



Urban water surveillance in Uganda

Guy Howard and Paul Luyima, Uganda

THE INDEPENDENT ASSESSMENT and routine surveillance of water supply is an essential component of public health protection. Inadequacies in water supplies whether determined by access, reliability, quality or quantity have profound impacts on health. The surveillance of the water sector allows inadequacies to be identified and their importance to health evaluated and priorities established. Furthermore, surveillance of water supplies has important social objectives as it aims to provide ongoing assessments of equity in water supply, the identification of vulnerable groups and barriers to safe water and the selection of appropriate solutions to improve water supply in priority areas.

Surveillance in urban areas has been prioritised by the World Health Organisation in the Rolling Revision of the *Guidelines for Drinking-Water Quality* (WHO, 1995). The approaches used in developed countries, where universal access to piped water at a high service level (typically in-house) is the norm, are generally less appropriate in urban areas in developing countries. Urban water supply in developing countries is usually more complex, with a variety of different sources (both piped and point) used by the population, with costs, quantities available and used and quality of water showing a much greater variation (Howard et al, *in press*). This paper deals with an ongoing research project in Uganda to develop and test methodologies and approaches to urban water surveillance that are appropriate and affordable for use in urban areas of developing countries.

Monitoring of urban water supply in Uganda

The current project, funded by DFID (UK) and WHO, covers ten major urban areas in Uganda, including the capital Kampala, which has a population of approximately 1.2 million inhabitants. The range of populations in the remaining towns varies from about 30,000 to 100,000. Seven of the towns have piped water systems operated by the parastatal National Water and Sewerage Corporation (NW&SC), whilst the remaining three have piped water systems run by urban councils and other suppliers. In most cases, the rate of household connection at either yard or in-house level is low and the use of communal piped sources, protected point sources (principally protected springs, but also boreholes and dug wells) and unprotected sources are common. For instance, overall household connection rates (including both in-house and yard level service) in Kampala can be estimated at 20 per cent, with a wide variation

between different areas seen, ranging from 2.5 per cent to 100 per cent. The city also contains 230 protected springs that are widely used by the unserved population and by water vendors.

The project, which is implemented by environmental health staff based in local Public Health Departments, builds local capacity in providing services and public health protection to urban communities. Surveillance at local levels is preferable because greater links can be made between the results of surveillance and the communities that are affected by poor water supply. Environmental health staff are well placed to carry out surveillance activities because their training includes the impacts of poor water, sanitation and hygiene on health. They have skills in low-cost water supply provision and the delivery of health education and, possibly most importantly, they work in the communities they serve. Local staff working with the project have developed mechanisms for information feedback with communities and local information sharing with other stakeholders.

National co-ordination is undertaken by the Environmental Health Division of the Ministry of Health who provide training and support supervision to Municipal public health departments. The Ministry of Health has now made surveillance of water quality a component of the minimum health services package. In addition, the Ministry consolidates data at a national level using a dedicated software package developed for the project and provides links to other key stakeholders, such as NW&SC and the Directorate of Water Development. The project has also provided support and equipment to NW&SC.

Routine water quality surveillance is carried out using on-site, portable water testing kits that can test for thermotolerant (faecal) coliforms, an accepted surrogate for *E.coli*, chlorine residuals, pH and turbidity. A key aspect in water quality analysis is quality control, although this is often difficult when undertaking microbiological analysis. In Uganda, two approaches have been devised to overcome this. Staff carry out duplicate tests on the first sample of each day's testing and the statistical measures of validity developed by the Public Health Laboratory Service in the UK are used (Lightfoot et al, 1994). The project has also developed an aseptic technique evaluation methodology to assess field staff performance in carrying out microbiological analysis and thus the validity of the results they produce.

A great emphasis is placed on risk assessment. Bacteria in water have a non-random distribution and therefore cau-

tion should always be applied when interpreting data. Furthermore, water quality data provides little information on the causes of contamination, nor does it adequately measure operational and maintenance performance. The use of sanitary inspection is vital in both these regards and has provided Municipal Health staff and the Ministry of Health with useful information about the principal causes of water quality failure, identifying design and construction faults and operation and maintenance performance.

The project cycle

The activities undertaken by each town follows the same process. An initial inventory is undertaken by staff of all the sources available to the population not served by a household connection to the piped water supply. This defines the numbers and types of sources that will be included in the later activities of assessment, routine monitoring and surveillance zoning. This data is supplemented with reviews of household connection data gained from water suppliers.

Following the inventory, training in surveillance techniques is given. These courses typically last for 5 days and place an emphasis on practical training in carrying out surveillance activities, developing local systems of information sharing, using data to improve water supply and community participation in monitoring and improvement. A baseline water quality assessment is carried out immediately after the training, during which time support supervision and more intensive training is provided to the Public Health staff. The baseline assessment includes sampling from piped water, point sources and households and sanitary inspections of both point sources and piped water.

In order to establish routine surveillance programmes, the project zones urban areas using a matrix of population density, socio-economic status and relative importance of different types of water supply. In addition to routine monitoring for public health protection, longitudinal studies of water quality of point sources have been undertaken in order to establish seasonal changes and to identify major causes of failure. In addition, household water testing is undertaken to monitor the uptake of key hygiene behaviours such as household water boiling.

Surveillance zoning

A key objective in this project is to target surveillance on the most vulnerable groups and priority areas in order to focus remedial and preventative actions where they are most required. The surveillance zoning process is based on an socio-economic index (using a combination of carefully selected indicators of relative wealth), population density and availability of different types of water supply. The zones are further refined through data collected on water usage. Socio-economic status is used because those communities that have the lowest socio-economic status are

likely to be those at greatest risks from disease due to a combination of poor access to services and greater vulnerability to disease due to poor nutrition and reduced immunity due to existing disease burdens. Population density is important, as higher population densities are likely to increase the risk of contamination due to greater and more intense pollution. Furthermore in such areas contamination of a water source may be expected to affect greater numbers of people and the introduction of a pathogen may result in more rapid transmission. Water supply availability is used to determine the type of sources to be tested.

The use of water usage studies in developing sampling programmes. Whilst the availability of sources is an important criteria, the importance of sources as determined by actual use is essential when determining which sources should be sampled and how frequently. When properly designed, such studies also provide useful information regarding the most important factors in household selection of water source and information regarding the barriers faced by the urban poor in accessing good quality water supply.

Water supply status

As already noted, levels of direct connection to piped water supply are generally low. This appears to be driven by the high costs of connection rather than unit costs of water consumed. A simple cost analysis using 1996 household income and a 3-5 per cent envelope of willingness to pay, shows that the NW&SC cost of water supplied at public standpipes would marginalise less than 10 per cent of the Kampala population. With minimal usage, a yard level of service seems equally affordable. However, a reasonable average connection cost can be estimated at US\$ 600,000/00 (roughly US\$500) equivalent to twice the annual per capita income. Such costs are clearly prohibitive for the urban poor.

There are significant variations in the numbers and types of supply available to the unserved population in the first 7 towns included in the project. For instance, Mbale in Eastern Uganda has a particularly low number of publicly available sources for the population, reflecting a relatively high level of household connection. In general, piped water sources are most common, with the exception of one town and there are also significant differences between the types of piped water available. In Masaka, Kabale and Soroti public standpipes are the major source of piped water, whereas in the other towns, individuals with a household connection who sell water to their neighbours are the principal piped water source, with relatively few public standpipes.

A pilot water usage study in Kampala has shown that only 30 per cent of the urban poor utilise a single source and up to 30 per cent use at least three sources, with protected springs being the principal subsidiary source. The use of such water includes drinking and cooking. Proximity of the

source is the principal reasons for selection, with cost a highly significant subsidiary factor.

Water quality status and improvement of water quality

The data generated to date has highlighted some interesting water quality and water supply management issues that the Project, in conjunction with communities and stakeholders will be focusing on in the coming months. The piped water provided by NW&SC is generally of good quality in most towns. The compliance rate with a 0FC/100ml standard in Kampala has always been above 90 per cent and has been 100 per cent for a sustained period of time since October 1998. In most other towns a similar level of compliance is noted, with some exceptions in certain areas of particular towns. The Municipal supply in Soroti shows a much poorer rate of compliance, never achieving more than 60 per cent compliance and is commonly less than 40 per cent. The problems in this system are in distribution, as the treatment works appears to consistently provide good quality water. Local contamination is significant and is exacerbated by supply failures.

Maintenance of free chlorine residual in most towns is poor, although significant improvements in parts of Kampala have been noted. It is clear that inadequate dosing, frequent discontinuity and loss of pressure are partly to blame, but it should also be noted that chlorine loss in bulk system storage is a problem world-wide and in particular in tropical countries where high ambient temperatures encourage more rapid loss of a volatile substance. Discontinuity is a problem affecting most NW&SC and Municipal run piped water supplies and this reflects problems with lack of stand-by generating sets during the frequent load-shedding practised by the electricity supplier and in the case of Municipal supplies more fundamental problems faced in running urban water supplies by small institutions with multiple responsibilities and limited resources.

The data collected on point sources to date indicates that in most cases boreholes will provide good quality water. Protected springs show a more varied water quality. Some springs, including those in high-density areas, demonstrate a consistently high quality of water even under extreme rainfall such as that seen in the rains of 1997/98. Some show consistently high contamination, whilst others show a seasonal variation. Failures in water quality appear to relate more to poor sanitary completion and maintenance of springs. This leads to the development of more direct pollutant pathways as backfill areas (or catchments) become eroded. The rapid response to rainfall of many springs clearly indicates very localised contamination, for instance recent data shows that one heavy rainfall event resulted in high turbidity and microbiological contamination in springs always previously of good quality (0-10 FC/100ml). Flooding of collection areas is common, particularly in wet seasons, resulting in ingress of contaminated water into collection vessels. Although O&M is weak,

there are also fundamental design problems. The current protection utilises a simple canalisation approach with little or no fine media. Thus there is almost no capacity to remove suspended solids or bacteria if contaminated water enters the backfill area. An improved design has been prepared and it is hoped to identify a limited number of springs to test this design.

Initial assessments in many towns have shown that household water is contaminated, despite high levels of reported household boiling. However, more recent data indicates that contamination is decreasing and this appears to be related to both the testing of household water and the renewed incidence of cholera.

Improvements in water supply

The surveillance data generated in the towns currently covered by the project has already yielded benefits in improving water supply. For instance, in most Divisions (the principal administrative sub-unit with towns) in Kampala, increased funds have been released for improving water supplies with options ranging from establishing public standpipes to improving springs. One Division is taking this further by developing a strategy for water supply improvement including more flexible systems of payment for piped water at communal facilities and improvement of springs in key areas where piped water is believed to be unsustainable at present.

In Soroti, ongoing close collaboration between the surveillance and water supply arms of the Municipal Council has resulted in improvements in major defects in distribution, including the repair of major leaks in distribution. In Tororo, the Municipal Council has agreed to fund improvements of 4 springs with the District Council having agreed to fund the upgrading of a further two springs. Further work is planned to optimise health education and the promotion of better containers for household water storage. The interest of communities in the results of surveillance affords an important opportunity in promoting a safe water chain.

In terms of an overall improvement in water supply and water quality in urban areas in Uganda, it is clear that it will be necessary to adopt a flexible approach to water supply provision and to select technical options that meet the demands of communities, that are affordable, socially acceptable and that can provide safe and adequate water services. Almost certainly in some communities, the re-protection of springs will be an appropriate and sustainable intervention, whilst in other standpipes will be appropriate.

Conclusion

The project has shown that local Public Health Departments can undertake routine surveillance of water quality. The strengthening of local capacity to collect and analyse data is proving an effective way to improve services and to encourage greater participation of all stakeholders in im-

proving urban water supplies. The targeting of surveillance using the zoning process has been effective in providing support to the urban poor and in focusing resources in priority areas. The degree of interest in communities in receiving water supply surveillance information and support to improve their water supplies is substantial and has promoted active participation by communities in selecting improvement options and mobilising local resources. Whilst increasing access to piped water will be preferred in many areas, the data generated by the project has demonstrated that improvements to point sources is likely to be feasible and that improving operation and maintenance of such sources is essential. The low-cost approach to surveillance is crucial to sustainability, as it is doubtful whether local Government could afford more expensive mechanisms for surveillance. The project has shown that national co-ordination of urban water surveillance by the Ministry of Health can be effectively achieved. This is important both for support to local Government and development of national policy.

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GUY HOWARD, Robens Centre for Public and Environmental Health, University of Surrey, UK.
PAUL LUYIMA, Environmental Health Division, Ministry of Health, Entebbe.
