What Can We Learn about Analysis of the Situation of Water, Hygiene and Sanitation in an African Rural Health Area: Study Case of Kavumu in Democratic Republic of Congo?

Hermes Karemere[1, 2], Nathalie FARAJA Kalibanya[1], Jean-Louis BAHIZIRE Kayeye[3], Polycarpe CHIHIRE Barhahakana[1, 3], Johnny Kashama[4]

[1]Universite du Cinquantenaire de Lwiro, Sud-Kivu, RD Congo
[2]Ecole régionale de santé publique, Universite catholique de Bukavu, RD Congo
[3]Centre de recherche en sciences naturelles de Lwiro, RD Congo
[4]Chercheur independant, Canada

Abstract: _Background_: _Access to water supply services in a healthy environment continues to be a problem in many neighborhoods in the DRC. This is the case of the Kavumu health area where these services are defective and cause episodes of diarrheal diseases. The purpose of this study is to analyze thewaterhygiene and sanitation situation in Kavumu health area and propose strategies for its improvement._ _Methods_: _This study, a descriptive cross-sectional, was carried out in the Kavumu health area. It is a prospective approach supported by documentation and the interview. The survey questionnaire was sent to 287householders, from September 2016 to February 2017._ _Results_: _The study reveals that 86.8% of respondents are married, where women represent 66.2% and 73.2% of households have at least 5 members. The literacy rate is 23.3% for men and 30.3% for women. The Kavumu health area has 13 spring waters in 10 villages out of a total of 25. Nearly 6% of householders live in houses built of durable materials and 65.5% have unhygienic latrines. 39.7% of households produce household waste and 60.3% of households produce agricultural waste. 32.8% of households store waste in their yards._ _Conclusion_: _The water, hygiene and sanitation situation in the Kavumu health area remains rudimentary. In view of results of this study, the elaboration of a plan for the improvement of water, hygiene and sanitation services is essential in this health area._

Keywords: Water, Hygiene, Sanitation, Households, Kavumu health area, Democratic Republic of Congo

1. Background

Water, hygiene and sanitation services remain scarce in health areas and are still well below the target of 100% coverage [1-3]. According to a WHO study in 54 countries, 38% of health facilities do not have an improved water point accessible to the public, 19% do not have improved sanitation facilities, and 35% have no soap for hand washing.

In this study, water supply is the lowest in the African region: 42% of establishments do not have improved water points in situ or in the vicinity[1].In addition to poor water and sanitation coverage, environmental pollution and basic sanitation shortages are increasing inthe countries with limited resources, which are at the same time confronted with high population growth combined with rapid urbanization. This situation leads to the production of huge quantities of waste and waste water, the elimination of which requires significant financial resources which are not often available[4, 5]. Hygiene education programs exist and are taught theoretically. Sanitation infrastructure is present in developing countries but poorly maintained. The absence of drinking water and the budget line for the supply of these countries are handicaps to the correct implementation of hygiene measures taughtand lead to health problematic[6, 7]

In the Democratic Republic of the Congo, access to water supply services in a healthy environment continues to be a problem in many neighborhoods[7]. This inequality in the quality of a healthy environment creates a market for water vendors and encourages the use of non-potable spring waters and sinks in urban-rural areas. The lack of good quality water in an unhealthy environment poses a health risk to the population. This situation can lead commercial women sellers to provide unsafe drinking water to the population, exposing them to diarrhea, dysentery, cholera, salmonellosis and other diseases known as "dirty hands".

In addition, the water transport and storage systems used by vendors do not always guarantee good water quality. These wells or tap water contained in plastic containers, basins, or plastic bags that are poorly maintained are scattered in an unhygienic environment (the sanitary condition of the canteen, the clothes of the vendors or the uncovered water) polluted or contaminated and expose consumers to the risks of diseases.

In the Kavumu health zone, we observed that the population is truly exposed to poor hygiene due to poor management of household waste, non-evacuated wastewater and unhealthy living around dwelling houses. This situation makes malaria endemic. In addition, there is a shortage of drinking water, which inevitably leads to episodes of diarrheal diseases, including cholera. Can we learn more from the analysis of the water situation, hygiene and sanitation in the Kavumu health area? The objective of this study is to analyze the water, hygiene and sanitation situation in the Kavumu health area and to propose relevant local strategies to improve the conditions for water supply, hygiene and sanitation of the living environments of the same population.

2. Methods

Type of study, study site and study population
The study was descriptiveand cross sectional [8] and took place in the health zone of Kavumu in the Miti-Murhesa Health Zone, South Kivu province in the Democratic Republic of Congo where it analyzed water situation, hygiene and sanitation. The total population of the health area represent 75,772 inhabitants comprising 9,503 households, with an average of 7 to 8 people per household in 2016 (source: Miti-Murhesa Health zone report, 2016). Using simple random sampling, 287 households in the health area were selected to participate in the study.

Data Collection
Data collection was made from document review and interviews. The literature review covered the period from2010 to 2016 of the Health Zone reports, the patient registries of the Kavumu health area, and the reports of the health center supervision by members of the health team.The main data collected are the socioeconomic characteristics of respondents (sex, age, legal status, level of education and household size), water situation in the Kavumu health area (spring waters, flow, distribution as well as the accessibility in terms of time anddistance), hygiene situation (house type, latrines types, distance between latrines and houses and awareness of the existence of the dirty hands diseases) and sanitation situation(house cleanliness, yard cleanliness, types of wastes produced, storage place, distance between the house and the garbage.The interviews happened over the period from six months, from September 2016 to February 2017,using a semi-open-tested and improved questionnaire. The information collected dealt with socio-economic situation of the respondents, the water situation, the hygiene situation and the sanitation situation in the Kavumu health area.400 people were targeted by the interviews. These are man and female householders in the Kavumu health zone. Their choice was random. Respondents are those who were present at their homes when one of two investigators (principal investigator and a nursing student) initially trained in the survey, visited themat their homes. The interviews were conducted using a previously tested questionnaire. 400 heads of household were interviewed.

Data analysis
Out of 400 questionnaires encoded, 114 questionnaires were excluded due to incomplete responses. Only 286 questionnaires were used.The data collected was encoded in an Excel file for quantitative data and in a Word file for qualitative information. For qualitative data, the information was analyzed by each of the three themes defined as water, hygiene and sanitation. For each theme, the analysis focused on the observed situation, its causes and consequences and possible solutionsproposed by the respondents. In the case of quantitative data, tables and graphs have been drawn up, categorizing the information collected in socio-demographic data, those relating to water, hygiene or sanitation in the health area.

3. Results

3.1 Socio-economic characteristics of the sample

Table 1 shows that the majority of respondents in the Kavumu health area are married (86.8%); women represent 66.2%, and 73.2% of households have at least 5 people. The illiteracy rate is high in the sample: 23.3% of men and 30.3% of women. Almost one quarter of households (23.3%) have 3 to 5 children aged 5 or older.

Table 1: Socio-economic characteristics of the sample: Number of households

	Household number (n= 287)		%
Sex	Male	97	33,8
	Female	190	66,2
Age (years)	18-27	122	42,5
	28-37	97	33,8
	38-47	41	14,3
	48-57	15	5,2
	58+	12	4,2
Marital status	Single		
	Married	249	86,8
	Widow	25	8,7
	Divorced	13	4,5
Education level	illiterate	67	23,3
	Primary	123	42,9
	Secondary	76	26,5
	University	21	7,3
Household size	1-4	77	26,8
	5-8	152	53
	8+	58	20,2

3.2 Water situation in the Kavumu health area

3.2.1 Spring waters, flow and distribution

Table 2: Spring waters and distribution in the Kavumu health area

Village	Population	Household number	Spring water number	Quantity/day/ household(liters)	Distance between village and health care center (km)
Buhinda	789	81	0	0	3,5
Buloho/Buliriko	4463	622	1	5,3	2,5
Buloho/Lunanga	4337	520	0	0	3
Bulungu	1354	170	0	0	2,5
Burhala	709	62	0	0	2
Businde	3731	584	2	7,99	0
Bwimika	5913	600	1	9,4	1
Cibuye/Cadirha	3678	119	0	0	3
Cirato	5085	704	1	8,8	2
Cirhedja	631	99	1	53,24	3,5
Cirhodu	5671	726	0	0	2
Igurhu	3491	443	0	0	2
Kabale	5007	627	1	11,02	3

Kabamba	5277	687	2	46,5	2
Kakenge	1077	157	1	20,4	2
Kalango	1367	150	0	0	3
Kamakombe	3372	409	0	0	3
Karhanda	4767	917	1	4,3	2
Kashenyi	1450	190	0	0	4
Kashwago	1244	143	0	0	3
Majalwe	878	111	0	0	3,5
Mushungurhi	4973	552	0	0	1
Nyakarhalaga	5519	666	0	0	3,5
Nyamakana	533	115	2	57,6	2,5
Nyantangwe	456	49	0	0	3
Total	75772	9503	13	224,55	

3.2.2 Distribution of spring waters in the Kavumu health area by villages.

The Kavumu health area has 13 spring waters in 10 villages in the health area out of a total of 25 villages. These spring waters have variable water flow rates (0.24 liters per second to 0.02 liters per second)as showed in table 3

Table 3: Spring waters distribution per village and their flow rate in liter per second

Spring waters	Village	Flow rate L/s
Karhabisha1	Kabale	0.08
Kabulanga	Bwimika	0.065
Muzibira	Businde	0.02
Nyakaziba	Nyamakana	0.0547
ADI-Kivu	Businde	0.034
Nyacibundu	Karhanda	0.046
Cigolo	Cirato	0.072
Kalushige	Kabamba	0.24
Karhabisha 2	Kabamba	0.13
Buloho	Buloho/Buliriko	0.038
Matali	Cirhedja	0.061
Rwanzobe	Nyamakana	0.022
Kakenge	Kakenge	0.037

Because of their high flows, the two sources in the village of Kabamba have offered the possibility of installing water supplies serving neighboring villages that are either without sources or that have low flow rate. As shown in Table 2, spring water are unevenly distributed in 10 villages out of the 25 villages in the Kavumu health area, which represent 40% coverage.
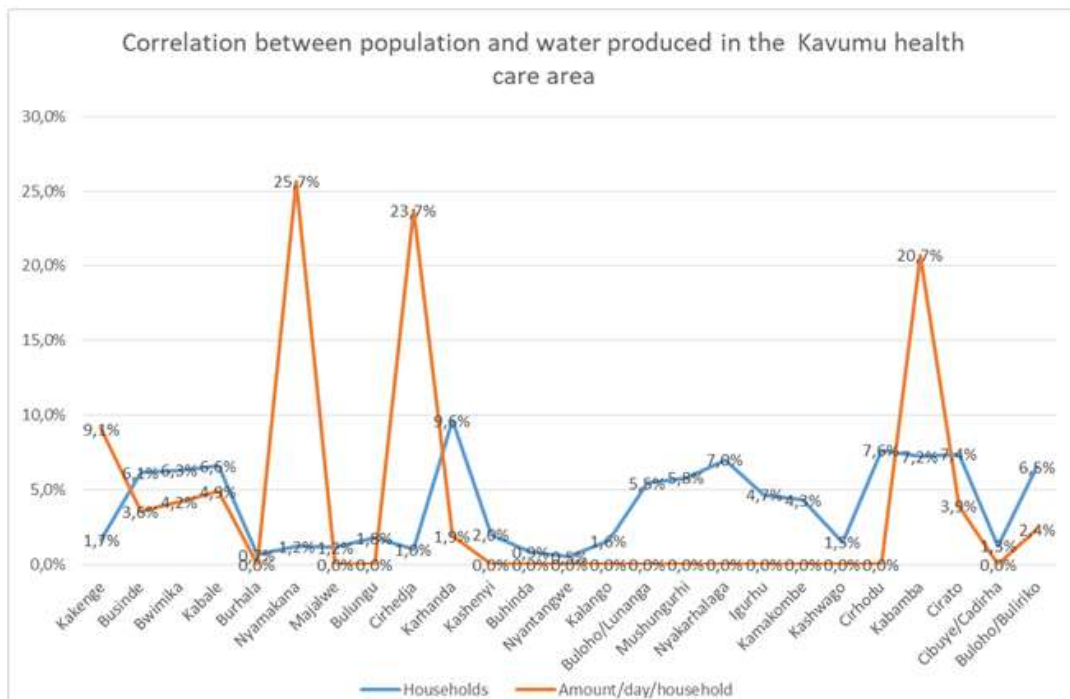

Figure 1: Correlation between the amounts of water produced per day and the population

The village of Karhanda with the highest number of households representing 9.6% of all households in the Kavumu health area only has 1.9%of the total water of the health area while the village of Nyamakana which only has 1.2% of all households holds 25.7% of water. Several villages have no water despite the high proportions of households.

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3.3 Accessibility to water sources in terms of distance and time

Table 4: Access to water source

		Household number (n=287)	%
Distance between household and water spring (m)	1-500	30	10,5
	501-1000	85	29,6
	> 1000	172	59,9
Time to reach the spring water (min)	0 - 30	59	20,6
	31 - 60	101	35,2
	>60	127	44,2

Nearly 60% of householders or family members travel more than 1000 meters to access the water source and 44% take more than 60 minutes to access the water source as shown in Table 3

3.4 Hygiene situation

Table 5: Hygiene situation in the Kavumu health area

		Households number (n=287)	%
Types of houses	clay	187	65,2
	semi-durablesmaterials	83	28,9
	durable materials	17	5,9
Types de latrins	Hygienique	98	34,5
	Non hygienique	186	65,5
Distance (inmeters)	0 - 5	177	61,7
	10-Jun	67	23,3
	More than 10	43	15,0
Awareness of dirty hand diseases	Yes	273	95,1
	No	14	4,9

Table 5 shows that only about 6% of householderslive in houses constructed of durable materials, 65.5% have unhygienic latrines, sometimes attached directly to houses, 15% have latrines of 10 meters or more apart of their houses and almost 5% are unaware of the existence of dirty hand diseases in the Kavumu health area. In order of frequency, known dirty hand diseases in the Kavumu health area are cholera (17.4%), amoebiasis (32.8%), verminosis (8.7%), dysentery (13.2%), typhoid fever (24.1%) and skin infection (3.8%).

3.5 Situation of Sanitation

According to Table 5, household cleanliness is not ensured on a daily basis by nearly 55% of respondents, 57.8% do not clean their yard, 39.7% of households produce household waste and 60.3% of households produce agricultural waste. In the absence of industry, no household produces industrial waste. To store waste, 32.8% of households use their yard, 52.9% use garbage and 14.3% use bags.

For 28.2% of the households, the garbage is located at more than 5 meters from their house and for 61.3% their back yards do not have sewers. In this case, waste is evacuated by runoff when it rains, during the rainy season and sewers infiltrate during the rainy season.(In that case, the waste is evacuated by runoff waters when it is raining, during the raining season and it dries during the dry season).Finally,

53.7% of households have weeds in their yards, evidence of poor backyard maintenance.

Table 6: Household sanitation situation in the Kavumu health area

		Number of households (n=287)	%
House cleanliness	yes	129	44,9
	no	158	55,1
Yard cleanliness	yes	121	42,2
	no	166	57,8
Types of waste produced	Domesticwaste	114	39,7
	Agricultural waste	173	60,3
	Industrialwaste	0	0
Storage place	yard	94	32,8
	garbage	152	52,9
	bags	41	14,3
distance (in meter)	0 to 2	112	39
	2 to 5	94	32,8
	More than 5	81	28,2
Sewerpresence	Yes	111	38,7
	No	176	61,3
Presence of weeds	Yes	154	53,7
	No	133	46,3

4. Discussion

Socio-economic characteristics of respondents
The heads of the households interviewed are young (42.5% are in the age group of 18 to 27 years). In this health area, men and women marry early due to lack of schooling (23% illiterate and 43% have not yet reached primary school level). The percentage of 53% of our surveyed houshoulds who have between 5 and 8 people corroborate other results in Democratic Republic of Congo[9] andis explained by the fact that the health area of Kavumu, which is from a developing country only have between 6 and 8 people in households as stipulated in the WHO standards showing that the size of the household should vary between 6 and 8 people in countries sending development [1]and the big size households have the tendency of being poor[10, 11]. In the Kavumu health area, as in the whole of the Democratic Republic of Congo and Africa, women are homeholders while men are the ones who take care of activities that produce family income. Rajaomanana, noted in his study in Australia that in underdeveloped countries, women are direct responsible of the household because it is she who are all that happens because the man is in charge of other family projects [12]. Our results show that 66.2% of our respondents are females. The reason of having a large percentage of women is explained by the fact that each time we went on the field, we were welcome by women because they first prepare children for school, waiting until all the children wake up in addition to prepare food to bring to their husbands who preceded them in the morning for rural activities.

Water situation
The Kavumu health area has 13 spring waters, while Kajivunira*et al*. found that the Irhambi-Katana group had 56 unequally distributed spring waters throughout the Grouping[13]. The authors showed that there is less spring water at high altitude and more spring waters on the shores of Lake Kivu. The Kavumu health area is also at high

altitude and that is why we incriminate the altitude as a factor of having few spring waters. These spring waters have varying flows. The source of Kalushige is the one with the highest flow (0.24 L / s), followed by the Karhabisha2 source (0.13 L / s) and the one with the lowest flow is the source of Muzibira (0.02 L / s). Because of their flows, the Kalushige and Karhabisha2 springs are used in adduction in villages that have no sources, villages with low flows of springs and villages with unmanaged springs. Wateradduction can provide water for villages that do not have spring waters in the Democratic Republic of Congo[14]. The overalldaily water quantity and number of households ratiois224.55liters. In all villages in the Kavumu health area, that ratio is as low as 120 liters [13]. In regards to the number of households we have in each village, we come to the conclusion that the spring waters of the Kavumu health area produce too little water. A population of 9503 households representing 75772 people uses 77734.08 liters of water. This represents an average of only 300 ml per person per day.Compared to the 7.5 to 15 liters per day that is recommended by WHO, considering only basic survival needs (drinking and food), basic hygiene practices and basic cooking (WHO, 2011). This proves that the quantity of water is very insufficient and therefore does not cover the water needs of the population.These results corroborate those of Kajivunira*et al*. (2015), who carried out a study on the assessment of spring waters in the Irhambi / Katana rural group and came up to the same conclusion that the quantity of water is insufficient and does not meet the needs of the population. The distance from the source or tap is over 1000 meters. These findings show that there is a very small number of spring waters and the lack of total water supply in the Kavumu health area. According Kajivunira*et al*., [13]and Tonia and Amat, [15], the problem of lack of water adduction and supply in the developing countriescompel people to get water far from their housesas we have noticed with our results. As the distance between the water point and the house increases, the time taken from the spring water to the house becomes also long, as shown in Table 4. The insufficiency or lack of water in this area is a cause of dirty hands diseasessuch as cholera, formidable by its epidemic character [3, 16, 17]

Hygiene situation
Two-thirds of the people surveyed use clay for construction, with all the hygienic conditions that are linked to it. In fact, this type of construction is an indicator of the socio-economic level of the population and reflects poverty. These living conditions have also been pointed out by Atokare (2008) inTchad and according to him, they are commonin developing countries in generaland remarkable in the Kavumu health area. In fact, the primary cause of the morbidity and mortality rates of children under five years old is poverty and this same poverty is the basis of the poor living conditions in the developing countries[10, 18, 19]. The clay house is constructed with mud (floor) and covered by straw or metalsheet. Poverty also means that certain living parameters are not met within a household, such as adequate hygiene and sanitation and latrines which are unhygienic as presented in Table 5. Poverty and ignorance are the two factors explaining these results because the population of the Kavumu health area is poor;they do not have sufficient resources to make hygienic latrines and lack knowledge to do so. The distance between the latrine and the house varies between 0-5 meters for the population of the Kavumu health area. These results corroborate those of Dorandeu (2008) and Imbert (2001), who have shown that latrines in the developing countries must absolutely be away from houses to avoid the risk of contamination of the population with the germs of diseases, especially dirty handsdiseases[4, 20]. Studies have shown that the distance between the latrine and the house does not have enough impact on the transmission of germs diseases. If latrines are hygienic therefore distance does not matter, whether large or small, [21, 22]. The small distance between the house and the latrine is at the origin of illnesses linked to the insalubrities, especially dirty hands diseases. These results can be explained by the fact that disease cases are observable in the population of this health area and these diseases cause socio-economic losses and human lives. These results are in agreement with those of [23]who showed in his works that the presence of precarious hygiene is a source of the known dirty hand diseases of 95% of peoplesurveyed, including cholera, typhoid fever .

Situation of sanitation
The results on sanitation show that 55.1% of our respondents do not ensure the clean their house. The lack of water, sanitation and hygiene services seriously undermines people's ability to take appropriate infection control measures through healthy hygiene practices. Unaware of the consequences of unsanitary conditions in and around their homes, the population of the Kavumu health area usually neglect the cleanliness of their backyards and the surroundings. These consequences are mainly due to dirty hand diseases which develop in the environment and the population is therefore exposed to these diseases because vectors such as flies find appropriate places ofgrowth and accomplish their life cycle[4]. This is confirmed by the results of [23]that an unhealthy environment is a place of reproduction of vectors of dirty hand diseases and thus, in this environment, cases of dirty hand diseases are always probable. In the courtyard or the plot are thrown the waste produced by our respondents. The waste produced is agricultural and household waste. These results can be explained by the fact that the entire population of the Kavumu health area is agricultural oriented, which is why the waste is agricultural (Bean peel, Cassava, Banana, Corn, Sweet Potato, Potato, taro, etc.). These results coincide with those of [9] which asserts that farmers households subsequently produce agricultural waste. These waste products are stored in a garbage can. These results can be explained by the fact that the population of the Kavumu health area recognizes that the waste must be stored in one place and this place is called "garbage". However, according [24], these bins should not be called garbage because they do not meet the standards (1m long, 0.60m wide and 0.80m depth). The distance between the trash and the house is just 0-2 meters. These results are due to the insalubrities of the yard and the smallness of the lot and the ignorance of the population. Kangoy*et al*., (2016), in their studies on waste management in the Kasai-Oriental Province, have shown thatin waste management, man is his own enemy has it this mismanagement leads to harmful consequences like diseases[9]. On top of that, there are sewers or waste waters. For example, 38.7% of our respondents had sewer in the

yard while the remaining 61.3% do not. These results can be explained by the topography of the Kavumu health area, where sewers can be disposed of or stored and will be evacuated by runoff when it rains, during the rainy season and sewers the rainy season. That is to say, despite a strong population, there is always sewerage. The problem of non-maintenance of the plot is once again the basis of unhealthy conditions in the Kavumu health area. Thus, 53.7% of our respondents have weeds in their yards compared to46.3% who do not. These results are due to the lack of yard maintenance by home owners. Indeed, not mowing of grass has consequences which even directly or indirectly affect the inhabitants of the house [1].

From the study of the Kavumu health area, we retain the following:
1) The Majority of heads of households surveyed are women, they are more available and more present at home (66%).
2) Illiteracy and primary education: 66% of respondents
3) 60% of villages have no water source and thus depend on the sources of neighboring villages, causing 60% of households to travel more than 1km to access the water with a tremendous waste of time and physical fatigue. Water is thus insufficient and unevenly distributed within the Kavumu health area.
4) 65% of houses are built of clay, a poverty indicator with consequences on health, education, hygiene and sanitation (65% of toilets are unhygienic and waste management is out of the ordinary).

5. Conclusion

The water, hygiene and sanitation situation in the Kavumu health area remains rudimentary. The development of a plan for improvement by the public authorities will have to involve the women and aim among other things the education, the arrangement of the existing spring waters, the water supply where it is possible, the building of hygienic toilets, the management policy of public waste management and compulsory housing sanitation.

List of abbreviations
Not applicable

6. Declarations

Ethics approval and consent to participate:
The research protocol as well as the questionnaire had previously obtained the approval of the research ethics committee of the University of the Cinquantenaire de Lwiro and the acceptance of the study of the Head of Miti-MurhesaHealth Zone. A written consent form were filled and signed by householders to participate to the study.

Consent to publish:
Both authors declare that they consent to publish this study.

Availability of data and materials: Not applicable

Competing interests:

This study does not present any conflict of interest for the authors of this article.Both authors declare that they do not have any competing interests.

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