Measuring Household Filter Use

Household water treatment is gaining popularity globally, yet it is difficult to assess how much water is actually treated by households. Submersible dataloggers provide insight into actual use of defluoridation filters in rural Ethiopia. Rick Johnston[1], Lars Osterwalder[2], Tesfaye Edosa[3]

More than 100 million people worldwide are exposed to high levels of fluoride or arsenic in drinking water, which most often originates from natural sources [1], [2]. Ideally, both chemically and microbiologically safe alternate drinking water sources should be identified. However, developing new supplies is a long-term endeavour, and in some water-scarce areas there is simply no alternative to chemically contaminated water. In such cases, removing chemicals from drinking water is the best option, at least in the short term. Many technologies have been proven effective for removal of arsenic and fluoride, including adsorption filters that are easy to operate and tend to be relatively inexpensive.

The capacity of removal filters depends principally upon the water chemistry: the concentration of the contaminant to be removed is obviously important, but pH and competing ions may also have significant effects. Compared to laboratory settings, filters typically display lower removal capacity under field conditions. For example, contact precipitation filters in Eawag laboratories have removed up to 6.5 g of fluoride per kilogram of filter material before treated water exceeds 1.5 mg/L, but more commonly about 3 g/kg removal is seen in Ethiopian household filters (cf. Annette Johnson's article on page 10).

Aside from the water quality, the treated water volume is the main parameter determining when the contaminant will 'break through' the filter (exceeding 1.5 mg/L fluoride in the treated water). A household defluoridation filter with 10 kg contact precipitation media should be able to remove 30 g of fluoride before breakthrough. However, it is not easy to convert this figure into a number of months even when the raw water fluoride level is known. Meters cannot measure the slow and intermittent flows in such filters, while self-reported consumption is imprecise and may be biased.

Submersible dataloggers

As part of the ongoing fluorosis mitigation work in Ethiopia, 200 household defluoridation filters were distributed in April 2010 by the Oromo Self-Help Organization (OSHO) to several rural communities in the Ethiopian Rift Valley. In eight of these household filters, small submersible dataloggers, recording pressure and temperature at regular intervals, were placed in the treated water reservoir. A ninth logger recorded atmospheric pressure. By subtracting atmospheric pressure from pressure readings in filters, the height of the water column (and thus the volume of stored water) could be calculated at five-minute intervals [3]. In these households, an almost continuous record of about 50 000 readings was collected.

In household interviews, respondents reported filling their filters on average 2.1 times a day, which matched well the average of 1.8 recorded by the dataloggers. However, dataloggers indicated that daily consumption was on average 12.5 litres, compared to self-reports of 19.4 litres. When normalised by the number of household residents, the measured consumption averages 2.0 litres per capita per day, which is probably adequate for meeting drinking water needs, but not for providing cooking water. Survey respondents also reported that they mainly used the filters for drinking water rather than for cooking water.

Dataloggers allow calculation of short and long-range dynamics of water use. Fig. 1 shows longer-term trends in filter use in one typical household. Use steadily increased while the filter was new, peaking at approximately 20 litres per day. Use then declined for several months, reaching a low in late August, before increasing and holding fairly steady in September and October. Records from the other filters show similar trends. Part of this trend can be explained by heavy rainfall in the summer season – people traditionally collect and drink rainwater when available.

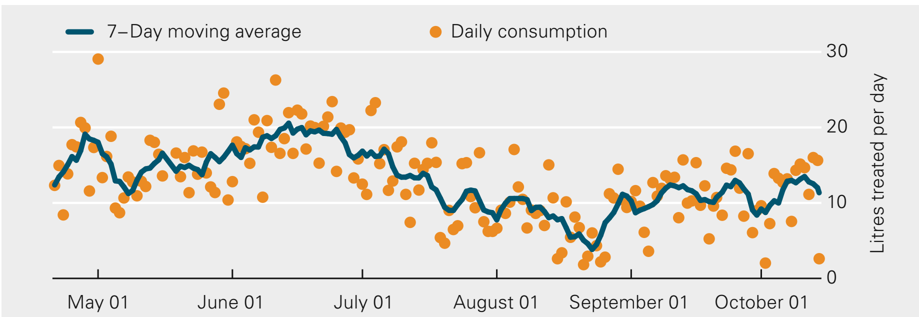

Figure 1: Consumption of treated water in a typical household.

Outlook

Dataloggers yield objective measurements of overall water consumption, but more importantly provide insights into the short and long-term temporal trends of filter use. While such data collection would be prohibitively expensive for routine use, this method can provide valuable data for research studies.

Though the number of households surveyed is small, this research suggests that defluoridation filters are more or less consistently used in rural communities where they have been distributed, but that households use filters only for some of their consumptive needs. Future promotion efforts are planned to increase use of filtered water for cooking and for drinking.

[1] Amini, M. et al. (2008): Statistical modeling of global geogenic arsenic contamination in groundwater. Environ. Sci. Technol., 42(10), 3669–3675.

[2] Amini, M. et al. (2008): Statistical modeling of global geogenic fluoride contamination in groundwaters. Environ. Sci. Technol., 42(10), 3662–3668.

[3] Johnston, R.B. et al. (2011): Measuring use of household drinking water filters: field experiences from Ethiopia. 35th WEDC International Conference, WEDC, Loughborough, UK.

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