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**Household drinking water characteristics in a peri-urban
community: the case of Kifumbira Zone, Kampala, Uganda**

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A study to determine the drinking water quality improvement practises at household level was undertaken in Kifumbira Zone, a Kampala peri-urban area, Uganda. The socio-economic conditions of 150 households were identified using questionnaires and in-depth interviews. Solar water disinfection (SODIS) was introduced to 10 households and water from their boiled drinking water and SODIS treated water was monitored for three months. The social survey indicated that boiling was the most common method applied to improve the drinking water quality – mainly using charcoal and electricity. 65% of the respondent households boiled their drinking water, while the rest consumed it unboiled due to the high cost of charcoal. The raw water sources exhibited microbiological contamination as evidenced by the presence of thermotolerant coliforms and high risk scores on the sanitary inspections conducted. There was a statistically significant difference ($p < 0.05$; $n = 15$) in the mean count of thermotolerant coliforms for boiled and SODIS treated water.

Introduction

Millennium Development Goal 7c emphasizes the commitment by UN member states to reduce by half the proportion of people without “sustainable access to safe drinking water” by 2015 (UN Declaration 55/2 2000). The Millennium Development Goals give urgency to the challenge of basic service provision for the rapidly expanding informal and peri-urban settlements in African cities (Kulabako et al. 2007). The municipal authorities lack adequate capacity to provide basic services to the needs of the growing populations due to urbanisation, particularly in the peri-urban settlements. In Uganda, the national urban water coverage is 77% (MWE 2010). The National Water and Sewerage Corporation (NWSC), a government parastatal, is responsible for providing water and sewerage services to the urban settlements of Uganda. Uganda’s efforts to serve the poor communities have focused more on increasing access and affordability of piped water as evidenced by the introduction of community water dispensers (pre-paid meter technology).

In Kampala, the capital city of Uganda, the population is estimated at 1.2 million, 60% of whom are estimated to live in the peri-urban settlements (UBOS 2002). The increasing population, coupled with the limited capacity by municipal authorities to improve access to basic services results into environmental pollution. Consumption of faecally contaminated water is an important route of transmission of enteric pathogens in many regions of the world lacking infrastructure to guarantee safe water quality and hygienic management of human waste (Quick et al. 2002). A review study conducted on water, sanitation, and hygiene interventions, as well as their combination, on the effectiveness of reducing diarrhoeal illness showed that household water quality interventions (point-of-use water treatment) were more effective than has been previously acknowledged (Fewtrell et al. 2005). This presents a need for exploring application of household water quality improvement technologies to minimise effects of contamination especially in areas where the environmental conditions are highly polluted. However, it is important that, prior to the introduction of alternative technologies, the demand from the communities is established. Therefore, this paper presents experiences from Kifumbira Zone of Mulago III Parish in Kawempe Division of Kampala District, Uganda to determine the significance of household water quality improvement. The objective of the

study was to collect various data types including technical and socio-economic issues, sanitation practices, and the water situation; to have an understanding of the institutional set-up and socio-economic dynamics. This information was used to develop the criteria for selecting the participating households where the alternative household water treatment technology- solar water disinfection (SODIS) was introduced.

Materials and methods

Field surveys and interviews

The multi-criteria selection method was applied to identify a study area representative of peri-urban areas in Kampala. A social survey involving administration of a questionnaire and structured interviews to 150 households representing 3% of the population was carried out in Kifumbira Zone. The household selection criteria for the pilot SODIS application was based on households; having lived in the place for more than one year, use of un-piped sources of water, willingness to participate in the study, home ownership, and self-reported disinclination to boil drinking water. The questionnaire was pre-tested for validity and reliability in 15 households and modified accordingly. The data collected included household characteristics, water sources and how they are utilized by the community, socio-economic status of the local people, health conditions and, willingness to participate in the research project. Data analysis was carried out using Microsoft Excel 2003 and Stata 9.0, and the results are presented using percentages of the respondent households categorised by socio-economic indicators and statistical inference.

Field and laboratory measurements

Sanitary inspections were carried out at the water sources, and laboratory water quality analysis of samples was done to determine the physicochemical and microbiological characteristics of the water. The sanitary inspection forms were designed based on the water quality surveillance guidelines developed by Howard (2002). A sanitary inspection form was filled for every raw water source used by the study households from December 2009 to March 2010 and water samples were collected concurrently. The sanitary inspection 'Yes' scores were added and ranked to obtain the qualitative risk ranking. Physicochemical water quality parameters were measured in situ using a HANNA portable meter. The raw water samples were then transported to the Public Health and Environmental Engineering laboratory of the Faculty of Technology at Makerere University Kampala to analyse the microbiological quality as thermotolerant coliform counts (TTC) according to the Membrane Filtration method using Membrane Lauryl Sulphate Broth (MLSB). Results were presented as TTC /100ml, or the number of colony forming units per 100 ml.

A pilot study on solar water disinfection (SODIS) was conducted in 10 households in the study area. SODIS demonstrations through community meetings with the 10 households were carried out alongside provision of 2 (two) 1-litre PET bottles per household. After the 10 households started SODIS application, 500ml samples were drawn from their regular drinking water containers and the bottles of SODIS exposed water for a period of 3 months. The physicochemical characteristics were measured in situ. The samples from SODIS treated water bottles and the household drinking water containers were analysed for thermotolerant coliforms. The mean thermotolerant coliform counts for the drinking water and SODIS-treated water were compared using Stata 9.0.

Results and discussion

Socio-economic conditions

The average household size in Kifumbira Zone was found to be 6 members; out of whom > 60% are employed. From survey responses, employment includes small-scale businesses (29%), i.e. household members who manage shops, kiosks, brewing alcohol and operating workshops; public service (21%); and self employment (20%). Other forms of employment include vending/hawking (9%), casual labour (4%), and work in private companies (1%). The household income was inferred from household expenditure. It was revealed that most of the residents live on less than one US dollar (USD) a day, given that 35% spent from 26,000 to 30,000 Uganda shillings (UGX) a week. This is an average of UGX 4,000 per family per day which is equivalent to approximately USD 0.3 per person per day for a 6-member family. Five percent (5%) of the residents reported an expenditure of UGX 5,000 per week or about UGX 714 per family per day. The economic situation in the study area reflects the typical situation in low income communities who live on less than a dollar per day. Unfortunately, the cost of improving the drinking water quality is expected to

compete with other basic needs and may be one reason for the expressed constraint of boiling water for drinking purposes.

Water supply and distribution in Kifumbira Zone, Mulago III Parish

The water supply in the study area is mainly from yard taps connected to the NWSC piped system, and sources such as springs. Nine out of ten respondents obtain their water from the NWSC piped system while the rest obtain their water from the springs. Seventy two percent (72%) of respondents said that they always had to pay to get water at a cost ranging between UGX 50-100 per 20-litre jerry can. Twenty seven percent (27%) of the respondents said that they never have to pay for water, while 1% said they sometimes pay for the water depending on where they fetch it from. Water is obtained from 'free' sources, e.g. springs, when they have no funds. The 27% who never pay for their water could imply those using contaminated sources.

Ten percent (10%) of respondents suspected that their supply was polluted even though no water quality data had been presented to them; and the sanitary conditions around the water points seem to agree with the suspicion. The sanitary inspection scores of the water sources are in line with the spring contamination suspicion. The springs (Sources 2 and 3) have a higher risk score (7 to 10) compared to the yard taps which ranked low (0-3). These sanitary risk scores concur with previous studies in Kampala which indicated that over 80% of springs have faecal contamination even when protected, with the situation worse in the densely populated peri-urban settlements (AquaConsult 2002).

Many of the people who use springs and boreholes for their domestic supplies are unable to fetch from NWSC yard taps, citing financial constraints as revealed by the social survey. This situation could imply that a number of residents of Kifumbira Zone are constantly at risk of contracting waterborne/water-related diseases arising from the use of contaminated water sources, and unhygienic practices. According to the interviewed respondents and the survey results, the common diseases suffered are waterborne/water-related given that a number of people still drink water without boiling or other form of treatment. The statistics from the nearby health centers visited by the residents in the area showed that most patients are victims of malaria, respiratory infections, and diarrhoeal diseases. The difference in responses to the survey and the epidemiological data could have resulted from the recall bias of the respondents. It could have also been a result of non presentation of the patients to the nearby clinics. Studies in similar communities indicate malaria and diarrhoeal diseases as the most common diseases in peri-urban settlements (Amuyunzu-Nyamongo and Taffa 2003).

Drinking water habits

The social survey revealed that 35% of the respondents drink tap water without boiling, believing that it is safe since it comes from the yard taps. It was found that even those who get water from the springs, despite their suspicion that the water is contaminated, drink it without boiling. The reasons given for this habit are that charcoal for boiling water is expensive and sometimes they do not have time to boil the water. A few people said that they drink packaged water (in 100ml plastic bags) bought from kiosks at a cost of UGX 100 (~USD 0.05) per packet.

According to the oral interviews, most people in the area claimed that they do not have problems with improving their drinking water quality. However from the questionnaires, 76% of the respondents said they experienced challenges associated with the high cost of charcoal used for boiling. The discrepancy may be due to the fact that during oral interviews the respondents were not constrained in their answers, and provided socially acceptable face-saving responses to the interviewer, unlike when responding to the structured questionnaires. This implies that at least 76% of respondents are vulnerable to consuming water which is likely to be contaminated because of poor hygiene at the water sources, and possible use of dirty containers to draw the water, and unmet water quality improvement costs. This proportion of the population in the area is higher than the earlier suggestion that 61.9% of the residents in the study area did not boil their water (Kiyimba 2006). The survey revealed the willingness by people who had a problem with drinking water quality improvement to take up alternative options and knowledge on how to obtain safe drinking water at a lower cost.

The need to provide safe drinking water for the study community formed a basis to introduce solar water disinfection (SODIS). Community meetings were held to share the challenges and experiences of practicing SODIS. The major concern highlighted by the community was the lack of water quality indicators at household level after SODIS treatment to ascertain actual improvement in microbiological water quality. The TTC counts obtained from 15 household data sets were analyzed for variance between drinking water and SODIS treated water quality using Stata 9.0. The ANOVA showed a statistically significant difference ($p < 0.05$). The median TTC values for the raw source water, SODIS-treated water, and the boiled drinking water was compared for each household. Indeed the boiled water shows higher TTC counts compared to the

source water and SODIS-treated water pointing towards possible contamination during handling and/or storage for data obtained from the selected households for the same date of analysis.

Preliminary findings

1. The preliminary field findings show contamination during handling and/or storage of drinking water at household level. This finding reinforces the need for household-based water treatment methods which are affordable and acceptable to the community.
2. The socio-economic conditions of the study area render SODIS as a viable technology to improve the water quality at household level. However, since SODIS is a new technology to the community in the study area, training on SODIS application for both the households and the community will be necessary. This highlights the need to study the effects of improving hygiene practices at household level and the efficacy of SODIS process.

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