000).

What is necessary for a holistic view of the adoption of new technologies is a model that illustrates the primacy of social networks but does not ignore the way these are interpreted and internalised on an individual level. Rogers (1995) has come closest to marrying these, in his model technologies are made up of hardware and software in much the same way as a personal computer . The hardware is the tools or the component itself, while the software is the information about how it is used. This thesis will focus on the on the users of 'hardware' (customers of water kiosks) and their understanding of the 'software' necessary for correct decisions (which kind of water to use for drinking and cooking). The speed of diffusion of this understanding is based on the perceived relative advantage of use, the perceived complexity or difficulty of use, trialability and observability (Rogers, 1995). The stages through which an individual passes before adoption, according to Rogers, are shown over the page.

Figure 8: Rogers' stages of adoption

The diffusion model is missing a step; modification. This can be evident throughout the whole uptake process, and it effects how the innovation is used. The potential users' lack of knowledge is under-theorised, and the phenomenon of reinvention of a technology by the user is completely ignored (Rogers. 1995). Both of these phenomena are of particular interest in this study, as either or both may help to explain the misuse of water kiosks or the lack of diffusion of the information about correct water use. Another criticism comes in the form of a bias toward blaming the individual. Researchers such as Rogers have tended to focus on the individual user and their lack of correct use, not on systemic or technological faults. For example, they have often failed to consider the pertinent question of whether the innovation matches the actual or perceived needs of the individual use. There is a danger, and one not addressed in the research discussed above, of focusing solely on economic factors and falling into the common Western preoccupation with price. But, the main problem with research into adoption of new technologies is "that we know too much about innovation success and not enough about innovation failures" (Rogers, 1995.105).

2.2 Health risks of Fluoride and peoples' understanding of these risks

There may still be debate over the possible health benefit of exposure to small doses of fluoride in drinking water but there is a scientific consensus that high levels of exposure can lead to serious and debilitating health problems. Fluoride is found naturally in minerals such as fluorite, mica and apatite which form metamorphic rocks and granite and is also present in varying concentrations in natural water (WHO, 2006). The groundwater in the area of research as in many parts of Kenya, Ethiopia, Tanzania, India, Pakistan, Bangladesh, Mexico and Iraq contains levels of fluoride above the 1.5 mg l^{-1} guideline limit for drinking water set by the WHO (2006). Globally 70 million people are exposed to fluoride above this limit (WHO, 2006), the impacts on health are shown below.

Table 1: Health effects and symptoms of prolonged exposure to high levels of fluoride

Chronic Health Effects of High Level of Fluoride Exposure	Symptoms
Dental Fluorosis	Dark mottling of enamel as it develops evident when exposed to levels of fluoride above the 1.5 mg l^{-1} during childhood (WHO 2006).
Skeletal Fluorosis	Bone deformity and joint, nerve and spinal damage (WHO 2006).
Organ Damage	Liver and kidney damage in children drinking water with + 2.0 mg l^{-1} fluoride content (Xiong et al. 2007).
Cancer	Osteosarcoma, a type of bone cancer -exposure during childhood particularly in males (Bassin et al. 2006).

The results of long term exposure to high levels of fluoride are irreversible. Excess levels of fluoride are not perceivable in the taste, colour, smell or turbidity of water and unlike many other water related health risks is not removed by boiling. Fluoride technologies and

techniques exist to reduce exposure such as using alternative supplies, chemically treating the supply or as in Karagita using absorption methods to remove fluoride.

Somanthan and Chaudhari (2009) found that people's general level of education and their exposure to mass media are the most critical factors explaining willingness to invest in new innovations that would improve drinking water quality. These factors were even more influential than financial considerations. The research found that those who were able to pay for better quality water or the means to treat poor quality often do not due to lack of awareness of health risks. They found that willingness to pay can increase as much as 50% depending on the length of time the respondent attended school. An increase of 25% was recorded simply if participants read a newspaper once a week.

Silva de Castilho et al's (2010) research found that young people in rural Brazil accepted the health message that fluoride could be beneficial in small doses but rejected the causal relationship between excessive fluoride intake and serious health issues even after discussions on the subject with the researchers. In Thailand, Takizawa et al (2010) analysed a campaign to encourage people to use alternative sources for drinking water but found many people were unaware of the risks of using untreated water for cooking, particularly boiling rice. This may be due to confusion with other health messages many of which emphasise boiling water. They concluded that water safety education particularly as part of a continuous curriculum was essential. Both of the above studies illustrate the primacy of health education in promoting correct understanding of risks. Without an understanding risks cannot be mitigated against whether technologies or innovations are implemented or not.

Looking at the repercussions of exposure to excessive levels of fluoride, Sujak et al (2004) found that aesthetic consequences such as dark mottling of teeth and enamel defects were considered to be of only of minor significance among Malaysian adolescents. This research took place with a limited sample and the researchers did qualify their findings by suggesting that specific socio-cultural factors have a significant role in shaping the perception of appearance. These qualifications were confirmed by Mwaniki et al's (1994) work in Kenya where dark mottling of teeth was considered embarrassing by 77.5% of respondents, with many of those effected changing their behaviour by covering their mouths when laughing or not smiling. Respondents were only willing to talk about these issues when pushed on specifics of dental health with the researchers finding a high tolerance to disease, with serious health conditions including schistosomiasis considered a normal part of life. Again, boiling was used as a preventative measure; people were aware of the dangers but not how to avoid them. The contrast between the results of these two studies highlight the dangers of suggesting broad applicability of findings when research is grounded in one social context with a limited sample, a consideration that must be taken into account in this research.

Research developing technological solutions has produced a number of viable alternatives to provide de-fluoridated water across different contexts, but research into how people

implement and use these solutions has been very limited to the detriment of the sustainability of many such interventions. Clearly this is an important issue but this is not reflected in the limited breadth of research done to date and coupled with lack of health data, fluoride remains off the list of health priorities on research, governmental and donor level.

2.3 Hygiene Promotion

The benefits of providing treated water can of course be nullified if the water becomes contaminated after collection (Trevett et al, 2005). The most dangerous of these contaminants originate from faecal material, which contains a range of diarrhoea-causing bacteria, protozoa, and viruses that are responsible for Cholera, Typhoid, Bacterial Dysentery, Hepatitis A and Viral Gastroenteritis. Of the 4 billion cases of diarrhoea worldwide per year, 2.2 million will be fatal, the majority of fatalities being children under the age of five (WHO, 2000). Nor is drinking water the only faecal -oral infection pathway; faecal material can find its way onto fingers, particularly immediately after defecation, soil poses a risk if open defecation is practiced, and flies can carry pathogens from the faeces to humans. Without a campaign of hygiene promotion, contamination through these pathways poses a serious health risk that cannot be alleviated with just an improved or treated water supply.

In studies in Nepal and Kenya it was concluded that women with a higher level of education are more likely to adopt hygiene practices and put them into action correctly than less-educated ones (Cairncross & Shordt, 2004). As with the Somanthan and Chaudhari, it is clear that for interventions to be successful they need to focus on the least educated. Yet many changes of health behaviour are undertaken for reasons having little to do with health; hand washing is an example can be done for aesthetic reasons or as an act of nurturing (Curtis, 2003).

Even an intervention as basic hand washing by itself can bring about a 47% reduction in the risk of disease, thus it has the potential to save a possible million lives a year (Curtis, 2003). For this reason promoting hygiene messages is essential for any project wishing to maximise the health benefits of implementing a new water system such as found in Karagita and Mirera.

3. Methodology

3.1 Type of Data

The methodology of any research project is dependent on the type of data to be gathered. There is no space here to enter into the debate over the advantages and disadvantages of the quantitative and qualitative approaches and it seems unnecessary to perpetuate the false distinction between the two. The two approaches are often complimentary and overlapping (Giddens, 1984, Cook & Reichardt, 1979), as shown in this thesis where quantitative data focusing on water sales, rainfall and economic status is elaborated on by qualitative findings on perceptions, attitudes, behaviours and beliefs.

3.2 Sample Population

Research focused mainly on water users with a particular focus on women and young people both of whom are generally responsible for water collection. It should be noted that the number of men responsible for water collection is rising. A focus was placed on female respondents as the majority of households are headed by female (57.1%) and the household head is the key decision maker (WSUP 2008a). Women generally have responsibility for upbringing and education of children and therefore the transmission of hygiene and health practices. Respondents with a cross section of educational and economic backgrounds were sampled as both of these factors are known to influence water and technology use and hygiene practice uptake. Details regarding age, marital status, occupation and backgrounds can be found in the Appendix C. The survey area, described in the literature review was determined by WSUP and their research needs. Data was collected from the sample population until theoretical saturation was reached.

3.3 Research Methodology

Data will be collected through a flexible research project with a focus on evaluation rather than action research. Flexible methodology is essential in this kind of context because it allows the researcher to be reactive to issues that may arise that had not previously been considered. Different types of flexible research have been considered but did not fit the research brief; case studies focus on a small number of participants which might therefore compromise the representativeness of the sample, particularly with the largely heterogeneous nature of the sample population. Grounded Theory is not appropriate with the strong practical orientation and use of focused questions in this research. Ethnography would have been employed but there was a lack of time in the field to build rapport necessary to facilitate date collection essential to ethnography.

A Rapid Participator Assessment was used; interviewee led and engaging respondents in recommendations offering a thorough perspective focusing on actions of members of the

community, their explanations for these actions and the implications for the community which consisted of;

Secondary Research – preceding design and development of methodology, academic studies were assessed and a thorough examination of WSUP's previous report took places. Informal interviews with project management, staff and affiliates took place and meetings attended.

Pre Testing – Interview questions and other research material were initially vetted and modified in collaboration with WSUP project staff and trialled infield.

Interviews – "The purpose of qualitative interviewing is to hear and understand what the interviewees think and give them a public voice" (Rubin and Rubin, 1995).

Semi-structured interviews were used because their flexibility allows questions to be withheld or added as necessary which can encourage respondents to elucidate on particular topics so important information is not missed (Russell Bernard, H 2006). A list of research questions (see Appendix A) acted as a guide to make sure that topics were covered and relevant information was gathered within time constraints. They were based on guidelines that require them to be clear, specific, interconnected, measurable, and substantively relevant without ever being leading (Robson, C. 2002). During the interview open process orientated questions were asked as opposed to closed or fixed scale because they put few restrictions on the interviewee and therefore give a clearer indication of their understanding and opinion although they are harder to analyse (Robson, C. 2002). A non-confrontational style was adopted and interviewees were assured that there are no right or wrong answers, no value judgements were to be made regarding their responses and that they were free to interrupt and ask for clarification at any time.

English is widely spoken among those with a higher level of education, many of the poorer community members do not. Although some participants were competent in English they seemed more able to fully articulate their opinions in Swahili. Interviews were mostly conducted with the aid of a Swahili translator to ensure a representative sample was surveyed. This raises the issue of the translator bias and possibly mis or selectively translating. To counter this a translator with close links to the project with experience in health data collection who understood the aims of the research was chosen . The need for translation not interpretation was explained, but in translation a balance between understanding and the specifics of the vernacular had to be made and translation of interview questions from English to Swahili and the responses translated back may have resulted in deviation from the original meanings. The translator, being from the area and familiar with the project cross checked information helping to triangulate participants' responses. With a majority of respondents female and the researcher male, gender may have played a role in interviewees' willingness to participate and to be open therefore a female translator was chosen.

Interviews were tape recorded and transcribed with analysis aided by notes and observations made in the field. Short periods, a maximum 45minutes, were chosen for interviews to avoid interviewee, interviewer and translator fatigue and impinging less on participants' limited free time.

Participant Observation – Interviews produce a record of *reported behaviour* but to obtain information that more closely reflects *actual behaviour* observation must be employed (Bentley, M.E. et al, 1994).

Participant Observation entails an immersion in the research setting, an involvement in the lived reality of the respondents, a recording of the details of actions, interactions and settings however seemingly inane in the form of diaries, checklists and notes. This requires not just a focus on behaviours but the social and cultural settings in which these behaviours take place. Of particular interest were hygiene practices; people washing their hands after defecation, or before preparing food, how they are washing their hands. Access to dwellings was limited to only some interviews so direct observation of hygiene practices was limited but valuable information indicating whether hygiene practices are taking place were still gathered by looking cleanliness of hands, clothes and physical environment . Other important observations were visible manifestations of skeletal or dental fluorosis and signifiers of economic status such as state of dwelling, clothing and household goods were recorded. A checklist was developed (see appendix) for systematic analysis with enough space to include notes on observations that were not expected.

Health walks- Familiarising researcher with communities giving an overview of general conditions observing behaviours such as open defecation, evidence of faecal material, display of health messages and interaction between kiosk workers and customers.

3.4 Sampling Strategy

53 semi-structured interviews took place. Random transects were used to select compounds, within compounds disproportionate sampling was used to reflect the large amounts of women involved in water collection and women's responsibility for household storage and family hygiene. This was non-probability sampling as the likelihood of an individual being included in this research cannot be calculated.

Triangulation of data can occur through using differing methods and equally through using varied information sources. Therefore a variety of different participants were questioned with differing ages, occupations and household and community roles.

Disabled and Muslim community members were not well represented by this sampling technique so snowball sampling was used to facilitate interviews.

3.5 Ensuring Research Quality

The discrepancy between what people actually do and what they say they do has troubled researchers since the inception of ethnography when the anthropologist Bronislaw Malinowski found himself stranded on the Trobriand Islands. It may not simply be a case of active deception but can be explained by many reasons; an inability to remember correctly, an inability to articulate or behaviours may be considered so inane as not worthy of lengthy consideration. The use of multiple methods here consisting of semi-structured interviews, health walks and observation will facilitate triangulation, consistency of data across these methods will illustrate reliability hopefully dissipating what Malinowski found so troublesome. Participants were informed of the right to challenge, or query questions but rarely did, possible not feeling comfortable in this unfamiliar situation (and the power structures embedded within) therefore participants were asked specifically if they had any questions at the end of the interview helping to foster an environment of collaboration.

3.6 Analysis

Content Analysis, focussed on pre-identified themes, themes identified by the researcher and themes developed during the interviews by respondents.

3.7 Ethical Considerations

All participants received a full briefing to make sure they understand the nature and purpose of this research and they understood that the data would be used for research purposes only. All participants were informed of their right to withdraw. Debriefing was neither necessary nor practical, especially since no information about the research was concealed. No personal names are used so that confidentiality is assured. All participants were made aware of this prior to giving their informed consent. No participants were placed in a position of physical harm and it is unlikely that participation has cause emotional stress or psychological harm. There may be a social stigma attached to sanitation and hygiene practices and a taboo on talking about them particularly to strangers therefore participants were not pushed to disclose any details they do not feel comfortable discussing. Observation took place but nothing beyond the public sphere where observation would be expected. Participants were asked to read and sign a bilingual consent form, which was read out loud and explained if requested.

4. Results & Discussion

4.1 Consumption of treated water and untreated water

4.1.1 Pattern of WSUP water kiosks use

87% (46/53) of respondents are using the WSUP water kiosks. 97% (33/34) of those living in the pilot area, within 100m of the WSUP kiosks, are using them despite availability of other kiosks. Reasons given for not using these other sources are that the WSUP kiosk is cheaper and the other kiosks do not provide treated water. Of those living in Mirera, outside the pilot area and generally over 100m from the WSUP kiosks, half (6/12) were not using the WSUP kiosks, all others relied on donkey vendors except one using a private borehole. Distance was the main barrier to use that most people cited.

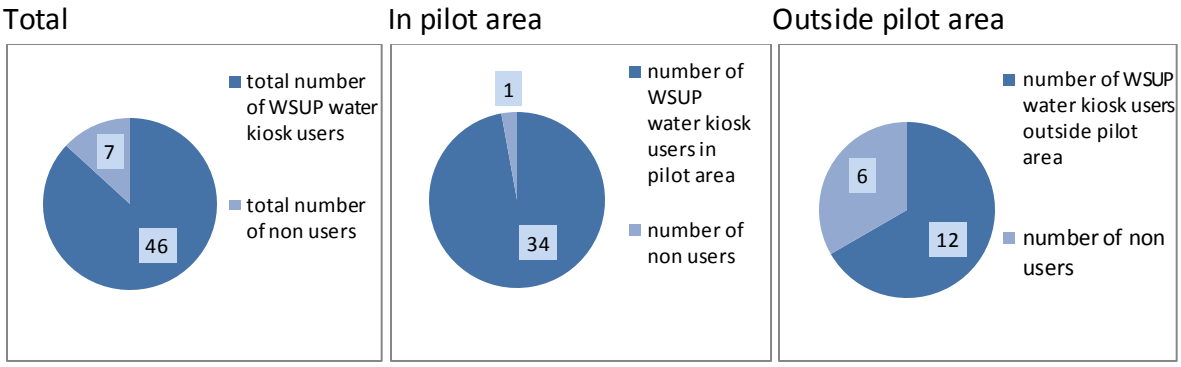


Figure 9: Pattern of WSUP water kiosk use

Within the pilot area use of the WSUP kiosks is high with only one interviewee resorting to donkey vendors because of her age and the large amount of water used in her household. In adoption of use of this new innovation there were very few *laggards* many using the WSUP kiosks since they opened conforming to the *innovators* stage of Rodgers' theory of technology diffusion.

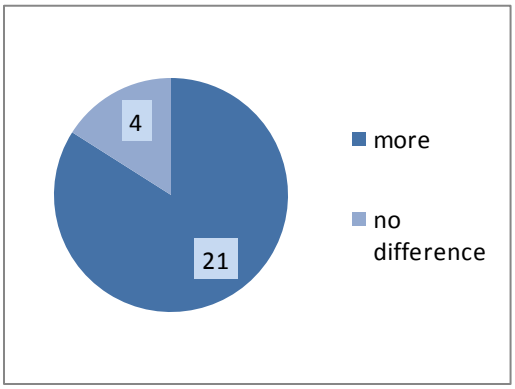
93% (39/43) of WSUP Kiosk users began purchasing water at the earliest opportunity (when the kiosk opened or when the respondent moved to the area), with female householders mostly being responsible for water collection. Before, the project respondents had paid between 2-5Kshs for 20l (0.02-0.06 USD), mostly to donkey vendors and to other kiosks.

84% (21/25) reported increased water consumption since beginning to use WSUP kiosks. The result of this increased consumption was observed in a high level of cleanliness amongst respondents particularly clean hands (a possible faecal-oral disease route) and clothes. In

almost every compound visited, women could be seen doing laundry or recently cleaned clothes hanging.

4.1.2 Interviewees' reported benefits since using WSUP Kiosks

- 4 respondents reported less incidences of diarrhoea.
- "this area is a very dirty area but now they are seeing some improvement because WSUP have been visiting people" - SSI 14.
- One respondent noted "a difference in the general hygiene and cleanliness of the area because the water is readily available and cheap" since the beginning of the WSUP project- SSI 15.
- A respondent running a nursery said "They have changed their hygienic standards because water is readily available" she had observed previously that children would turn up dirty but since the increase in supply most children are cleaner and suffer less from diarrhoea - SSI 20.
- One respondent put it succinctly; "hygiene comes from water, if you have water hygiene is practised" – SSI 47.



Increased water use because of access to a cheaper more reliable supply has brought about reported health benefits and observably high levels of personal hygiene. The low level of reported incidences of Diarrhoea (6 in the last 6 months across 53 households) show that increased access and health promotion have had a significant effect on the lives of residents of Karagita and Mirera.

Figure 10: Reported amount of water used since WSUP project began

All of these health benefits, it should be noted are augmented by use of treated water; 50% of interviewees purchasing treated water (20/40) reported household health improvements with respondents specifically referring to reduction in cases of amoeba, diarrhoea, stomach aches and, improvement in children's' teeth and less cholera outbreaks.

4.1.3 Purchasing patterns of treated water

70% (30/43) of respondents report purchasing treated water yet importantly 30% are not, the amount used and the reasons behind purchasing or not purchasing treated water are illustrated below.

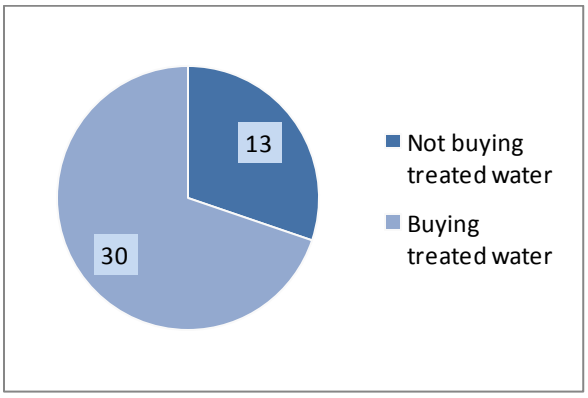


Figure 11: Purchasing patterns of treated water

Table 2. Reported amount of water used on a household level.

Average number of litres of **untreated** water bought daily from the WSUP kiosks per household	Average number of litres of **treated** water bought daily from the WSUP kiosks per household
72	20

Mean household size calculated as 3.4 (WSUP, 2008a).

Respondents' reasons **for purchasing** treated water

- The most cited motivation was to reduce risk of diseases (12 respondents out of 22): malaria, cholera, diarrhoea, parasites or unspecified disease in general.
- But only 5 people referred specifically to fluoride, reduced teeth problems or reduced risks of dental fluorosis.
- They are told at the water kiosks that treated water is safe for drinking and cooking.
- "because it's safe" SSI 28.
- "when you use the untreated you notice a difference in the taste" SSI 52, this was noted by 3 other interviewees.
- One interviewee uses treated water so she does not need to boil water before drinking.

Respondents' reasons for **not purchasing** treated water

- Treated water considered too expensive by 7 respondents; they are "used to buying for one shilling" SSI 4, one interviewee buying untreated "because it favours my pocket" SSI 7.
- The water boils faster when cooking with the untreated according to 2 interviewees.
- 2 respondents answered they were 'used' to drinking untreated water.
- 2 respondents were unaware treated water was available.

- "The residents here are confused because they have never seen two types of water even in Naivasha town" SSI 7.
- One respondent was overly concerned about chemicals he believed were being put into the treated water in high concentrations.
- Treated water is available from work.
- 19% of interviewees (7/37) considered treated water to be expensive. Yet before project 56% (22/39) paying as much as 5Ksh per jerry can from donkey vendors and the other 44% (17/39) paying at least 3ksh from non WSUP kiosks.

4.1.4 How the treated water is used

Adoption of the new technology can not be the sole aim of a project particularly if incorrect use nullifies any health benefits. Even among those purchasing treated water 20% are using it for drinking only and not for cooking therefore still exposed to high levels of fluoride.

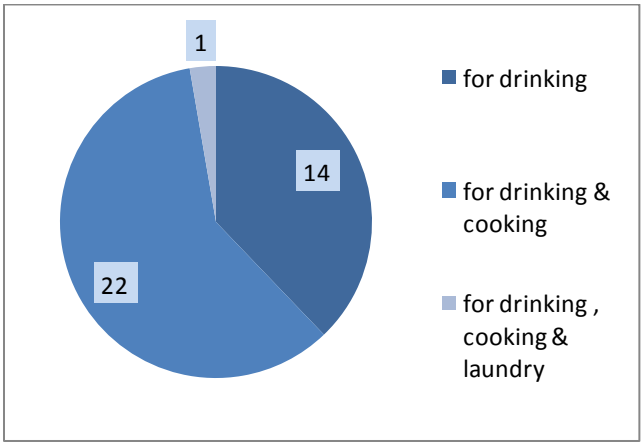


Figure 12: Respondents' use of treated water

Similar to Takizawa (2010) findings where the health benefits of a project to reduce fluoride intake and increase awareness of the risks of high levels of fluoride were jeopardised by the communities lack of knowledge of the risks of cooking with untreated water.

4.2 Factors effecting treated water purchasing

4.2.1 Understanding of the Relationship between Water and Health

When asked to define safe water respondents often equated safe water with treated water even the 5 respondents who were not buying treated water from the kiosk. Having continuously referred to treated water throughout the interview it may be considered the

'correct' answer with one respondent defining safe water as treated water despite having earlier said that she did not realise that treated water was being sold. Curtis et al (1994) suggest that the participant may modify their behaviour or responses trying to make a good impression on someone possibly considered belonging to a higher class or social status or simple an outsider. This may have been mitigated slightly by working with a translator from the area but to what extent is difficult to measure.

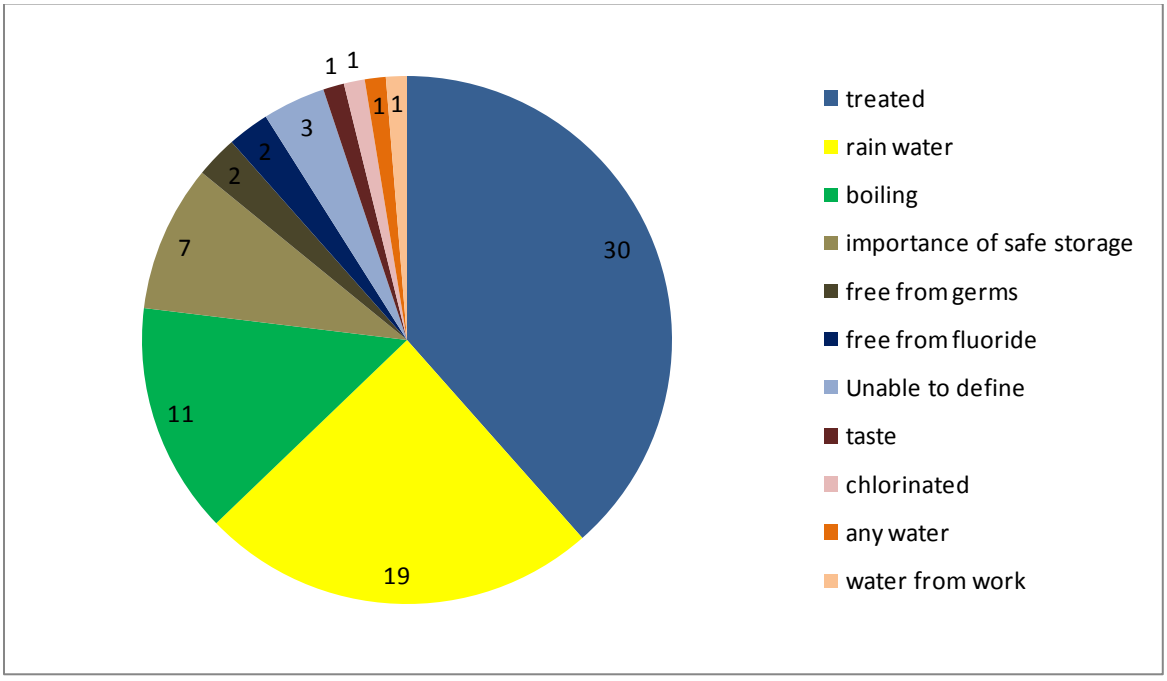


Figure 13: Mentioned when defining safe water

Treated water is considered safe but as shown below when asked what are the health risks related to unsafe drinking water dental fluorosis appears not to be a high priority in fact only cold, flu and vomiting are mentioned less times.

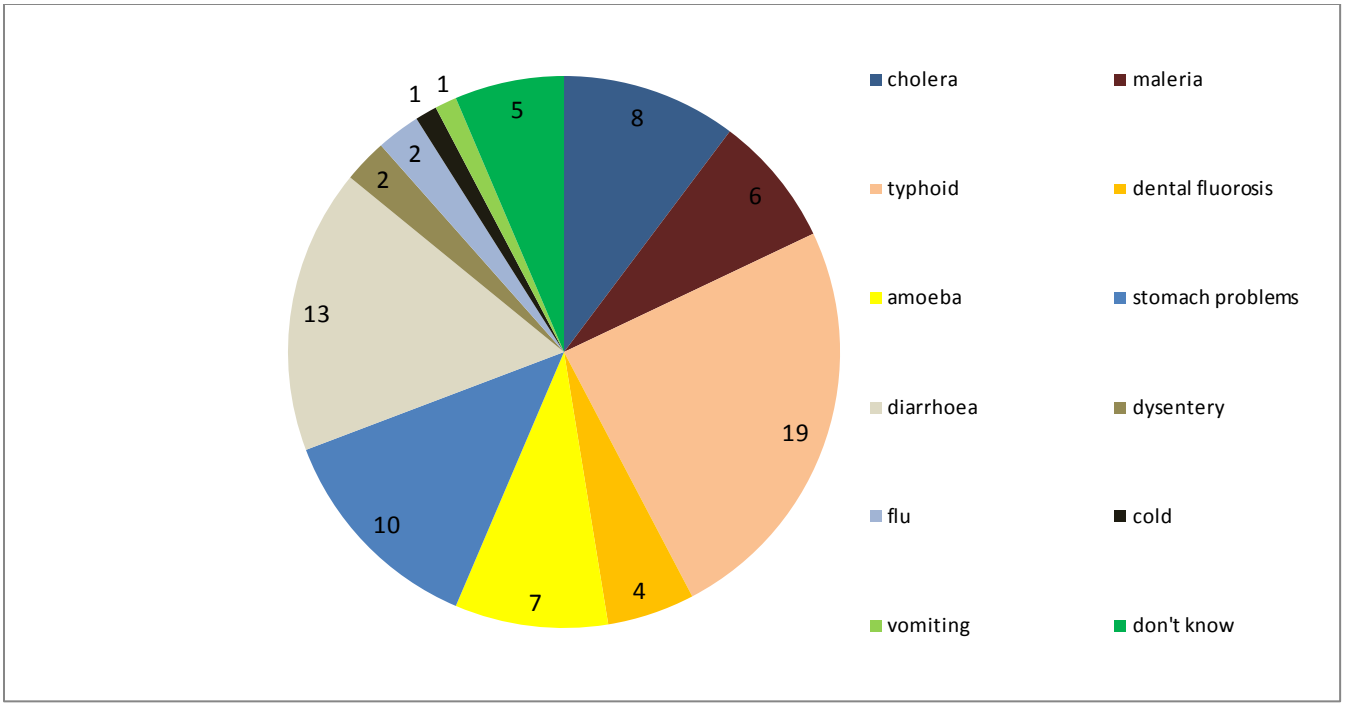


Figure 14: Health risks of drinking unsafe water identified

There is a lack of health knowledge among some respondents with 11% (9/78) of illnesses mentioned having no relation to drinking unsafe water. Analysis of these results showed that length of time in school, considered such an important factor in Somanthan and Chaudhari's (2009) research, was not a factor in understanding of health risks.

4.2.2 Economic Status

With price the most often cited reason for not buying treated water an analysis was done of the relation between water use and economic status. Economic status of respondents was defined by type of dwelling and occupation of the householders;

Table 3: Wealth Index

Economic Status Group	Definition
1 (poorest)	Mud/Wood dwelling, no employment
2	Mud/Wood dwelling, employed respondent or spouse
3	Concrete compound, no employment
4 (most affluent)	Concrete compound, employed respondent or spouse

The respondents were placed on one of the 4 corresponding groups and the amount of treated water used was tallied and an average was made leading to interesting results shown below.

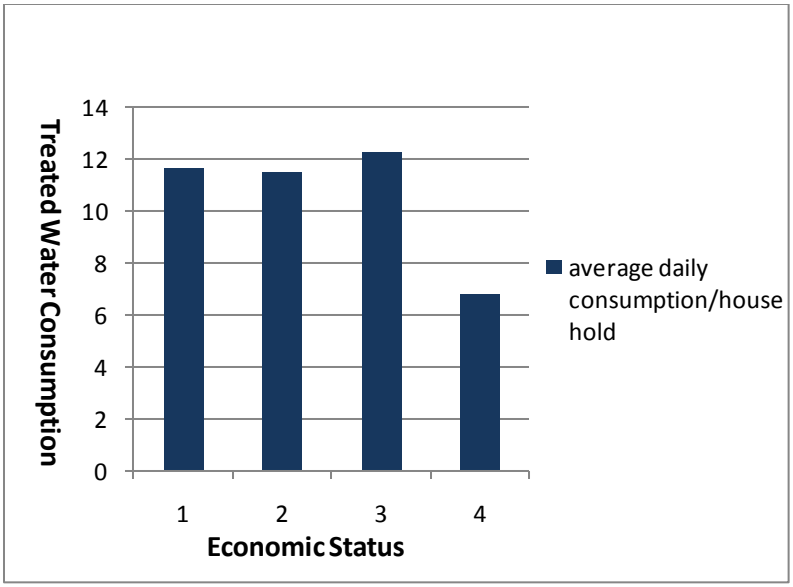


Figure 15: Average household consumption of treated water for each economic status

The respondents defined as the most affluent are purchasing and using the least amount of water where as all other economic groups including the poorest are buying similar amounts. Although a crude measure this does indicate that wealth may not be primary factor in water purchasing mirroring Somanthan and Chaudhari's (2009) findings.

4.2.3 Understanding of Fluorosis

Analysis found no relationship between treated water use and level of schooling, but there appears to be a link between understanding of the risks of fluoride and treated water use.

Aware of the risks of fluoride

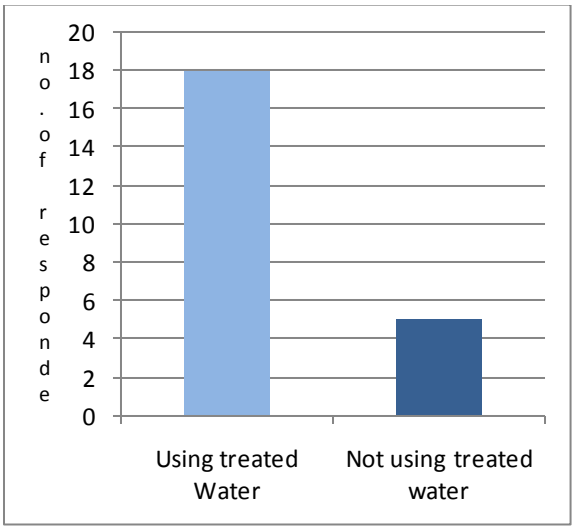


Figure 16: Risk awareness and water use

Unaware of the risks of fluoride

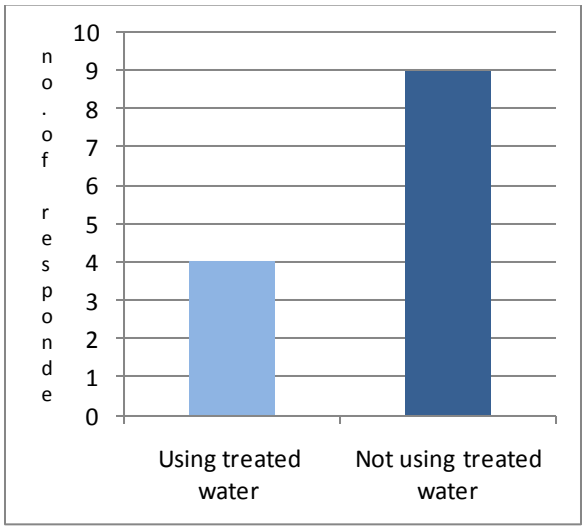


Figure 17: Risk awareness and water use

Bearing this in mind it is necessary to look closer at those respondents who reported price as their reason for not purchasing treated water.

Reported Reasons for not purchasing treated water

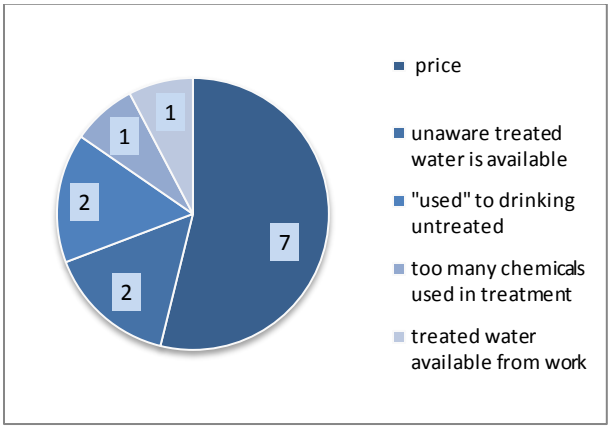


Figure 18: Barriers to water purchasing

Awareness of fluoride risk of those answering price

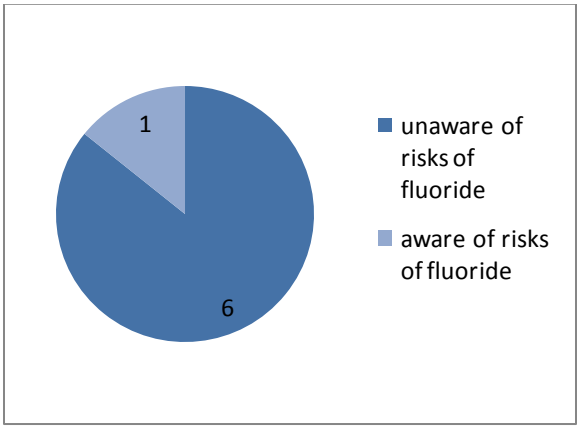


Figure 19: Awareness of fluoride risk

Respondents' decisions to purchase treated water follows the epidemic model where use of a new technology is not only proportional to but dependent on the spread of information. As in Somanthan and Chaudhari's (2009) work the lack of awareness of health risks is a more prominent factor than financial ability in decisions to invest in improved drinking water quality. The research here was based on a rough estimation of economic status and the assumption that those employed and with a better standard of dwelling are more able to pay for treated water. If price itself was the only issue it could be expected that the poorest respondents would be purchasing the least amount of water and amount purchased would increase as economic status increases. This was not found so the issue of price itself may not be key. Even the poorest respondents or those who have reported money problems are prepared to pay for treated water if they are aware of the health risks related to fluoride . It was found that people with no understanding of fluoride and therefore no understanding why they should pay more for treated water were unlikely to pay. This has particular resonance as 47% of respondents could not explain what excessive amounts of fluoride does to health.

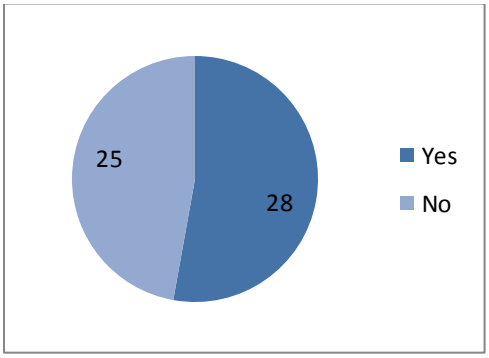


Figure 20 :Able to explain what excessive levels of fluoride does to health

Treated water use does not conform to Rodgers' *relatively perceived advantage*, being obscured because of the chronic and irreversible effects of fluorosis the advantages of using treated water do not quickly become apparent nor are observable. Resulting in 36% of respondents unable to explain why there is a price difference between treated and untreated water. This makes the need for education to create a need and thus a demand for treated water even more imperative. In this research there was not found, as Mwaniki (1994) reported in his study, a high tolerance to fluorosis. Those aware of fluoride do regard it as a health risk and buy treated water to mitigate the risk with only 4 respondents aware of the risk but not purchasing treated water three of whom were confused about availability and the treatment process.

Those aware of risks learnt from the Wildflower and Home Grown flower farms, in school for those attending until grade 8 primary and above, vendors or pictures on the kiosk, from WSUP meeting and seminars, from other organisations and booklets, from 'experience' living in the area for a long time, or from discussions with other community members.

4.2.4 Rainwater Harvesting

Another factor affecting water sales is availability of "free" (SSI 40) water collected from roofs after rainfall. Rainwater is used for washing, cooking and for livestock, of the 44 respondents collected rainwater 57% (25/44) were using it as a source of drinking water, "when it rains for an extended amount of time the kiosks do not have many clients because most people harvest water" (SSI 15). 14 of the 25 harvesting water would otherwise be collecting treated water from the kiosk. Water from initial rainfall is considered turbid or dirty from contact with the roofs and is generally kept for domestic use and only after prolonged rain is collected and the water is used for drinking.

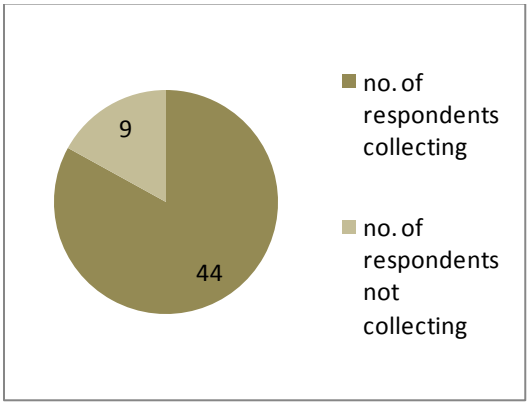


Figure 21: Respondents harvesting rainwater

There needs to be more research into rainwater harvesting with 83% (44/53) of respondents using this method coupled with the significant methodological difficulty of investigating rainwater harvesting in the dry season. Of particular interest should be how much water is provided by this method, safe storage and boiling and the role of climate change particularly with the reported unreliable rainfall of the past 2 years.

4.3 Health and Hygiene Practices

61% of respondents (32/53) see a relationship between disease and hygiene practices. The routes for the spread of this information were schools for those who attended form 7 primary and above, work in the Flamingo, Wildfire, Longonot and Oserian flower farms, from parents, WSUP seminars, the radio and the Red cross information campaign.

Some type of health practices followed by 48 respondents;

- 32 hand washing, 22 specified after using the latrine and 21 before preparing food high access to soap, considered affordable by most, only 9% (5/53) respondents observed with dirty hands.
- Reported behaviours such as showering, cleaning clothes and house triangulated by observation of clean hands and clothes.
- Other such as boiling rainwater water, cleaning jerry cans, using a jug to access water, covering and washing food, eating a healthy diet were reported but not observed.
- Open defecation was observed once during a health walk and animal faeces were present in 4% (2/53) of compounds visited.

There were 14 reported cases of illness within respondents households in the last 6 months; diarrhoea, malaria, teeth problems, stomach problems, flu and amoeba.

90% (48/53) of the community members questioned are willing to learn more about health, hygiene and fluoride with and 72% (38/53) had available time.

An important consideration when analysing these results is these issues can be sensitive for people to discuss. They can elicit false answers in interviews for example hygiene and health practices and decisions can be framed by participants in moral terms, particularly if water use and hand washing are interlinked with religious practices, most notably in Islam. Therefore a question or observations testing water use and hygiene can be interpreted as an assessment of a person's morality or a test of adherence to religious doctrines. This can lead to shame, embarrassment or even humiliation and likely false responses or modified behaviour to mitigate these (Zeitlyn, S., 1994, Pedersen, D., 1994).

4.4 Recommendations

Lack of awareness has been identified as the key factor behind lower than expected sales of treated fluoride free water. The community was asked what they would recommend WSUP should do to increase treated water use.

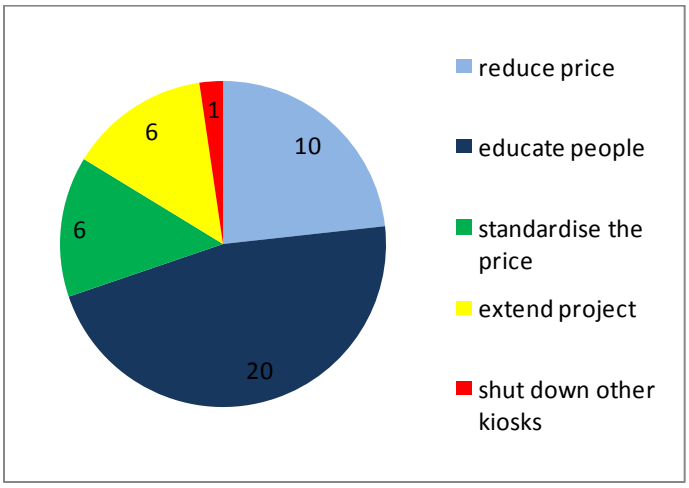


Figure 22:Respondents' recommended methods for increasing communities treated water use

- As recommended by the majority of community members and in research in similar contexts (Castilho et al. 2010, Takizawa et al. 2010) implementation of an information campaign to educate and reinforce messages to increasing treated water use needs to take place. The same routes that have been successful in promoting hygiene practices can be used to increase education about fluoride. Messages about fluoride can easily been included in health curriculum in school and in health campaigns at flower farms (Where many of the residents of Karagita and Mirera are during the day).

- Kiosk workers are an under used resource, they are in a position to interact with every customer and have the capacity to reinforce messages. Some are already informing customers whilst others were observed only collecting money. Training and possible incentives should be employed.

- The kiosks themselves are a perfect place to reinforce messages, better pictures and written messages explaining the correct use of treated water and the risks of not using it are needed.

- Many people use posters and old calendars for decoration in their houses, posters could be developed in collaboration with community members and distributed.

- Within the community there are murals and advertising painted on the sides of buildings, WSUP could use this method of wall branding to market their message.

- Those out of work or with no formal schooling or below class 7 primary (31% of participants) must not be marginalised and should be reached through house to house campaigns.

- One respondent had been part of a successful women's group in her old community and believed a similar groups could work here. They were involved in microfinance which could be of use for future latrine building projects as well as dissemination of information.

- With the organisation of dwellings into compounds WSUP could look into selecting individuals from each compounds to be trained to act as 'compound champions' responsible for promoting health and water message to the other 3 to 11 households and giving feedback to WSUP staff on any problems being encountered by the community.

5. Conclusion

With the continued growth in urban environments globally leading to high population densities projects to supply clean, reliable and safe water will put increased pressure on groundwater supplies. With excessive amounts of fluoride posing a health risk to those relying on groundwater for drinking in 23 countries worldwide there must be a renewed focus on fluoride on the governmental, NGO, donor and research level.

Technologies exist to reduce the amounts of fluoride communities are exposed to but equal emphasis must placed on the users of these technologies to ensure innovations match actual or perceived needs of the individual user.

With respondents opting for the cheaper options of untreated water and, whenever possible, collecting rain from their rooftops this thesis compared socio-economic factors and education levels with reported kiosks use and explanations for these behaviours to identify barriers to treated water use. The level of understanding a susceptible population has of the risk of fluorosis effects their likely level of exposure and what, if anything, they do to mitigate this risk. Implementation of an information campaign to educate and reinforce messages will help WSUP reach the full potential of the project and therefore make the largest impact on health and therefore the livelihoods of those living in Karagita and Mirera.

The short length of time involved makes the research a static description but the research setting is a dynamic environment with a very mobile population with unsettled work patterns and lack of job security therefore there is a need for continuous monitoring of the setting and expansion of the research.

Although the recommendations are specific to this area the need for education and community awareness is key to the success and sustainability of any water supply project be it in urban, peri-urban or rural environments in a developing or developed country.

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Appendix A

Interview Question Guide

After introductions, explanations of ethical considerations and conversation regarding family (married/no. of children), general life (religion/occupation) level of education and age.

How long have you lived here in Karagita/Mierera?
Why did you move here?
Where does water collection fit into a typical day?
Where do you buy water from?
When did you start using the kiosks?
Where did you buy water before?
How much did you pay?
Did you buy more or less water than now?
Do you buy treated or untreated water?
Do you know why there is a difference in the price between the treated and untreated water?
How much treated water do you buy?
What do you use treated water for?
Why do you/ don't you use treated water for drinking & cooking?
Who collects the water?
How do you store your water? Can you show me?
Do you wash them? How? How often?
When was the Last time?
How do you access the water (pour, tumbler, ladle)?
Record if they are covered and where they are located
Who is responsible for decisions about water in your household?
Who pays for water in your household?
Is it expensive to buy treated water?
What do you do if you cannot pay?
Do you have any problems with the water kiosks?
Who do you talk to if you have a problem with the water kiosks?
Is there anything you would like to improve about your water supply? How could this be done? (Household connection?)

Apart from the water kiosks what alternative supplies are you aware of? Do you use any of them? Why?
Does rainfall change your water use? What do you use it for?
What makes water safe for drinking?

What are the health risks related to drinking unsafe water?
What are the advantages of using the treated water?
Have you noticed any health improvements?
What is the best way to increase your/other peoples' use of treated water?
Do any of your family have problems with their teeth (discolouration) or bones?
What do you think caused that? Is there a problem in the local area?
What can be done to combat this?
Have you heard about the term fluoride? Explain what it does to your health.
Have you ever been taught or informed about fluoride-related problems and their consequences here in the community?
If yes, who did it? What were you told? How often was that done?
What are the causes of illness here? What do they do to your health
Are any illnesses affected by hygiene practices?
What hygiene practices do you follow?
Where did you get learn this?
Has anyone talked to you about hygiene practices?
What did they speak to you about?
Have you and your family changed your hygiene practices? Why/Why not?
If hand washing – How do you wash your hands? When? Where?
Do you have access to soap? Is it expensive?
Have you noticed health improvements?
Has any member of your household been ill in the last 6 months?
Do you want to learn more about health and hygiene?
Do you have time to learn about health and hygiene?
What is the best way for you to learn about health and hygiene?
Do you have any questions for me?

Appendix B

Observation Checklist

Location
Date

	Observation	Notes
Observable manifestation of dental fluorosis skeletal fluorosis In other householders		
Type of Housing area		
Type/State of dwelling		
Type/State of clothing Of other householders		
Type/State of Household goods		
Hands Washed after Defecation Soap?		
Hands washed before preparing food Soap?		
Are the interviewee's hands visibly dirty		
Are other householders' hands clean?		
Are there hand washing facilities near		
Evidence of faecal contamination In dwelling Surrounding dwelling		
how is treated water stored		
is it covered Clean Location		
how it is moved from storage scoped or poured		
How is untreated water stored		
How is treated water used How is untreated water used		
Is there household treatment		

Are there facilities for RWH		
Other Observations		

Appendix C

Details of Respondents

	Gender	Age	Married	No.of children	religion	Occupation	Level of Education	Length of time resident	Motivation for moving here
SSI 1	m	18	n	none		no job		15 years	
SSI 2	f		n	1	catholic	in business		born here	
SSI 3	f		y	3	christian	no job (husband flower farm)	year 8 primary	9 years	Got married here and so moved
SSI 4	f	24	n	1		sells brew	year 8 primary	4 years	came to find work
SSI 5	f		y	4		no job	year 8 primary	10 years	Got married here and so moved
SSI 6	f	22	y	1		no job	year 8 primary	born here	
SSI 7	m		y	4		no job	year 7 primary	30 year	came to find work
SSI 8	f		y	7		no job (Husband a teacher)			
SSI 9	f		n	6		no job	year 4 primary	born here	n/a
SSI 10	f	25	y	1		housewife	year 4 primary	1 year	got married here
SSI 11	f	20	y	2		no job (husband sells clothes)	year 3 primary	born here	n/a
SSI 12	f		y	6		sells material	year 7 primary	3 years	post election violence
SSI 13	f	56	n	children have died		landlady	year 3 primary	41 years	She came with her parents
SSI 14	f		y	6		no job, nor husband	year 2 primary	25 years	arranged marriage
SSI 15	f	40	y	5		no job, husband works in flower farm	year 8 primary	20 years	Came looking for employment
SSI 16	m	32	y	3		plumber	year 8 primary	8 years	looking for work
SSI 17	f	54	n	3		nojob	year 2 secondary	11 years	looking for work
SSI 18	f	50 ish (not sure)	n	5 & 2 grandchildren		no job	did not attend school	Been here for a long time (not sure exactly)	looking for work
SSI 19	f	55	y	7		sells charcoal	year 2 primary	more than 30 years	parents moved here, grew up here
SSI 20	f	50	n	3	full gospel	runs baby care	year 7 primary	20 years	had job on flower farm, now baby care
SSI 21	m	18	n	0	none	no job	Form 4 secondary	born here	n/a
SSI 22	f	22	y	2	Cath	no job	form 2 primary	3 years	got married here

SSI 23	m	50	y	5		security guard (Homegrown flower farm)	form 5 primary	40 years	for employment
SSI 24	m	33	y	3	cath	business and landlord	Standard 8 (primary)	10 years	looking for work
SSI 25	f	32	y	3	not sure	no job	did not attend school	5 months	Husband came here first for work (flower farm)and they followed
SSI 26	f	24	y	1	7th day	flower farm	Form 4 secondary	3 years	looking for employment
SSI 27	f	18	y	1	None	works with the animals	Form 8 primary	born here	NA
SSI 28	f	22	y	1		no job - husband flower farm	Form 2 secondary	1 year	looking for employment
SSI 29	f	24	y	3	7th day	no job - husband flower farm	Form 8 primary	4 years	looking for employment
SSI 30	f	51	n	2		no job	Form 2 secondary	7 years	looking for work
SSI 31	m	27	y	3	catholic	no job	Form 8 primary	7years	looking for work
SSI 32	f	28	y	2		no job - husband casual labourer	Form 8 primary	2 years	looking for work
SSI 33	m	28	y	2	christian	flower farm - Wildfarm	college educated	3 years	looking for work
SSI 34	m	23	y	1	Victory church	security guard	Form 4 secondary	4 years	looking for work
SSI 35	m	32	y		Anglican	Carpenter	Form 1 Secondary	5 years	looking for work
SSI 36	f	26	n	1	Presbyterian	no job	college educated	5 years	looking for work
SSI 37	m	26	y	1	catholic	Matatu driver	college educated	4 and a half year (1 in karagita)	has to live here for work
SSI 38	f	26	n	1	catholic	flower farm - longanaut	Form 6 primary	1 year	looking for work
SSI 39	m	28	y	3	1st born	works on a vegitable plantation	Completed Secondary	2 years	looking for work
SSI 40	f	35	y	3	christian	flower farm	Form 2 secondary	6 years	looking for work
SSI 41	f	26	y	3	christian	flower farm	Form 2 secondary	7 years	husband found a job here
SSI 42	f	22	y	2	none	no job - husband works in flower farm	class 8 primary	5 years	looking for work
SSI 43	m	35	y	2	christian	works on flower farm - osarian	Form 4 secondary	9 years	looking for employment
SSI 44	m	25	y	1	none	no job (wife works in flower farm)	class 8 primary	born here	n/a
SSI 45	f	58	n	4	Gospel trinity	no job	class 7 primary	10 years	looking for work

SSI 46	f	41	y	2	God Mercy	no job (husband flower farm - homegrown)	did not attend school	15 years	looking for work
SSI 47	f	45	n	4	Muslim	no job	did not attend school	12 years	looking "for greener pastures"
SSI 48	f	26	n	1	Muslim	no job	Form 4 secondary	10 years	came to live with family
SSI 49	m	28	y	2	christian	flower farm - homegrown	Form 4 secondary	4 years	looking for work
SSI 50	f	23	n	1	happy church	collects rubbish	did not attend school	born here	employed by white settler to clean rubbush from the road
SSI 51	m		n	3	catholic	collects rubbish	class 7 primary	17 years	lookin for work
SSI 52	m	30	n	none	catholic	collects rubbish	did not attend school	3 years	when he had an accident he was hospitalised outside Naivasha, when he recovered he didnt see the importance of going back up country
SSI 53	m	69	y	all his kids are grown up	muslim	collects rubbish	did not attend school	28 years	he came here when he was working in Nakuru