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Water usage studies in water quality surveillance

Guy Howard, Joanna Teuton and Paul Luyima, WEDC

WATER SUPPLY SURVEILLANCE is the continuous and vigilant public health assessment and overview of the of drinking water supplies, which is designed to provide assurance that water supplies do not represent an unacceptable risk to the health of the users (WHO, 1993). In order to provide public health protection, surveillance programmes must ensure that data is collected on the water sources used by the population (Howard, 2000). In many urban areas in developing countries, numerous types of water supply are available and therefore it is imperative to understand water use behaviour. This is particular relevance in poor communities, which in general are most vulnerable to public health risks from poor water supply (Howard, 2000; Lloyd et al, 1991; Howard and Luyima, 1999).

This paper will review the role of water usage studies in water quality surveillance programmes using an example from Kampala, Uganda.

Understanding water usage

In most surveillance programmes the initial activity is to undertake an inventory of available water sources. An inventory usually involves a review of available data from the water supplier about the number of connections of different service levels and identifying the numbers and types of alternative water sources. Whilst the inventories provide useful information regarding the types of water source available, it provides limited information about how many people use particular types of water source and for what purposes different water source types are used.

The numbers of people using a particular source type is important because if only very few families use a source, then there is a reduced need to take samples compared to more frequently used water sources. It is also important know whether water collected from different source types is used for different purposes. Of primary concern in surveillance programmes is the quality of water used for consumption – drinking and food preparation/cooking. In some situations, a ‘rationality factor’ has been observed in areas where there are multiple source types available (Madanat and Humplick, 1993; Almedom and Odhiambo, 1994). In these cases, water from sources deemed of lower quality by households is not consumed. Water used for drinking and food preparation is collected from sources of higher perceived quality. However, such strategies cannot be taken to be universal. In situations where more than one source of water is available that is considered ‘improved’ – protected or treated - there may be limited differentiation

in use (Ahmed and Hossain, 1997). As there may be significant variation in the use of different water sources, specific studies into water collection strategies and water use behaviour are important components of the overall water quality surveillance strategy (Howard et al, *in press*). Such approaches helps target limited resources on those sources of greatest importance to the population and in particular the urban poor.

Water usage in Kampala

A pilot surveillance project was implemented in Kampala, Uganda, between 1997 to 2000. An initial inventory identified that in many poor communities in Kampala both taps and protected springs can be accessed within a reasonable distance. Visits to low-income communities by the surveillance team suggested that the protected springs were heavily used and that a greater proportion of the low-income population used this water than would be suggested by availability. As a result, a study into the water usage behaviour was undertaken in 1999 to understand water collection practices in order to plan monitoring programmes.

There are a number of possible approaches to gathering information concerning water use behaviour patterns in developing countries, including both quantitative and qualitative techniques (McGranahan *et al.* 1997). In the current study, the principal purpose was to develop a urban-wide overview of water use patterns amongst low-income urban communities in order to develop appropriate monitoring strategies rather than look at local variations in such use patterns. As a result, a broad-spectrum survey approach using a household questionnaire was adopted to ensure that general trends could be identified. A qualitative approach would have been useful in providing detailed information about particular patterns and behaviours at local levels, but it was felt that the findings would be difficult to extrapolate to other areas of the city.

Kampala is divided into 5 Divisions, each containing a number of Parishes. The socio-economic status of each Parish was estimated using a 6-factor socio-economic index (Howard and Luyima, 1999). The target population for the study were households living in Parishes classified as low-income where there was a choice of water sources. A total of 1035 households were required in the study for statistical validity.

A questionnaire was developed for the study to obtain information about 3 key areas:

- The sources people use to get water and their relative priority for each household
- The extent to which (if at all), differential use of water sources was in operation
- Factors which influenced choice of water sources

This paper will address the first two aspects of the study. A provisional questionnaire was devised and piloted in 10 communities in Kampala. In conjunction with this, focus-group discussion and observation was also carried out to further develop the questionnaire. Further refinement of the questionnaire followed translation and back-translation into local languages and the final version prepared in English with a local translation available for each enumerator.

A two-stage stratified sampling approach was adopted. Each Division was allocated an appropriate number of questionnaires based on the proportion of the target population living in the Division. A random sample of Parishes in each Division that met the criteria was taken using a random numbers table. Within-Parish sampling used a systematic approach. The interviewer moved along a transect through the community from an initial central starting point. Questionnaires were completed at every 5th house on the right. Where a household refused to participate, interviewers went the next house that agreed to do an interview and then reverted to the original approach.

Results

Taps are the first choice water supply for about 60% of the low-income population, with protected springs accounting for over 30% of first choice sources as shown in table 1 below. Few people use unprotected springs or other types of water source (including scoop wells, sole use of vendor or rainwater and purchase from water tankers).

The numbers of households in the whole target population that selected taps and protected springs as first choice water sources are similar to the overall numbers of each source that were identified as available across the city from the inventory. However, there is a wide variation between

different Parishes in terms of the type of source selected as the first choice source. Taps as a first choice source varied from as low as 20% of households in one Parish to 100% in another. Protected spring use as first choice ranged from 0% to 75.6%. In only a few Parishes were unprotected springs used as the first choice source, although in one Parish these were first choice sources for 31.1% of households. The relationship between use of sources and the number of particular source types available in an individual Parish varied with source type, with a statistically significant correlation seen for protected springs ($R = 0.641$, $p=0.01$), but not for taps.

Almost 50% of households use more than one source. Of the second sources used, the overwhelming majority are protected springs. The use of protected springs as a second source by households using a tap as the primary source is particularly significant, although use of a tap as a second source when a protected springs is the first choice source is also common, see table 2. Both taps and protected springs are used when unprotected springs or other sources are used as the first choice source.

There is very little difference in the overall level of use of protected springs and taps within low-income households in Kampala, with 62% of household using protected springs and 71% using taps. However, as noted above, there is significant variation between actual levels of use of different source types in different communities.

The data on use of water from different sources indicated that there was little difference in the use for consumption of water from different sources. Cooking and drinking was recorded by over 95% of users of taps and protected springs. Where a tap is used as the first source and a protected springs as the second source, there is no significant difference between the use of this water for consumption (reported cooking and drinking being 2.4% and 2.3% higher for taps than springs).

Where unprotected springs are used as the first source, 94% of households use this water for drinking and cooking, although only 66% of households using an unprotected springs as a second source use this for cooking and

Table 1. Use of water sources as first choice source in Kampala

Source Type	Number of households	Percent
Protected spring	341	32.9
Unprotected spring	47	4.5
Tap	617	59.6
Other	30	2.9
Total	1035	100

Table 2. Percentage of source types used as second source

Source	Households using 2 nd source	Protected spring as 2 nd	Unprotected spring as 2 nd	Tap as 2 nd	Other as 2 nd
Protected spring as 1 st	119	28%	9%	60%	3%
Unprotected spring as 1 st	20	20%	25%	55%	0%
Tap as 1 st	356	85%	1%	10%	3%
Other as 1 st	7	57%	0%	43%	0%

62% for drinking. There appeared to greater rationality when the first choice source was a protected spring as less than 50% of households using an unprotected spring as a second source used this water for drinking or cooking. When the first choice was a tap, however, over 60% of households still used the water from an unprotected spring for drinking and 80% used this water for cooking. All users of other sources use this water for drinking and cooking irrespective of whether as a first or second choice source.

Although there is some limited evidence of rationality in the use of water from unprotected springs, this represents a very small number of households. Overall, there seems little evidence of a rationality factor coming into play and certainly it can be concluded that water from both taps and protected springs is used for consumption and therefore both must be considered in the surveillance programme.

In the study, the use of vendors and rainwater was also investigated. A vendor was classified as someone who collects and sells water whose source is not known by the purchase rather than someone directly by a household employed to collect water from a known source. The study indicated that few households collected water from vendors (17.2%). Collection of rainwater was common (66.9% of households), although only half of these households collected rainwater using guttering and a tank, but simply collected roof run-off in a bucket.

Discussion

Whilst across the whole city, it would appear that the selection of the first choice water source is similar to the availability of sources, this relationship does not appear to be true for individual Parishes. Furthermore, the overall use of protected springs and taps shows significant differences from the availability of such sources. Far more households use protected springs than would be predicted from the inventory and the data from the study suggested that protected springs and taps require equal consideration within the surveillance programme. This is further emphasised by the lack of a rationality factor noted in the use of water sources.

In order to be able to use the survey data to estimate likely water use behaviour in other communities, the levels of use were assessed against a set of other basic socio-economic and water availability criteria. Analysis of this data indicated that the score of a Parish on the socio-economic index was strongly correlated with increased use of multiple sources and that the number of protected springs within a Parish as correlated with the use of springs as a first choice source. This then allowed likely water usage strategies to be estimated for those Parishes not included within study. This was of particular use as the surveillance project had developed a system of zoning for Kampala that allowed each parish to be identified on the basis on an index including socio-economic status, population density and water coping strategy (Howard and Luyima, 2000).

The very limited use of vendors was somewhat surprising as in other African towns, vendors of water have been identified as important to the coping strategies of the urban poor (Cairncross and Kinneer, 1992; Whittington et al, 1991). It seems likely that in Kampala the very large numbers of alternative sources limits the attractiveness of vendors for poor households who can obtain water easily from a variety of sources. The common use of rainwater as a supplemental source of water in Kampala also suggests that this is important to consider both within the testing of water sources and in interpreting results of testing of water stored within the home. In the latter case, seasonal variations in household water quality could be influenced by the collection of rainwater.

The high level of use of protected springs highlights the importance of ensuring that these sources are improved to reduce the degree of contaminated water consumed by this population (Howard, 2001). This has been done on a pilot level in Kampala and shown to be effective in reducing contamination (Howard et al, 2001). Such incremental improvements that respond to immediate demands by low-income families may be more sustainable than introducing public taps which, because the water must be purchased, are often at significant risk of disconnection.

Conclusion

The level of use of sources should be taken into account when considering which types of water sources should be included in the surveillance programme and the weight each should receive in terms of sampling and inspection. Water usage studies allow surveillance activities to identify and target water sources widely used by this population and to be more flexible in their approach to data collection. The information generated by the studies provides a useful planning tool for national and local surveillance bodies and can greatly improve the efficiency of surveillance in meeting the needs of local people. The level of use of different sources allows the scope and intensity of the monitoring programmes to be refined and reflect the real public health concerns related to poor water quality. However, they do not replace inventories and are most useful when undertaken once data on source availability has been collected. This allows the water usage studies to be directed at key questions of importance to the surveillance programmes and targeted on those areas of greatest need.

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GUY HOWARD, WEDC.

JOANNA TEUTON.

PAUL LUYIMA.
