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Research Application Summary

Status of water quality in the springs of Huye Town, Rwanda

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Abstract

The treatment and supply of drinking water in Rwanda is carried out by Water and Sanitation Corporation (WASAC), a state owned public company. However, WASAC is not able to supply water to all households. Consequently, the non-serviced households depend on springs to meet their water requirements. However, water quality in these springs is barely known. This study was conducted to establish baseline water quality in the rural areas around Huye Township. Interviews were conducted and questionnaires were administered within the population of the project area. Subsequently bacteriological, physical and chemical parameters were analysed at Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires (LHEDA). Results showed that in dry season pH of water from springs (6.21) and from containers (5.62) were slightly acidic. In the rainy season all springs were polluted with Faecal Coli forms, *Streptococcus* and Total Coliforms and for Total Aerobic Flora at 62.5%. *Escherichia coli* contamination was quite high (25%) for water from family containers which was not the case in the water directly taken from the spring implying that more contamination occurs during water transportation and storage. There is therefore need to undertake spring protection and insitu water treatment at household level.

Key words: Drinking water quality, Rwanda, spring protection, spring water, water treatment

Résumé

Le traitement et l'approvisionnement en eau potable au Rwanda sont assurés par la Société d'eau et d'assainissement (WASAC), une société publique appartenant à l'État. Cependant, WASAC n'arrive pas à fournir de l'eau à tous les ménages. Par conséquent, les ménages non-servis dépendent des sources naturelles pour satisfaire leurs besoins en eau. Cependant, la qualité de l'eau de ces sources est à peine connue. La présente étude a été menée pour établir la qualité de l'eau de dans les zones rurales du canton de Huye. Des entretiens ont été menés et des questionnaires ont été soumis à la population de la zone du projet. Ainsi, des paramètres bactériologiques, physiques et chimiques ont été analysés au Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires (LHEDA). Les résultats ont montré qu'en saison sèche, le pH de l'eau provenant des ressorts (6.21) et des barils (5.62) était légèrement acide. En saison pluvieuse, toutes les sources sont polluées avec des formes de Streptococcus et Coliformes Total et pour Total Aerobic Flora à 62,5%.

La contamination par Escherichia coli était assez élevée (25%) pour l'eau provenant de conteneurs du ménage, ce qui n'était pas le cas dans l'eau directement prise de la source, ce qui suggère plus de contaminations pendant le transport et le stockage de l'eau. Il est donc nécessaire d'entreprendre des actions de protection des sources naturelles et de traitement de l'eau au niveau du ménage.

Mots clés: Qualité de l'eau potable, Rwanda, protection des sources naturelles, eau de source, traitement de l'eau

Background

The Millennium Development Goals (MDGs), agreed in 2000, aimed to halve the proportion of people without sustainable access to safe drinking water and basic sanitation between 1990 and 2015. Water quality is an important human development indicator. It is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself (UN- Water and Sanitation, 2015).

Ensuring access to safe, sustainable water use and sanitation will accelerate attainment of multiple environment and health-related goals for sustainable development (United Nations, Rio conferences, 2012). Africa faces huge challenges with multiple issues that adversely affect public health. One major challenge is the ability for both rural and urban Africans to access a clean water supply (Lori Lewis, 2016). The WHO (2006) stated that, in 2004, only 16% of people in sub-Saharan Africa had access to drinking water through a household connection (an indoor tap or a tap in the yard). Not only is there poor access to readily accessible drinking water, even when water is available in these small towns, there are risks of contamination due to several factors.

The final Rwanda progress report of the Millennium Development Goals (2014) showed that the Government of Rwanda was still very far from achieving expected target of 100% of safe drinking water especially in rural and peri-urban area (Figure 1). With the vision 2020, Economic Development for Poverty Reduction Strategies: EDPRS II and National Water Supply and Sanitation targets (2005), Rwanda is committed to achieving 100% water supply coverage country wide by 2017. Despite these initiatives, water supply and sanitation is still a major issue. According to the National Policy and Strategies for Water Supply and Sanitation Services (2010) the sources of rural water supply are distributed as follow: 78.5% of Rwanda's rural population use natural sources of water supply including unprotected sources, 32.2 % protected springs; 46.3 % piped water; 19.9% boreholes or wells equipped with a hand pumps (1.6%). However, water quality in the springs is barely monitored and as such there is no known baseline information on the spring water quality in Huye and other parts of the country. This study therefore determined the biological, physical and chemical water quality parameters of spring wells and household water containers.

Figure 1. Access to safe drinking water by District, Rwanda report of the MDGs (2014)
Source: DevInfoRwanda

Methodology

The study was conducted in Huye sector, Ngoma Sector, Mukura Sector and Tumba sector of Huye district (Figure 2). The GPS was used to map the water points (Figure 2) to allow for geo-referencing. The annual rainfall varies from 1200 mm to 1400 mm per year and the area has an average temperature of 19°C. Huye district topography is characterized by a vast number of hills and mountains, a fact that results in high soil erosion and loss of water. In order to know the local name of each chosen spring to be analysed, we consulted the local inhabitants and the local authorities. The choice was based on the availability of water in dry season and the capacity to supply a big agglomeration.

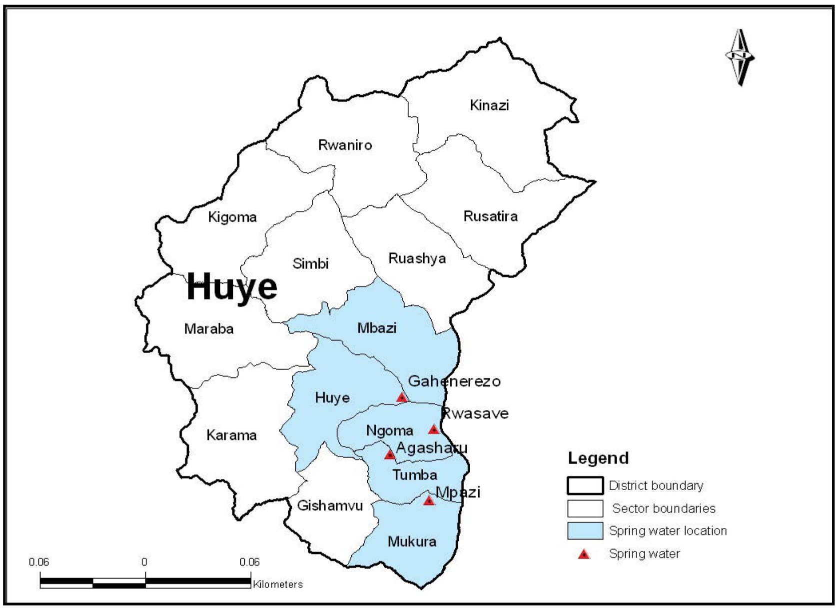

Figure 2. Spring locations on Huye district map
Source: GIS-UR-Rwanda

Data collection and analysis was undertaken using standard analysis procedures. The water pH was measured by potentiometry using an appropriate pH-meter WTW-PH 538 which is a digital electronic pH meter that provides measurement of pH. Conductivity was determined using a Conductimeter inoLab, which is a cell of conductivity for underwater or appropriated instrument which allows measuring electric conductivity of aqueous solutions. Ammonium, nitrate and nitrites were measured using colorimetric method. Microbiologic analysis for Total Aerobic Flora, Total Coliforms, Fecal Coliforms, *Escherichia coli*, *Streptococcus, Salmonella* and *Shigella* were done following standard methods (AFNOR, 1997).

Results and Discussion

Physicochemical parameters. Table 1 shows the result of the mesurements of the physico-chemical parameters of spring water in Huye district and Table 2 parameters for water from household containers. The overall mean pH in dry season was lower than the WHO recommended range of 6.5< pH< 9.2. This could be a result of soil acidity. It is increasingly being recognized that although acid soils in Rwanda occupy approximately 45% of the arable land, 60% of the highland areas are covered by acid soils with pH less than 5.5 (Beenart, 1999). Huye district is located in high land region and spring water analysed in dry season was only slightly acidic with a little excess of nitrates, which may cause corrosion for galvanized metallic pipes while during rainy season the mean pH corresponded to acceptable WHO range. This could be a result of dilution. Family containers for storing water are not big, so the retention time to allow reactions to increase nitrates, nitrites and ammonium concentrations was not sufficient.

According to Premazzi *et al.* 1989, the health risks from exposure to nitrates are related not only to their intake but also to the presence or absence of conditions leading to their reduction to nitrites in the body. Infants constitute the most vulnerable group because the lower acidity in their stomach allows the growth of certain microbes that contain enzymes capable of reducing nitrates to nitrites.

Table 1. Physical-chemical properties of spring water in Huye district

Season	Dry season				Rain season			
Water springs	Gahe	Mpare	Mpazi	Rwas	Gahe	Mpare	Mpazi	Rwas
pH	6.25	6.1	6.68	5.81	8.02	6.8	7.1	7.9
Conductivity (µS/cm)	131.8	74.7	121.1	129.1	111.6	69.8	121.9	134.5
Ammonium (mg/l)	0.014	0.018	0.054	0.019	0.04	0.006	0.07	0.04
Nitrates (mg/l)	38.98	20.5	15.75	33.22	29.6	18.1	36.6	0.3
Nitrites (mg/l)	0.003	0.012	0.014	0.011	0.11	0.12	0.08	0.08
WHO standards	6.5< PH< 9.2	Conductivity (µS/cm) < 1000		Ammonium (mg/l)< 0.5		Nitrates (mg/l) < 50		Nitrites (mg/l) < 0.1

Source: LHEDA-UR (Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires)

Table 2. Physicochemical parameters of water from household containers in Huye district

Season	Dry season				Rain season			
Water springs	Gahe	Mpare	Mpazi	Rwas	Gahe	Mpare	Mpazi	Rwas
pH	5.74	4.14	6.0	5.94	7.2	6.9	7.2	7.8
Conductivity (µS/cm)	116.8	137.7	138	129.9	110.6	150.5	142.8	71.4
Ammonium (mg/l)	0.0146	0.0073	0.019	0.016	0.006	1.50	3.0	0.02
Nitrates (mg/l)	24.24	15.3	24.09	33.74	29.9	0.05	37	0.18
Nitrites (mg/l)	0.0173	0.0086	0.019	0.031	0.09	0.90	17.4	0.1
WHO standards	6.5< PH< 9.2		Conductivity (µS/cm) < 1000	Ammonium (mg/l) < 0.5		Nitrates (mg/l) < 50	Nitrites (mg/l) < 0,1	

Source: LHEDA-UR (Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires)

Bacteriological parameters. Table 3 presents microbiological data of spring water in Huye district. The bacteriological quality of a drinking water depends on the absence of certain bacterial species such as faecal coliforms, staphylococcus, streptococcus, *Escherichia coli*, *salmonellas* and *shigellas*. Some species can be tolerated, but for limited concentrations, in conformity with the WHO Guidelines for Drinking-Water Quality, (2004) and standards fixed by the legislation on drinking water which is currently in force in each country. Bacteria are considered as indicators of drinking water pollution and give the indicator of whether water is recommended for human consumption or not. For water that was taken directly from the spring, there was no *Escherichia coli* contamination nor *Salmonella* and *shigella* contamination but for other bacteria analysed all the sources were contaminated and contamination increased during the rainy season. So this water needs to be treated before consumption. The four springs studied were chosen because of the fact that they were used by a big number of population from surrounding agglomerations and the fact that the spring water quantity was sufficient during the whole year (Rainy season and dry season). *Escherichia coli* contamination (25%) found in water from family containers but were not in the water directly taken from the spring. This suggests that the contamination occured during transportation and water storage.

Conclusions and recommendations

Our findings indicate that the four springs studied were visibly degraded and may not have been rehabilitated since they were constructed or corrected. However, physicochemical analyses show acceptable physicochemical quality for all analysed parameters but old galvanized pipes may cause some health problems due to acidity corrosion. Nevertheless, household containers had high levels of bacterial contamination. It is therefore recommended that the population needs to be educated on keeping clean containers used to draw and store water and to advise population to boil water or use Ministry of Health recommended bactericidal disinfecting guidelines before drinking water. Importantly, the sources of contaminations must be traced and eliminated through regularly testing and monitoring by the health authorities and local administration. Spring protection is the best intervention for improving source water quality in a rural area. Additionally, there is need to improve water treatment technologies including chlorination, filters, and solar disinfections. Further research to extend this work to other parameters with health significance is recommended to improve on this baseline information.

Table 3. Level of microbiological contamination in spring water during dry and rain seasons in Huye district

Season	Dry season				Rain season			
Water springs	Gahe	Mpare	Mpazi	Rwas	Gahe	Mpare	Mpazi	Rwas
Total Aerobic Flora (cfu/100ml)	<1	3	124	25	2.1	5.1	3.1	5.1
Total Coliforms (cfu/100ml)	4	24	1000	100	>5.100	>5.100	>5.100	>5.100
Fecal Coliforms (cfu/100ml)	<1	<1	<1	<1	<1.100	< 1.100	< 1.100	< 1.100
Escherichia coli (cfu/100ml)	A	A	A	A	A	A	A	A
Streptococcus (cfu/100ml)	<1	<1	<1	2.1	2.1	>5.100	>5.100	>5.100
Bacteria (cfu/20ml)	A	A	14	A	A	A	A	A
Salmonella and Shigella (cfu/5l)	A	A	A	A	A	A	A	A

WHO Standards	Total Aerobic Flora< 20 cfu/ml	Total Coliforms	*Escherichia coli* : A	Streptococcus : A	Bacteria : A	Salmonella and Shigella : A

Note: A: absence and P: presence

Source: LHEDA-UR (Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires)

Table 4. Level of microbiological contamination in household containers during dry and rain seasons in Huye district

Season	Dry season				Rain season			
Water springs	Gahe	Mpare	Mpazi	Rwas	Gahe	Mpare	Mpazi	Rwas
Total Aerobic Flora (cfu/100ml)	3.103	2. 102	3.104	7.102	2.103	>3. 103	>3. 103	4. 102
Total Coliforms (cfu/100ml)	3. 104	2. 104	4.104	5. 103	>5.102	>5.102	>5. 102	>5.102
Fecal Coliforms (cfu/100ml)	20	<1	1. 103	2. 102	3.1	>5. 102	>5. 102	2.102
Escherichia coli (cfu/100ml)	A	A	A	A	A	P	P	A
Streptococcus (cfu/100ml)	5. 102	2. 103	3. 103	3. 103	>5.102	5. 102	2. 102	102
Bacteria (cfu/20ml)	A	12	40	6	A	A	A	A
Salmonella &Shigella (cfu/5l)	A	A	A	A	A	A	A	A

WHO Standards	Total Aerobic Flora< 20 cfu/ml	Total Coliforms	*Escherichia coli* : A	Streptococcus : A	Bacteria : A	Salmonella and Shigella : A

Source: LHEDA-UR (Laboratoire d'Hygiène de l'Eau et des Denrées Alimentaires)

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