



## Research paper

## A thought leadership piece: Where are the rural groundwater quality data for the assessment of health risks in northern Malawi?

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## ABSTRACT

The Sustainable Development Goals place a strong emphasis on water quality. However, what is the local capacity to ensure safe water availability in a low-income country such as Malawi where groundwater is still the primary source of drinking water for rural communities? We conducted a systematic review of peer-reviewed literature containing primary data on groundwater used for drinking water in northern Malawi published over the period from 2006 to 2016. We also interviewed district, regional, and national government representatives supporting the water quality management sector. The results showed that the government cannot tell if groundwater is safe for drinking in the northern region of Malawi. Current literature provides only minimal information on groundwater quality for the assessment of human health risks, and there are limited laboratory services. Nitrate and pH were the most commonly available data. There is evidence that the following constituents need further investigation about possible human health risks: antimony, arsenic, barium, calcium, chloride, color, cyanide (CN<sup>-</sup>), *Escherichia coli* and/or thermotolerant coliform bacteria, fluoride, iron, lead, manganese and turbidity. Water quality monitoring needs to especially consider mining activities, including uranium. Varied levels of engagement appear in that while there is some strengthens in the national government capacity, as this is decentralized to districts weaknesses are most evident with no laboratories and either limited data or no data in the case of the most rural districts. Malawi needs to build human capacity, laboratory infrastructure and a publicly available water quality database under national government regulatory oversight with real time monitoring data available to both district and national government decision makers, practitioners and water users to determine groundwater quality for the assessment of possible health risks.

## 1. Introduction

Sustainable Development Goals (SDG) 3, 6, and 12 place a strong emphasis on water quality (United Nations, 2017). While integrated monitoring and guides for best practices are available (UN-Water, 2017), the SDGs do not state what water quality constituents for analysis and what frequency of monitoring is needed to safeguard human health practically in a low-income country. The National Water Policy, set forth by the Malawi Government (2005, pp.3), states that ‘water of acceptable quality for all the needs in Malawi’ should be made ‘readily available and equitably accessible to all Malawians’. What is the local capacity to ensure safe water availability in a low-income country such as Malawi where groundwater is still the primary source of drinking water for rural communities? The absence of an open access national database of water quality results and the lack of a consistent monitoring program among water users, local and national Malawian government

branches and practitioners make data access and transfer for decision-making difficult (Kayser et al., 2015).

Crane and Silliman (2009) suggest, for select water quality parameters, using basic hand-held instruments or test strips in the field at a high frequency by volunteers in rural regions of developing countries. Despite its lower precision and accuracy, this approach may offer a better representation of the temporal and spatial conditions than higher quality analytical instrument data collected by technicians at limited sampling intervals. However, there have been limited efforts in Malawi on effective rural water user participation in water quality monitoring.

The northern region of Malawi covers an area of nearly 27,000 km<sup>2</sup> and has a 2008 census population of almost 1.7 million, mostly located in rural communities using groundwater for drinking water and spread over 6 districts (Chitipa, Karonga, Likoma, Mzimba, Nkhata Bay and Rumphi) (Malawi Government, 2009). Eidhammer (2017) notes that “at the time of independence [in 1964], many of the most highly

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educated Malawians were from the north(ern region), educated at mission schools” (page 8). Although interest in the quality of groundwater used for drinking water is growing globally, in northern Malawi, there has been no systematic review of the currently available data and no determination of what constituents may pose a human health risk and need further investigation or what practical monitoring steps are needed for Malawi to meet the SDGs for water quality. In Malawi, the rural water supply is decentralized to districts acting as local governments, where the water office is structured identically in each district and reports to the national Ministry of Agriculture, Irrigation and Water Development. Our work will build on other work in Malawi that has looked at water quality governance (Kayser et al., 2015) and the dynamics of power and trust between development partners in the water sector providing funding and the local government (Soublière and Cloutier, 2015). It also builds on the global discussion on monitoring requirements and practices observed for other low-income countries (Crocker and Bartram, 2014).

This thought leadership piece highlights the local capacity for how to ensure rural safe water availability in a low-income country such as Malawi by looking at what groundwater quality laboratory analysis has been done, where it has been carried out, indicators of possible human health risks and environmental laboratory capacity considerations. The aim of our study is to better understand the capacity for rural water quality monitoring and find lessons to share and on-the-ground implications to inform solutions for attaining the SDGs on water quality in a resource-limited environment.

## 2. Materials and methods

### 2.1. Systematic literature review

A systematic review was conducted of publicly available groundwater data published over the period from 2006 to 2016. However, because the Malawian Government does not publish open access water quality data, we only considered peer-reviewed literature containing primary groundwater data. Google Scholar and Pub Med were used as internet search engines. Keywords for the search included combinations of the following: groundwater, aquifer, water quality, well, borehole, Malawi, contamination, pollution, Lilongwe, Blantyre, and Mzuzu. We selected these keywords based on the authors' experiences in the field. We also searched literature known to the authors. The inclusion criteria for the systematic literature review was groundwater sample results where the water may have been used as drinking water from the 6 northern districts of Malawi. Study records were managed in Microsoft Excel. We only used full text papers, and if papers were not open access, we requested a copy of the paper directly from the authors. Selected articles were then reviewed by the corresponding author for the origin of authorship, funding source, and water quality data, after which the results were reviewed by all authors. We did not include water quality data for urban municipal piped water systems. We also did not include grey literature for consistency with accepted systematic review practices, such as unpublished data from academic laboratories.

### 2.2. Key informant interviews

Following the systematic literature review, from June to December 2017, we conducted face-to-face or mailed structured surveys focusing on current water quality issues and capacity based on their link to World Vision Northern Zone rural water supply interventions. Interviews were conducted with local government District Water Officers ( $n = 6$ ); the regional urban piped water supply system provider ( $n = 1$ ); government laboratories ( $n = 3$ , located in each the northern, central and southern regions); and the national ministry in charge of water supply, the Ministry for Agriculture, Irrigation, Water, and Development ( $n = 1$ ). Surveys were conducted in English. Key informant interviews with rural water users were not included.

### 2.3. Ethics

Ethical clearance for this study was obtained from the Malawi Government, National Commission for Science and Technology. Written consent was obtained from respondents. All research tools and data are available from the corresponding author.

## 3. Results

This section presents results on the national water quality guidelines for groundwater used for drinking water by rural communities, where and what existing data are available for the northern region, plus environmental laboratory capacity infrastructure and human capacity considerations to ensure safe water availability in Malawi.

### 3.1. What are the water quality guidelines for drinking water?

In Malawi, water quality guidelines for drinking water are set by the national government. There are two drinking water quality criteria, the Malawi Bureau of Standards (MBS) MS 214:2013 (Malawi Bureau of Standards MBS, 2013), which is the drinking water specification for urban and semi-urban area piped water providers, and MS 733:2005 (Malawi Bureau of Standards MBS, 2005), which is the specification for groundwater from borehole and shallow wells used for drinking. Both of these standards differ from the World Health Organization (WHO) (2017) guidelines. While MS 214:2013 has criteria for 58 chemical and physical determinants, MS 733:2005 only has criteria for 27 determinants, while the WHO summary tables cover guideline values for 90 chemicals that are of health significance in drinking water. There are also differences in the stated levels; for example, while the WHO guideline value for fluoride is 1.5 mg/l, in MS 214:2013 it is 0.7 mg/l, and in MS 733:2005, it is 6.0 mg/l. However, for other constituents, the MS 214:2013 and WHO criteria are the same, such as that for arsenic of 0.01 mg/l, while MS 733:2005 for arsenic is five times this (0.05 mg/l). Neither MBS guideline (Malawi Bureau of Standards MBS, 2005, 2013) contains water quality criteria for uranium, yet the World Health Organization (WHO) (2017) has guidance levels for radionuclides in drinking water and for the chemical aspects of uranium. Though a uranium mine was opened at Kayelekera in northern Malawi in 2009, nationally only MS 214:2013 includes gross alpha and beta activity. This contrasts to Namibia, where there is also a uranium mine and a drinking water limit for uranium has been set at 1 mg/l (NamWater, 2017). During our interviews, four respondents mentioned the need for uranium water quality monitoring.

Neither of the MBS guidelines (Malawi Bureau of Standards MBS, 2005, 2013) is available online, both are only available as paper copies from MBS offices which would be difficult for rural water users to obtain.

We probed further into the water quality guidelines for drinking water during our interviews. A national ministry representative stated, “If you apply the WHO guidelines, all of our schemes would fail”. This was echoed by a government laboratory chemist interviewee who said, “if we say that it [drinking water] has to meet these stringent standards [WHO guidelines], then a lot of boreholes would be abandoned”. The interview data show that at a national level there is an awareness of water quality guidelines for groundwater used for drinking water by rural communities and of the differences between national standards (Malawi Bureau of Standards MBS, 2005, 2013) and the guidelines of the World Health Organization (WHO) (2017).

### 3.2. Where and what are the groundwater data in northern Malawi?

We initially identified 35 articles containing groundwater quality data for the assessment of health risks in Malawi and determined a final set of 9 that met our criteria for northern Malawi. Upon detailed review of the work by Kanyerere et al. (2012), these data were excluded from

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