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Access to Water and Vulnerability to Health Risks in the Melen and Elig-Effa Districts (Cameroon)

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Abstract:- In urban areas, particularly in precarious neighborhoods, the health of populations depends on the quality of water and their living environment. In cities, especially in precarious neighborhoods in developing countries where access to water resources remains difficult, the water consumed is not always of good quality because of its contamination by various wastes. This situation exposes city dwellers to waterborne diseases such as typhoid, cholera, skin diseases, diarrhea, etc. The objective of this article is therefore to show the health risks incurred by city dwellers who consume water from decentralized supply points (wells and springs) previously polluted in the precarious neighborhoods of Melen and Elig-Effa. The documentary research made it possible to collect a certain amount of qualitative data on the subject. The water supply methods used by populations, the use of water resources, the management of wastewater and waste, and the logic of the various stakeholders were understood through field observations, semi-directed interviews, and questionnaire surveys. Physicochemical and bacteriological analyses were carried out in five types of water supply structures. It follows that the populations of the studied neighborhoods are supplied mainly from wells and springs coexisting with latrines, household waste and waste water likely to pollute them. The waters sampled have a conductivity with values of 185.2µS/cm for the summary well of Melen II, 272µS/Cm for the summarily arranged well of Melen III, 600 for the arranged well of Melen V, 192 for the summary well of Elig-Effa II, 281.5 for the summarily arranged well of Elig-Effa III, 601 for the arranged well of Elig- Effa V, 199 for the unarranged spring of Melen I and 488 for the arranged spring of Elig-Effa I. These values are well above the normal threshold of water conductivity recommended by the WHO (250µS/cm). Temperature values between 26° and 27.5° do not comply with the potability standards set by France, Cameroon and the WHO (below 25°). The results also indicated the presence of nitrate without danger for the populations in the waters of wells and springs studied because their levels are well below the standards recommended by France (ÿ50 mg/l), by the WHO (<44 mg/l) and by Cameroon (ÿ50mg/l). The results of the bacteriological analyses show a significant concentration of coliforms and fecal streptococci. The concentrations of fecal coliforms are higher in the waters of the summary well of Elig-Effa II (301 CFU/100 ml maximum) than those of the Melen II summary well (238 CFU/100 ml maximum), the roughly prepared well of Melen III (151 CFU/ 100 ml maximum), the unprepared spring of Melen I (207 UFC/100 ml maximum), the roughly prepared well of Elig-Effa III (112 UFC/100 ml maximum), etc. These waters also show a high concentration of faecal streptococci. In the waters of the wells and springs studied, the values of which are between 4 CFU/100 ml maximum and 15 CFU/100 ml maximum. In view of these results, it appears that the The water on the site is unfit for consumption and likely to harm human health.

Keywords:- *Access to Water, Health Risks, Melen And Elig-Effa Districts, Yaoundé.*

I. INTRODUCTION

Access to drinking water is a daily struggle for hundreds of thousands of city dwellers who live mainly in developing countries. It is thus essential for human development. Thus, the absence of water and or at least its poor quality inexorably causes death due to diseases related to it. (WHO, 2006). In Cameroonian cities, the majority of city dwellers live in deprived neighborhoods without drinking water. They regularly use water from wells, springs and rivers previously polluted by various solid and liquid waste, which constitutes threats to their health. In this regard, thousands of city dwellers suffer daily from diseases due to a lack of drinking water such as cholera, amoebic dysentery, intestinal parasitic infections, etc. (Ngnikam E., et al, 2007). Within cities, disparities are expressed in terms of quantity and quality of water consumed between structured neighborhoods and precarious areas, which are poorly equipped (Moctar C., 2004). In the deprived areas of Cameroonian metropolises, difficulties in supplying drinking water are due, among other things, to the anarchic occupation of land, the extreme poverty of the populations and the insufficient financial means on the part of the public authorities (UN-Habitat, 2001). Indeed, the deprived areas, established without any planning, have a glaring lack of access roads to their breasts. However, the supply of drinking water follows the road network to which they generally adapt. Furthermore, the populations who live in these deprived areas have very low incomes to be able to claim a connection to the drinking water supply network (Mpakam H G., et al, 2006). This situation pushes most of the inhabitants of the deprived areas to resort to decentralized sources of supply (spring and well water) previously contaminated by makeshift latrines and waste water (Kengmoé E., 2013). Access to drinking water is a real concern in the deprived neighborhoods of Melen and Elig-Effa. The immediate consequences are the use of more easily accessible non-potable water sources (springs, wells, rivers and boreholes), hence the health risks. The objective of our study is to take an X-ray of the current state of access to drinking water in the precarious neighborhoods of Melen and

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Elig-Effa, but also to identify the waterborne diseases faced by city dwellers.

II. MATERIALS AND METHODS

A. Geographical Framework of the Upstream Watershed of the Abiergue

The Melen and Elig-Effa neighborhoods that constitute our study area are located in the Yaoundé 6th District. The Melen neighborhood is subdivided into 8 blocks (Melen I to VIII) and Elig- Effa into 7 blocks (Elig-Effa I to VII). They currently cover an area of 103 ha with an estimated population of around 30,000 souls (RGPH, 2005). They are limited to the northwest by Mokolo and the Cité Verte; to the southwest by Mvog Bétsi and Ngoa-Ekéllé; to the northeast by Mokolo and to the southeast by Ngoa-Ekéllé. (Cf. Figure.1).

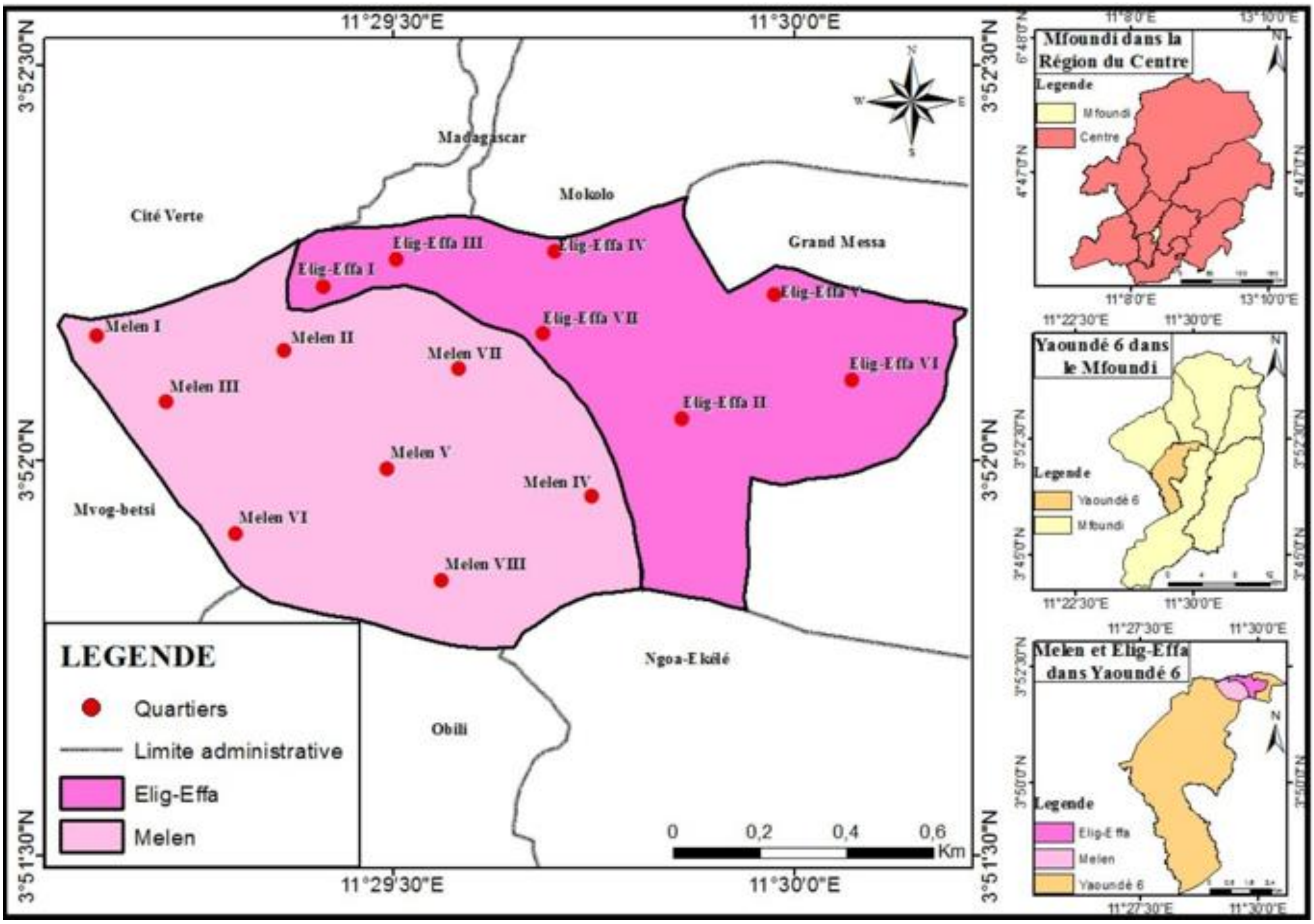

Fig 1: Location of the Study Area
Source: Shapefiles INC, 2018

The city of Yaoundé is influenced by the humid tropical transitional climate characterized by bimodal rainfall with four distinct seasons: a long rainy season from March to June and a short rainy season from September to October but more intense; then a long dry season from December to February and a short dry season from July to August. The average annual temperature is around 23.5°C and the average annual rainfall is around 1,565 mm. During the short rainy season, the populations of the lowlands of the Melen and Elig-Effa districts face numerous flooding problems and the degradation of their living environment due to the rising waters of the *Edjoa Mballa* River and it is also during the same period that the barrel latrines are emptied, hence the water pollution.

Three relief units characterize this site: the interfluves, the slopes and the valleys. The average altitude is 743 m. The lowest altitude (669 m) corresponds to the valleys and the highest part (over 817 m) corresponds to the summit of the study area (Cf. Figure 2). The study area is crossed by the Edzoa Mballa and Mingoé rivers. The altimetry map (see Figure 2) shows the dominant reliefs of the study area. The highest point is located southeast of the Melen neighborhood. It corresponds to 817 m at the level of Melen 8. Further east of the Melen neighborhoods, the altitudes decrease to 669 m at the level of the Edjoa Mballa River. In general, the study site is very hilly and has varied slopes (see Figure 3). This relief determines sanitation and hygiene practices.

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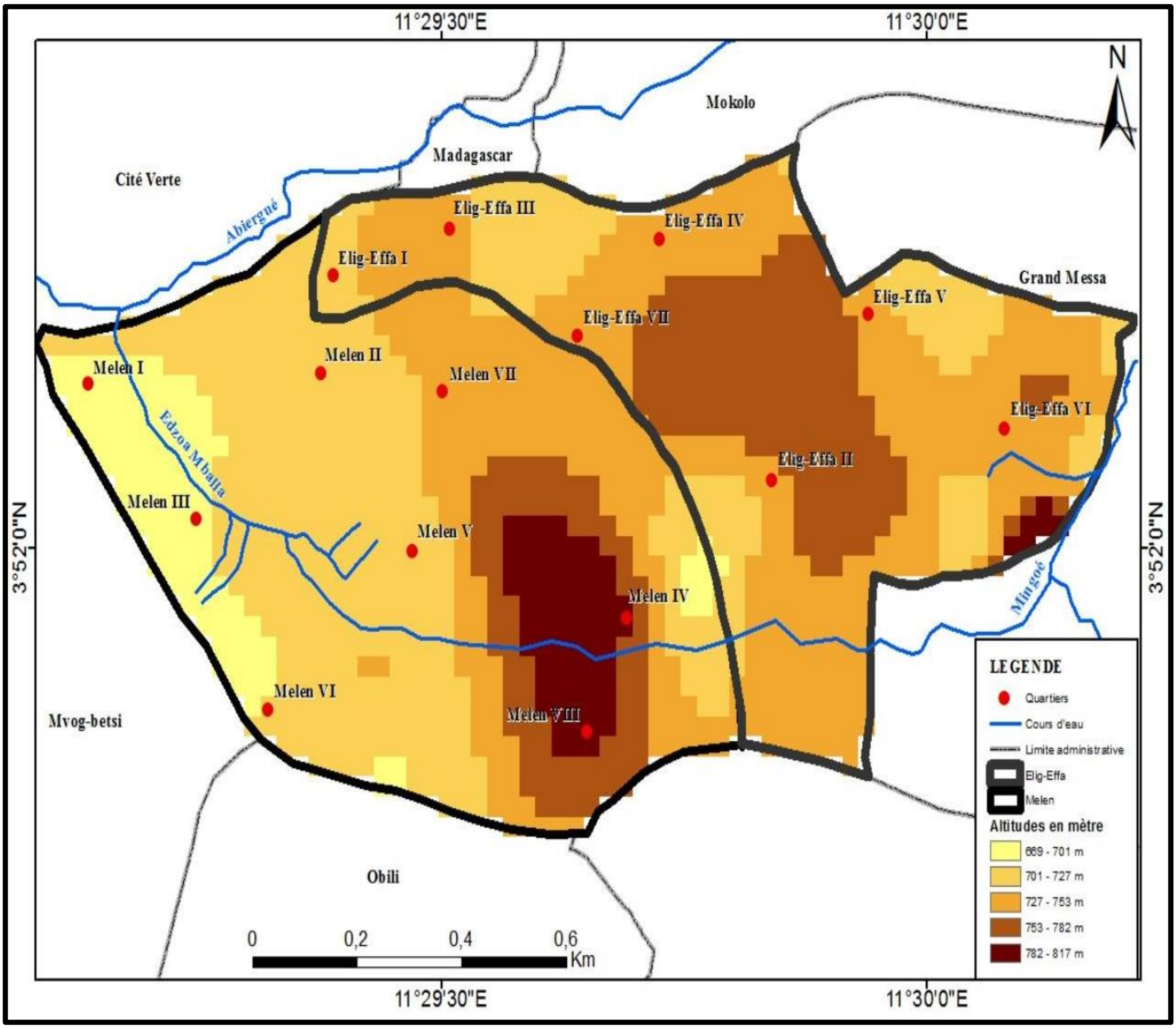

Fig 2: Altimetry of the Melen and Elig-Effa districts
Source: Digital Terrain Model, 2013

Areas with gentle slopes where populations are crowded together are often the scene flooding, stagnant water and accumulation of various waste.

➢ *Depending on the Steepness of the Escarpment, Three Categories of Slopes can be Distinguished:*

- Parts with steep slopes (between 15 and 25%)
- Parts with medium slopes (between 10 and 15%)
- Parts with gentle slopes (between 0 and 10%).

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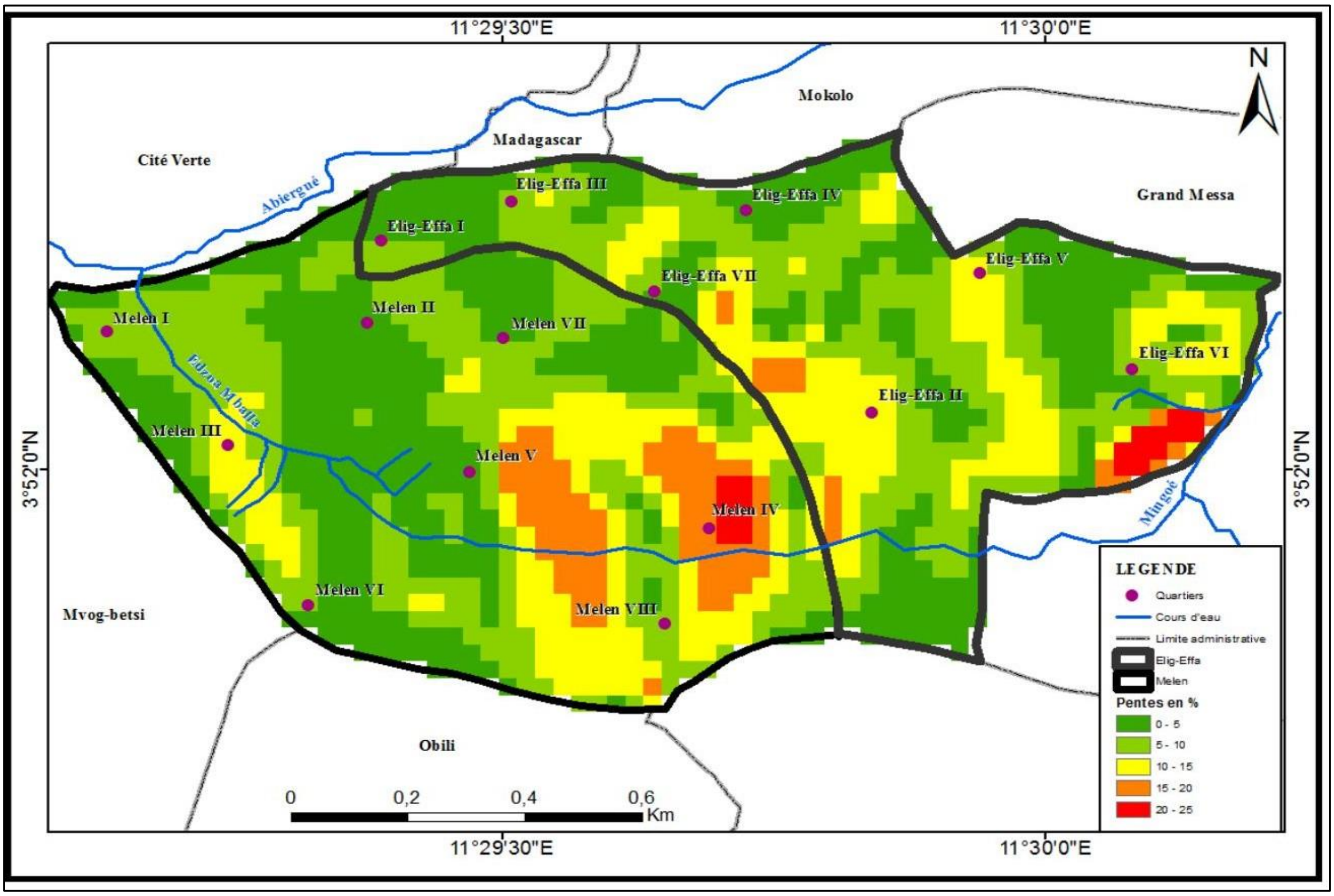

Fig 3: Slopes of the Melen and Elig-Effa Districts
Source: Digital Terrain Model, 2013

Today, in the Melen and Elig-Effa districts, as elsewhere in the city of Yaoundé, there is sparse, poor vegetation, consisting mainly of fruit trees (oil palms, mango trees, guava trees, etc.), floral species and food crops, etc. These different trees are scattered throughout the study area. In the districts, there are several fruit trees. Most of the vegetation, concentrated in the lowlands, is made up of sissongo, imperata, etc.

The Melen and Elig-Effa districts cover an area of 102 hectares. Its main watercourses are: Edjoa Mballa and Mingoé. All runoff waters converge there.

The hydrographic network collects runoff water to ensure the sanitation of the site. Mingoé and Edjoa Mballa have cleared deep valleys where the streams flow.

In general, watercourses serve as natural outlets for all waste generated by residents. The flow of wastewater follows the topography. In the lowlands, several barrel and stilt toilets are built along the watercourses and natural drains. During flood periods, the Edjoa Mballa and Mingoé rivers overflow their beds and carry everything they find in their path. The hydrographic network, despite its low density, plays a very important role in the sanitation process of the neighborhoods.

The environment of populations living in hydromorphic areas is seriously degraded. In general, the physical environment of the study area is very rugged and its consequences on the living environment are undeniable.

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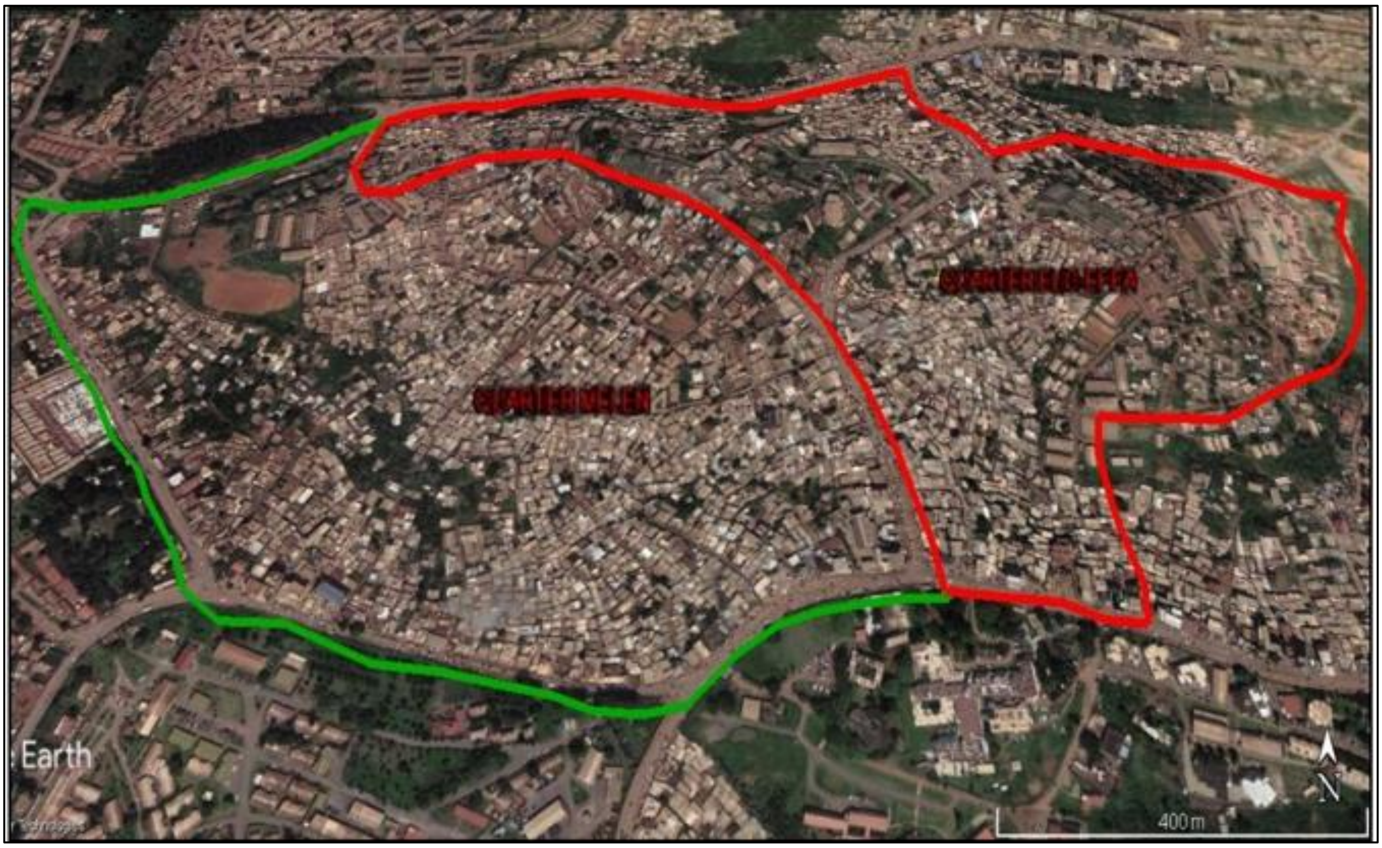

Fig 4: Houses in the Precarious Neighborhoods of Melen and Elig-Effa
Source: Google Earth, 2023

The precarious neighbourhoods of Melen and Elig-Effa stand out clearly from the other neighbourhoods not only because of their age and high population density, but above all because of the anarchic accumulation of buildings (see Figure 4). The situation is increasingly inextricable given the constant population growth and the extensive anarchic occupation of the site. Generally speaking, there is a high concentration of housing from the bottom of the slope to the top, and a relaxation at the level of the interfluves.

This area is inhabited by mainly poor people. Here, the houses are heterogeneous. Houses made of salvaged planks dominate the area. Floods occur regularly during the rainy season. In this neighborhood with precarious housing, the gutters that contribute to the evacuation of waste water are blocked by garbage of all kinds; with a predominance of basic latrines and generally barrel latrines.

III. METHODOLOGY

This study was based on the collection and analysis of secondary and primary data. The collection of secondary data consisted of a documentary research to explore previous work on issues related to water and the health of populations in African cities in general and Cameroonian cities in particular. The primary data were collected in the field in each of the 2 districts AND blocks: field observations, semi-directed interviews, questionnaire surveys and water sampling. Direct observations were useful in understanding forms of sanitation and water supply methods, assessing the condition of sanitation infrastructure (latrines, septic tanks, canals evacuation, etc.) and unsanitary conditions in the different neighborhoods. The semi-directive interviews with the sanitation stakeholders present were carried out with the aim of better understanding their logic and action strategies in terms of household waste management, wastewater and water supply to residents. A questionnaire was administered to a sample of 152 households from the Melen and Elig-Effa districts spread across 15 blocks. The data collected were subject to graphic and cartographic processing in order to spatialize the phenomena and describe the variables studied.

The samples were taken at the various selected points (wells and sources). They were carried out in July 2020. The samples were taken between 8 a.m. and 12 p.m. in one day. The water samples taken from 8 different sources of water supply preferred by the populations (summary wells, improved wells, and springs (equipped) were analyzed in the laboratory to determine their physicochemical (temperature, nitrate, conductivity, pH) and bacteriological (fecal streptococci and fecal coliform) parameters. The water temperature was determined using a HQ14d conductivity meter. The pH was measured using a Hach pH meter (HQ11d). The electrical conductivity expressed in (µS/cm) was measured using a Hach conductivity meter (HQ14d). Nitrate ions ($NO3^-$ (mg/l), were determined by the cadmium reduction method using a Hach DR/2010 spectrophotometer and the values expressed in mg/l. For the enumeration of fecal coliforms, the " colorimetry *on filter membrane* " analysis method was used. After incubation, the colonies are counted and

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their total number estimated by the formula:

$$\text{UFC} = \frac{\text{Nombre de colonies comptées}}{\text{Volume d'échantillon filtré (ml)}} \times 100 \text{ ml}$$

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Where CFU = Colony Forming Unit per 100 ml. The quantification of fecal streptococci was based on the " *filtration on membranes* ". The colonies are counted and their total number estimated by the formula: Where CFU = Colony Forming Unit per 100 ml.

IV. RESULTS

A. Water Supply Methods in the Melen and Elig-Effa Districts

Water supply in the study area mainly concerns two aspects: the Camwater drinking water supply network and decentralized solutions water supply (wells and springs).

➢ *The Camwater network*

The drinking water supply network only exists in the subdivided part of the site (slopes, peaks and interfluves). This network does not allow the entire population to have access to drinking water. The problems of access to drinking water are mainly linked to the cost of connection which varies according to the distance of the applicant households. We can also mention the crowding of houses which blocks the passage of the various pipes. As a result, the majority of families are not connected to the Camwater network. The water deficit of the Camwater is therefore essentially compensated for by water from decentralized supply points such as wells and springs.

➢ *Wells*

In the upstream watershed of the Abiergue, populations without a connection to the Camwater network use three types of wells: Undeveloped Wells, Roughly Developed Wells and Developed Wells.

- *Undeveloped Wells (PNA)*

Undeveloped wells have no safety features or protection of the water resource. Their immediate environment is neither drained nor concreted. Also, the risks of infection of users, contamination of the resource by neighboring latrines, household waste and stagnant wastewater are high. Water from Undeveloped Wells (see Photo 1) is used mainly for household chores (dishes, laundry, cooking, cleaning the house, etc.) and very rarely for human consumption. This type of well is the most widespread in the study area.

Photo 1: Summary Well at Melen III
Photo Essomba, 2020

- *The Summarily Arranged Wells (PSA)*

These are structures that are beginning to be developed with the aim of ensuring relative safety when drawing water and protecting the water resource (see Photo 2). The PSAs are equipped with:

- A coping stone, generally made of rubble or concrete masonry.
- A mound in half-metal or masonry.
- A cover made of precarious material.

Photo 2: Puits Sommaire à Melen III
Photo Essomba, 2020

- *The Developed Wells*

The Developed Wells are structures built according to the rules of the art. They are equipped with safety, comfort, hygiene and resource protection devices. The water from this type of structure, in addition to domestic use, is generally intended for human consumption. In the area, a few developed wells have been identified (Cf. Photo 3).

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Photo 3: Wells Built in Melen 6
Photo Essomba, 2020

In general, in the upper Abiergué watershed, 70.41% of households use well water, while 29.59% do not.

- *Springs*

There are several sources in the neighborhoods of our study area. Still based on the classification proposed by Djeuda HB (2001), we can distinguish: Developed Sources (DS) and Non-Developed Sources (NS).

A. The Developed Springs

These are structures that have benefited from development around the resurgence point of the groundwater table. Some of these structures are equipped with PVC draw-off pipes with a diameter of between 25 and 40 cm. These springs are also polluted by latrines, waste water and wells.

B. Undeveloped Springs

These are basin-shaped groundwater catchment points; with no cover, no sealing device, and even less wiring. This type of structure is generally found in marshy areas. The retention of the water trickle is ensured by the presence of clay soil. The water collected in this type of structure is generally used for household chores and sometimes even for human consumption. In the Melen and Elig-Effa neighborhoods, these springs are polluted by waste water from latrines, domestic wastewater and household waste.

In the studied neighborhoods, 7.4% of households use spring water while 92.60% do not use it. This area is covered by various constructed or natural water points from which populations obtain water for various household needs. The lack of maintenance of these water points and the sanitation conditions abominable in the riverside neighborhoods of the area (stagnation of waste water, poor management. household waste, emptying latrines into rivers and building latrines near wells and springs) increase the risk of contamination of the water used by populations; thus exposing them to various waterborne diseases.

B. Health Risks in the Melen and Elig-Effa districts

In the Melen and Elig-Effa neighborhoods, populations are exposed to various health risks related to the contamination of consumed water. Indeed, on the ground, latrines are built without taking into consideration the security perimeter protecting wells and springs. These built latrines are in most cases close to wells and other water points. Thus, if the water points are not well designed, the water collected will be of questionable quality. The water table that surfaces in the lowlands of the neighborhood is likely to be polluted, and therefore the water from wells or springs as well. The absence of sewers and the presence of latrines with a bottomless bottom are the main factors in the pollution of groundwater. Wastewater discharged into the gutters, in front of the house or on the plots also constitute an additional factor of contamination of watercourses and groundwater in the area.

During the rainy season, well, spring and river waters are mostly polluted by solid waste. This period favors the transport of pollutants, various materials by torrents which deposit them in water points, in this case springs and rivers. Some households immediately dump household waste into rivers. This practice is common in the lowlands, where the *Edjoa Mballa River flows.* During rainy periods, wastewater from piles of rotting household waste contaminates the water table through infiltration. The spatial arrangement of water supply points and latrines and garbage dumps has highlighted a high risk of contamination of surface and groundwater (see Figure 4).

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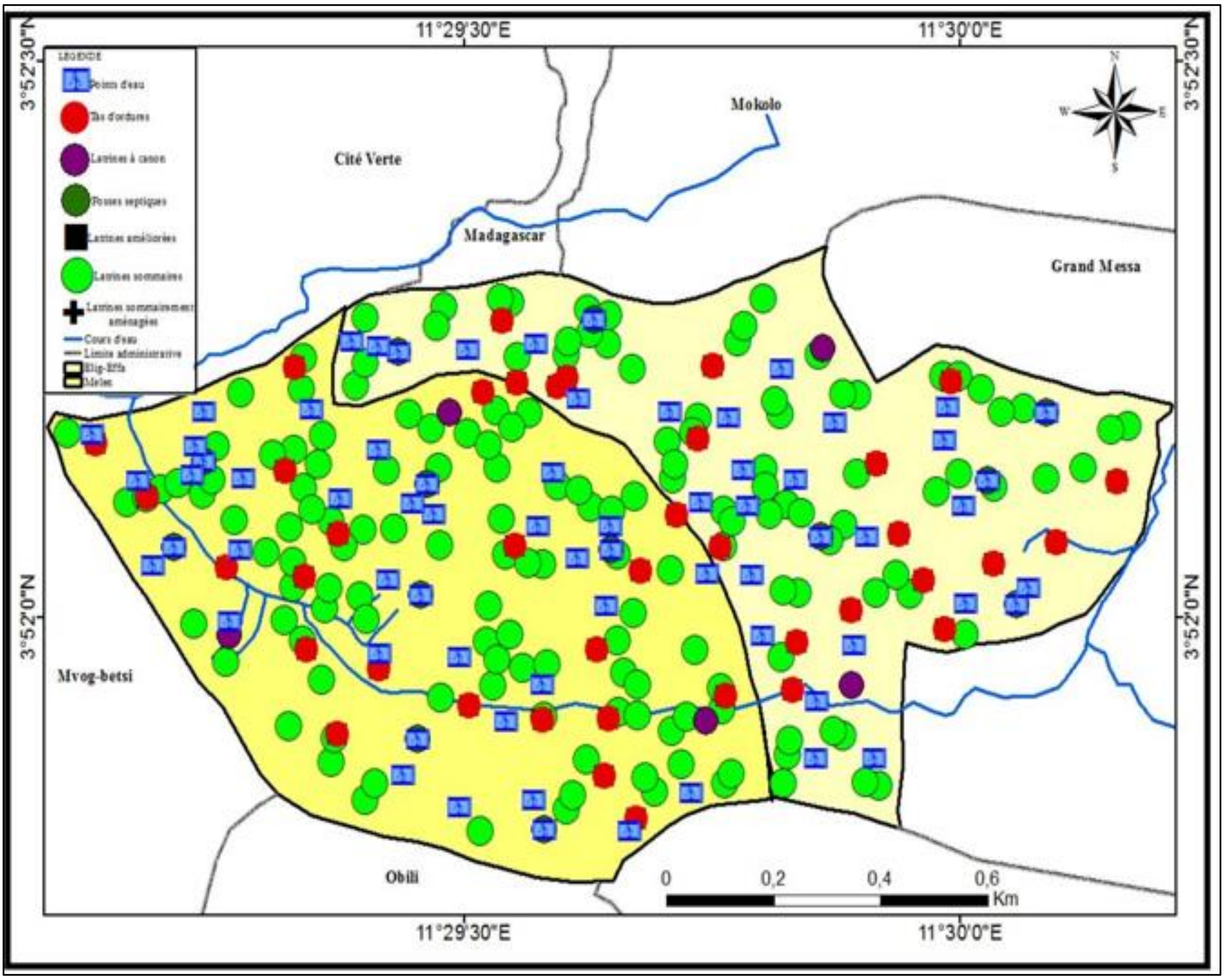

Fig 5: Distribution of Water Points, Latrines and Garbage Dumps on the Site
Source: GPS Surveys, 2020

Due to the promiscuity, pollution is further increased by the fact that the water point, even if it is located in front of the house, is still likely to receive, through the communicating vessel system, microbes from the neighbor's latrines or septic tank. The lack of reliable wastewater disposal systems such as sewers constitutes a danger to the urban environment and a threat to the health of the site's inhabitants. Indeed, wastewater, whatever its origin, is likely to contaminate nearby water sources. The infiltration of household wastewater and sewage can contaminate the water table and consequently the water resource. Groundwater is also contaminated by leaching.

➢ *Physicochemical quality of water in the study area*

The analysis of the physicochemical parameters of drinking water has enabled to attest to the poor quality of spring and well water (Cf. Table 1).

Table 1: Presentation of the Results of the Physicochemical Parameters of Well and Source Waters in the Study Area

Settings/ Samples	Temperature (°C)	PH	Conductivity (µS/Cm)	Nitrates (mg/l)
Summary well of Melen II	27,2	6,12	185,2	3,0
Melen III Well Roughly Arranged	27	6,14	272	3,6
Melen V well	27,2	6,56	600	5,3
Summary well of Elig-Effa II	27	6,11	192	3,1
Elig-Effa III's summarily arranged well	27,5	6,15	281,5	3,7
Elig-Effa V well	27,2	6,5	601	5,1
Undeveloped source of Melen I	26	6,13	199	3
Elig-Effa I developed spring	27	6,66	488	5,5

Source: Waste Water Research Unit, Faculté des Sciences, Université of Yaoundé I, 2020

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The results of the physicochemical analyses (see Table 10) show that the **pH** of the waters of the developed spring of Elig-Effa I and those of the developed wells of Melen V and Elig-Effa V comply with the French pH standard which is 6.5 to 9, that of the WHO of 1986 which is 6.5 to 8.5 and that of Cameroon which is 6.5 to 9. However, the pH of the other water points namely the summary well of Melen II, the summarily developed well of Melen III, the summary well of Elig-Effa II, the summarily developed well of Elig-Effa III and the undeveloped spring of Melen I do not comply with the standard recommended by the WHO, France and Cameroon. The waters have a low mineralization. Even if the **conductivity** values of the sampled waters, which are between 185.2 µS/cm for the Melen II summary well and 600 µS/cm for the Melen V developed well, comply with the Cameroonian standard of 2008, strictly less than 1000 µS/cm, they are well above the water conductivity value recommended by the WHO, strictly less than 250 µS/cm. The conductivities of the waters of the summary wells of Melen II (185.2 µS/cm), Elig- Effa II and the undeveloped spring of Melen I comply with this WHO standard. **The temperature values** of the sampled waters are slightly high (between 26 and 27.5 °C). These are above the French standard which is less than 25°C and the Cameroonian standard of 2008 which recommends a temperature less than or equal to 25°C for drinking water.

The results also indicated the presence **of nitrate** without danger for the populations in the waters of wells and springs studied because their levels are much lower.

- *The Bacteriological Quality of Water*

The analyses were carried out on the basis of samples taken in a single campaign: during the rainy season. These analyses focused solely on the search for indicator germs of fecal pollution (coliforms and fecal streptococci) and produced the following results (see Table 2).

Table 2: The Bacteriological Quality of Water

Settings/ Samples	Fecal Coliform (UFC/100 ml)	Fecal streptococci (UFC/100 ml)
Summary well of	238	11
Melen II	151	9
Melen III Well Roughly Arranged	42	6
Melen V well	301	15
Summary well of Elig-Effa II	112	10
Elig-Effa III's summarily arranged well	39	5
Elig-Effa V developed well	207	13
Undeveloped spring of Melen I	78	4

Source: Waste Water Research Unit, Faculté des Sciences, Université of Yaoundé I, 2020

- *Interpretation of Fecal Coliforms*

The analysis results show that the wells and springs studied have a significant concentration of fecal coliforms. The concentrations are higher in the waters of the summary wells, the summarily arranged wells and the unarranged spring than in the arranged wells and the arranged spring. The quality of the waters coming from these wells and springs highlights the contamination of the groundwater that supplies the populations by leaching from the surrounding latrines.

- *Interpretation of fecal Streptococci*

Our laboratory analysis results show that the well waters and the spring studied have a high concentration of fecal streptococci. The concentrations are higher in the waters of the rough wells, the roughly arranged wells and the unarranged spring than in the waters of the arranged wells and the arranged spring. The mere presence of fecal coliforms and fecal streptococci in water automatically makes it unfit for human consumption according to the standards for water potability recommended by France, the WHO and Cameroon. Fecal coliforms and streptococci come from the digestive tract of warm-blooded animals (Nola, 1998). By deduction, they contaminate the water from wells and springs used by the population through the phenomenon of leaching (Cf. Figure 23) of pathogenic germs and pollutants from the countless surrounding latrines.

The different types of soil in Yaoundé do not have the same permeability and have a great influence on the installation and operation of the different devices. sanitation. G. Bachelier1 (1954) indicate the presence of sandy and sandy clay soils in the lowlands facilitating the infiltration of wastewater and sewage. However, it is in this low area where there is a high concentration of barrel latrines, basic latrines with a lost bottom, etc. close to wells and springs supplying households. In these marshy areas, the soil is unstable, which explains the very frequent collapses of shallow latrines (Nola et al). On the ridges, the infiltration of liquid waste is slow because it is dominated by the layers of otherness (clayey laterite). The water points on the ridges are less polluted than in the valleys.

According to the Cameroonian, French and WHO standards for water potability, the water is not must not contain fecal coliforms and fecal streptococci in 100 ml of water retained.

A microbiological study was conducted in 19982 by Nola et al in the CYA6th (Yaoundé). This microbiological study was conducted on five spring water points and ten well water points. The fifteen study sites were selected in different localities, on the basis of their spatial distribution and their relative importance for the user populations. The isolation of microorganisms was done on selective culture media, using the filter membrane technique. The results show that these waters host numerous bacterial

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communities, including *Pseudomonas aeruginosa, Aeromonas hydrophila,* and indicator germs of fecal contamination. The maximum annual densities undergo spatio-temporal fluctuations and vary from 75 to 9,800, 4 to 7,800 and 3 to 5,800 CFU/100 ml of water respectively for *P. aeruginosa, A. hydrophila* and indicator bacteria of faecal pollution. The densities of bioindicators are strongly linked ($p < 0.01$) to the abundance of *P. aeruginosa* in spring waters and to the abundance of *A. hydrophila* in well waters. The origin of faecal pollution in these water points varies according to the sites and can be human, animal or mixed. Given the high density of bacteria present, consumers of these waters are exposed to short-term health risks.

In 2001, a microbiological and chemical study was conducted by Nola et al for one year on spring and well water in Yaoundé. Microbiological analyses were carried out using the membrane filter technique, and chemical analyses were carried out using standard analytical techniques. The maximum monthly abundances of *Pseudomonas aeruginosa* and *Aeromonas hydrophila* ranged from 1 to 22x103 CFU/100 ml-1, respectively of water, and from 1 to 7.8x103 CFU/100 ml-1. The spring and well waters analyzed are weakly bicarbonated, soft and have a weak to medium mineralization. The pH varies from 3 to 5.

A bacteriological study (Nola et al 2012) of spring and well water was carried out over a period of one year in the city of Yaoundé. This study aimed to determine the rate of fecal coliforms and fecal streptococci in these groundwater's. The monthly density of fecal coliforms and fecal streptococci varies respectively from 1 to 72 × 102 CFU/100 ml-1, and from 1 to 31 × 103 ml-1 in the waters.

V. DISCUSSION

The uncontrolled urbanization in the Melen and Elig-Effa neighborhoods in Yaoundé and the poor hygiene and sanitation conditions are at the origin of the precariousness of the living conditions of the populations and the increase in their vulnerability to health risks. The work carried out by Kengne N. (2000) is consistent with the observations made in the field. when they show that poor management of solid and liquid waste leads to health problems for populations and unsanitary conditions in cities. In receiving areas such as rivers and groundwater, natural water becomes unfit for consumption. The studies by Ngnikam E., et al (2007) in the Mingoa watershed in Yaoundé, on the causes of diarrhea in children under 5 years of age, highlight the fact that these diseases are directly linked to poor hygiene and sanitation practices. The method of sanitation (latrines, septic tanks, and sumps), and the state of finishing of the structures have a significant influence on the frequency of diarrhea.

In terms of drinking water, in general, their observations show that all households are aware of the risks of contracting a waterborne disease following the consumption of dirty water, but they are unaware that certain habits lead to water pollution. Assako Assako et al. (2006) agree by showing that the human concentration, in the limited spaces of cities presents real and worrying health risks due to the proliferation of precarious neighborhoods, almost generalized urban poverty associated with the inadequacy of sanitation systems, waste management, hence pollution of water resources. This point of view is also shared by Wethe, J. et al. (2003) when he argues that the multiplication of waterborne diseases in African cities is accentuated by the pollution of water resources. These waters carry a multitude of pathogenic germs for humans and are responsible for many epidemics. The most recurrent diseases are epidemics of dysentery and cholera. The studies of Talom S. (2009) also show that in the precarious neighborhoods of Yaoundé, there are different types of toilets, namely traditional latrines with a lost bottom, and barrel latrines which are generally very polluting and contaminate water resources. The work of Mougoué B. et al. (2012) in the city of Yaoundé also demonstrates the proximity of wells and latrines which promotes the lateral and vertical transfer of coliforms and fecal streptococci contaminating both the groundwater and surface water.

VI. CONCLUSION

The health of populations is closely linked to the quality of the products consumed and the living environment. The study of health risks linked to access to water in the districts of Melen and Elig-Effa revealed the existence of several methods of water supply by the populations, in particular the Camwater distribution network for wealthy people with the means to obtain a connection. The majority of poor populations obtain their water mainly from wells and springs that may or may not be developed and from paid standpipes. Poor management of household waste and wastewater; transported either by runoff water to the bed of watercourses or by infiltration water to the water table, as well as the construction of barrel latrines opening into watercourses and with a lost bottom near wells and springs contribute to the contamination of surface and groundwater. The consumption of this water by populations exposes them to various waterborne diseases. The physicochemical and bacteriological analyses carried out at different supply points (developed source, summary well, developed well) in order to determine the quality of these waters showed that the conductivity values are 185.2µS/cm for the summary well of Melen II, 272µS/Cm for the summarily developed well of Melen III, 600 for the developed well of Melen V, 192 for the summary well of Elig-Effa II, 281.5 for the roughly arranged well of Elig-Effa III, 601 for the arranged well of Elig-Effa V, 199 for the unarranged spring of Melen I and 488 for the arranged spring of Elig-Effa I. These values are well above the normal threshold of water conductivity recommended by the WHO (250µS/cm). The temperature values which are between 26° and 27.5° do not comply with the potability standards issued by France, Cameroon and the WHO (below 25°). The results also indicated the presence of nitrate without danger for the populations in the waters of the wells and springs studied because their levels are well below the standards recommended by France (ÿ50 mg/l), by the WHO (<44 mg/l) and by Cameroon (ÿ50 mg/l). The results of the bacteriological analyses show a high concentration of fecal coliforms and streptococci. The concentrations of fecal coliforms are higher in the waters of the summary well of Elig-Effa II

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(301 CFU/100 ml maximum) than those of the summary well of Melen II (238 CFU/100 ml maximum), the roughly arranged well of Melen III (151 CFU/100 ml maximum), the unarranged spring of Melen I (207 CFU/100 ml maximum), the roughly arranged well of Elig-Effa III (112 CFU/100 ml maximum), etc. These waters also show a high concentration of fecal streptococci. In the waters of the wells and springs studied, the values are between 4 CFU/100 ml maximum and 15 CFU/100 ml maximum. In light of these results, it appears that the water on the site is unfit for consumption and likely to harm human health.

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