# A tale of two cities

**How can we provide safe water for poor people living in African cities? Dan Lapworth, Jim Wright and Steve Pedley are working to find out.**

Across much of Africa, cities are growing quickly. Current projections estimate that by 2050, 60 per cent of the population will be living in urban areas – half of them in slums. Many of these people have little access to services such as clean water and sanitation, and the UN has identified fixing this as a major priority.

The lack of piped drinking water forces many slum-dwellers to use shallow wells that are at high risk of contamination from poor environmental hygiene and inadequate sanitation; this is likely to increase as cities expand. This means drinking water is often contaminated by disease-causing micro-organisms from pit latrines and insanitary surfaces, with serious implications both for public health and livelihoods.

Diarrhoeal disease, for example, is a major cause of childhood deaths, and cholera can spread rapidly in these conditions. The combination of urban population growth, political instability in some parts of Africa and the ongoing lack of investment in the continent's water and sanitation sector mean this issue needs to be urgently addressed.

Kabwe, in Zambia, is a bustling transport hub on the main highway between Lusaka, the capital, and the second city Ndola. The inhabitants depend heavily on groundwater for their water supply. In slum areas the use of shallow wells is very common, and on average only one in ten people have adequate sanitation.

Since Kabwe's mining industry collapsed in the late 1970s, the proportion of houses supplied with clean piped water has fallen. Older residents remember when most households in the town were supplied with both raw and treated water; they knew not to use the tap in the garden for drinking as it was unsafe. Fast forward 40 years and the infrastructure can't support the rising demand. In slums like Makululu, residents have turned to shallow, unprotected hand-dug wells, to supplement household water use. This is a

*Groundwater sampling in Kisumu, Kenya.*

worrying trend, and one we see across Africa.

One of our number, Dan, co-ordinated a team of Zambian and UK scientists to carry out a groundwater quality survey across Kabwe in 2013–14. This revealed that shallow household supplies (less than 10m underground) were highly contaminated throughout the year with faecal bacteria and nitrate, as well as elevated concentrations of the commonly-used insect repellent DEET.

There was significantly more contamination in the wet season compared to the dry season, and in poorer areas compared to richer ones. Deeper groundwater sources (more than 50m below ground) were generally free from faecal bacteria, but some in poorer areas showed elevated nitrate, another contaminant from pit latrines. Shallow wells therefore pose an ongoing risk to users and even deep sources need to be protected in the longterm.

As part of the work Dan is leading, the team tested a field sensor designed to measure a protein called tryptophan, an indicator of waste-water contamination, particularly with faecal matter – the most serious problem for people who drink water from shallow wells.

The study's findings are exciting; it seems the sensor will be a really useful tool with a wide application for rapidly mapping groundwater contamination by faecal bacteria. It needs no reagents and is easy for health workers to use in the field. It can detect both the presence of faecal contamination in groundwater and how much of it there is within minutes, compared to a day or more for other methods. This can be crucial when helping households manage their water supply, particularly during an outbreak of water-borne disease. The test could be invaluable in the early stages of assessing risks in water supplies, or in monitoring the effects of attempts to improve groundwater quality through planned interventions.

## Safe for human consumption?

Kisumu is Kenya's third largest city and grew up around the Lake Victoria railhead of the historic railway that once linked the port of Mombasa to Uganda. In colonial times, the city was planned with a centre consisting of administrative buildings and European residential areas, with housing for Africans around the periphery.

As the city has expanded since independence, the provision of public services has struggled to keep pace with population growth in the former outlying African neighbourhoods. This means residents find their own means of meeting their need for water and sanitation, using shallow hand-dug wells to supplement the gaps in piped water supply coverage, and pit latrines for sanitation. As with Kabwe, the presence of pit latrines near shallow wells in Kisumu has a high risk of contaminating groundwater with human waste.

In Kisumu between 1999 and 2004, a group of Kenyan and British researchers led by Steve carried out a water quality survey of hand-dug wells in some of these outlying neighbourhoods. The team tested for microbiological and chemical contaminants, mapped out pit latrines and wells, and recorded hazards around the wells, such as nearby pit latrines.

Earlier this year, Jim co-ordinated a follow-up survey by the same team to see what had changed over the past decade. As well as recording hazards and testing wells, the team also interviewed well owners and those using the groundwater.

The survey showed that the groundwater from the wells is still heavily contaminated with faecal bacteria. The number of hazards around the wells had increased in the decade since the first survey, as Kisumu's population expanded. Interviews with well owners and groundwater consumers suggest that they are generally aware of these risks and try to cook with and drink piped water rather than well water.

In a more detailed study of two neighbourhoods, the survey also suggested that residents were using over 300m$^3$ of groundwater a day. For those struggling to make ends meet, groundwater remains an affordable way of supplementing the costly piped water supplies, despite its high levels of microbial contamination.

There has been a long-running debate about the relative importance of water quality and water quantity. Some argue that cleaning water up is the way forward for public health. Others say delivering enough water to meet people's needs – no matter what its quality – will bring greater benefits.

Perhaps the way forward for Sub-Saharan Africa's growing slums is to recognise that groundwater is an affordable option that the urban poor are unlikely to stop using any time soon. We should focus on practical ways of reducing the risks they face from contamination – this involves a range of measures including siting wells and boreholes a safe distance from potential sources of contamination such as pit latrines and sewers, and using better construction techniques, such as adequately lining well shafts and sealing wellheads with a concrete apron to reduce contamination. It's also essential to maintain and protect head works – the equipment at ground level, including the well cover and the device used to lift water.

Other measures that could help include simple and more hygienic methods of collecting the water, such as using a hand pump or rope winch rather than a rope and bucket which can pick up contamination from the ground. And all this must be supported by effective communication of the risks to households. It's a big challenge as most of Africa has very limited water-quality data with which to inform policy and practice, but new tools like the tryptophan field sensor, being trialled in these projects, may enable better targeted water quality monitoring.

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