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Availability, Accessibility And Modes Of Drinking Water Management In The Commune Of Aguegues, South Of Benin

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***Abstract*—The purpose of this study is to analyze the availability and accessibility of water for domestic use, and to study drinking water management methods and their impact on the health of populations in the lakeside municipality Aguégués, south of Benin.Access to drinking water is difficult in the municipality of Aguégués. There is a lack of water points (boreholes and modern wells), waiting time and long distances to get water. Consequently, the average volume of water used per day per capita is relatively low and even below the standards advocated by WHO for nearly 94% of the population of this municipality leading to health risks. The methodology used takes into account the literature search and the field survey. In almost 40% of the households surveyed, at least one person had diarrhea in the two weeks preceding the survey. The prevalence of waterborne diseases in this Benin commune is mainly related to people's behavior in water management, hygiene and family sanitation. There are 3077 cases of diarrheal disease annually and 850 cases of cholera**

Keywords—Municipality of Aguégués; Accessibility to water; Management of drinking water; Waterborne

1.INTRODUCTION

The management of water as a natural resource is a matter of concern for many states. The OECD (full name) report highlights this issue and insists that special attention should be given [1]. The shortage of drinking water is aggravated by the increase of the population and consequently of the needs of drinking water and other uses (agriculture, breeding, industries...)[2]. People living in rural areas and urban periphery are forced to collect unconventional water sources that are true sources of contamination due to the shortage of safe drinking water

The "water decade, a source of life" is part of achieving the Millennium Development Goals (MDGs), which aims to halve the number of people without access to water safe water or basic sanitation until 2015. In Benin, despite the progress made in setting up drinking water supply facilities resulting in the existence of more than 22,000 collective water points in 2012, a significant proportion of the population still uses alternative sources (traditional wells, cisterns, private water points, etc.) as their drinking water supply. Health statistics indicates that - diarrheal diseases constitute the fifth cause of consultation in health centers (SNIGS, 2016) [3] for children under 5 in Benin.

The geographical location, climate and relief of certain regions are also factors that are not conducive to achieving this objective. As in some areas of Benin, much more effort is needed in the commune of Aguégués which is essentially lacustrine in the department of Ouémé. This municipality is subject to severe seasonal floods during periods of flooding from August to November [4].

The small tongue of land that connects the municipality to the plateau through the district of Avagbodji is its only non-lacustrine area during floods [5]. This situation makes it difficult for people to live with hygiene and sanitation. Among basic social services, water is one of the most requested services in the area [5].

II. MATERIALS AND METHODS

A Study zone

The lakeside municipality of Aguégués, with an area of one hundred and three (103) km², is located southwest of the department of Ouémé between 6 ° 30 'north latitude and 3 ° 30 east longitude.

It is a set of islands of alluvial accumulation housed in the lower part of the Ouémé River submerged by floods of three to five months per year and limited:

- in the north by the communes of Dangbo and Akpro-Missérété;
- to the south by Lake Nokoué and the municipality of Sèmè-Podji;
- in the east by the Porto-Novo Lagoon and the municipality of Porto-Novo;
- and to the west by Lake Nokoué and the lake district of Sô-Ava.

The inhabited area extends about 500 m wide along the Ouémé river.

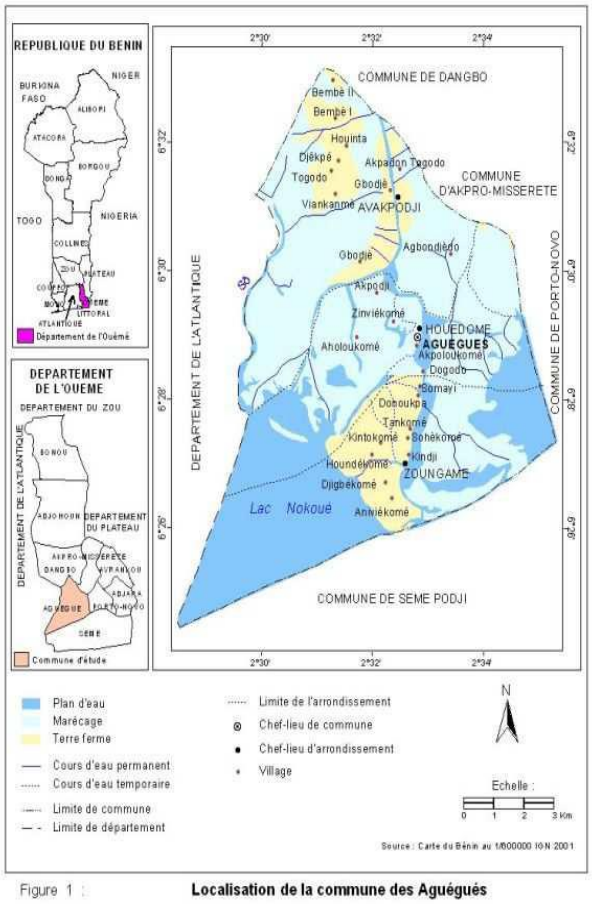

Figure 1 : **Localisation de la commune des Aguégués**

Figure 1: Geographic location of the Aguégusés Commune.

The lakeside municipality of Aguégués has a humid tropical climate characterized by two (02) rainy seasons and two (2) dry seasons of unequal size. The seasons are as follows:

- a long rainy season (April to July);
- a small dry season (August to September);
- a small rainy season (October to November) and finally a long dry season (December to March).

The main river that crosses the Aguégués is the Ouémé delta. This town is the berm and the vast swampy bottomlands that separate the lagoon of Porto-Novo and Lake Nokoué. The grand canal of Totchè is its dividing line in the South with the municipality of Sèmè-Podji.

The commune of Aguégués is a lakeside city which counts 03 districts composed of 21 villages. It is a rural community with 5874 households for a population of 44562 inhabitants at RPGH-4 2013 with an average household size of about 06 members per household. The annual growth rate is 3.69% compared to 3% nationally. This fact is justified by polygamy and the forced and early marriages observed in this environment.

B Data collection phase

1. The field survey

To reach the objectives of the study, we collected necessary data based on quantitative and qualitative approaches during field survey.

For this purpose, the questionnaires, the interview guide and the observation grids are drawn up. The field survey was carried out in the three districts of the municipality of Aguégués. The nine (09) investigators who have been well trained before the investgation conducted the field investigations. **How many were interviewed?** The interviews were conducted in the local language spoken by the surveyed populations and generally lasted between 1 and 1:30 am. The choice of households was made by the random walk method with an interval of three. In this survey, the household defined in relation to drinking water management is usually composed of a woman with her husband and their children. The person responsible for the management of drinking water, in most cases is a woman and she answered the questions. The questionnaire included questions relating to psychological factors (measured on a scale of 0 to 1 and -1 to 1) related to the transport, storage and consumption

of drinking water and hand washing as well as information on latrines and socio-demographic data. In addition, data on household and food hygiene were collected during a rapid observation. A pretest of the questionnaire took place before the start of data collection.
An inquiry was also made to the Directorate General of Water (DGEau) to get an idea on the coverage of drinking water on the one hand, and in the health centers of the study area to get an idea about the frequency waterborne diseases to which the population is exposed on the other hand.
Free or direct observations were made to verify information collected by questionnaire based on facts and practices, such as hand washing, watering, storage, transport and treatment of water, activities around water points.

2. Processing and statistical analysis of data

At first, the frequencies of the measured behaviors were calculated and two groups were distinguished each time. A group of people with behavior (to a high degree) and the second group who do not (or to a lesser extent) have been taken into account. Subsequently, the averages (M) of the related psychological factors were calculated for the two behavioral groups and compared to each other. To test the significance of the difference between these averages, t tests were applied. Similarly, the magnitude of the effect (r) of this difference was calculated. Psychological factors whose difference in means between the two behavioral groups is significant and the size of the effect is greater than r = 0.4 (r = 0.3 means an average effect, r = 0.5 means a large effect) have been taken into account in the proposals intervention strategies.
The counting of the survey cards was done manually. The results from this recount constituted part of the database used. The data collected in the specialized agencies and in the field completed this first part of the data. The coded data was processed using the Excel spreadsheet.

The different samples taken by source of water supply were conditioned and then assayed in the laboratory. It was then possible to establish a matrix of physicochemical parameters, the lines of this matrix representing the different sources of water supply prospected and the columns, the physicochemical parameters. This matrix has been subjected to Principal Component Analysis (PCA) to describe the links between water sources and physico-chemical parameters.

In addition, in order to verify whether or not the water produced by the water supply is compliant with national and WHO standards, Student's t-tests with a sample or failing Wilcoxon tests at a sample (when the normality of the data was not verified) was achieved. For these statistical analyses, the error of type I (α) was fixed at 5% to guarantee a good accuracy of interpretation.

Regarding the bacteriological quality of the water, the concentrations of different bacteriological organisms were determined. This made it possible to construct box plots (similar to boxes with mustaches) to illustrate the distribution of bacteriological organisms in the water produced by the water supply sources studied. All statistical analyzes were performed in R version 3.2.2 software.

The data on the amount of water used by each individual per day, the distance from the water point to the concessions, are compared to the standards of the World Health Organization to assess the availability, accessibility, water management and its impact on people's nutrition.

III. RESULTS AND DISCUSSES

3.1 Sociodemographic variables

The sample concerned 98.7% of women. Respondents are between 15 and 89 years old (M = 35.99, SD = 13.1). 75.4% have no formal education compared to 82.7% who cannot read or write. Christianity was the most represented religion among respondents with 55.9%, followed by Islam (30%), Vodou (13.3%) and other animist religions (0.9%).
More than two-thirds of those surveyed indicated that fishing, agriculture and livestock were the main occupations. , trade or food processing (Figure 2). Other no less important activities such as trade, crafts, transport and fuelwood are also observed in the study environment.

3.2. Water accessibility in the commune of Aguégués

3.2.1. Sources of water supply

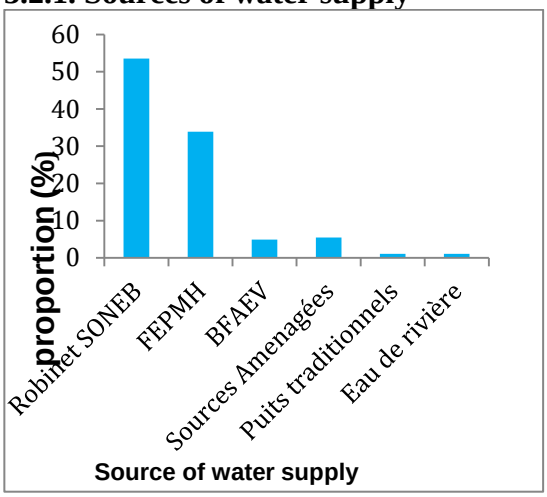

Figure 2: The main sources of water supply. Source: Field Survey Result, 2015.

An examination of Figure 2 reveals that 54% of surveyed households use SONEB waters compared to 34% who handle FEPMH waters and 5% use fountain water connected to EVAs. 5% of households use managed spring water, 1% for traditional well water and 1% for river water. It is easy to see that some households in the localities surveyed still use river water and traditional wells for different domestic uses. It also emerges from this observation that the waters provided by the conventional sources of SONEB and FEPMH are much more solicited by the population.

3.2.2. Evaluation of the volumes of water used per inhabitant daily.

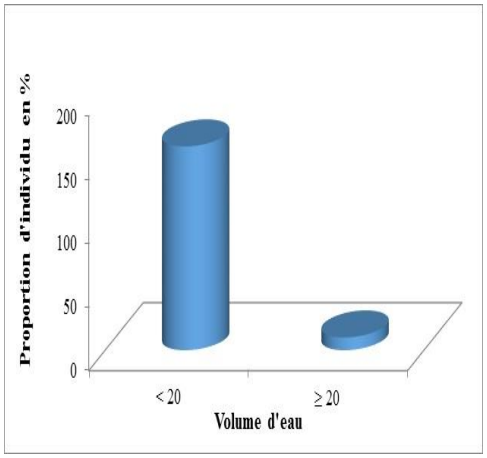

Figure 3: Presentation of the volume of water used per day and per capita. **Source:** Field Survey Result, 2015.

The careful study of Figure 3 leads to the correct conclusion that the inhabitants of almost all the households surveyed (94.12%) use less than 20 liters of water per day for different household uses. Only 5.88% have a quantity of water greater than or equal to 20 liters per day. The quantity consumed may be due to the difficulties experienced (time and distance) for the drawing. In this environment people do not wash themselves twice a day.

3.2.3 Distance between households and water points of dwellings

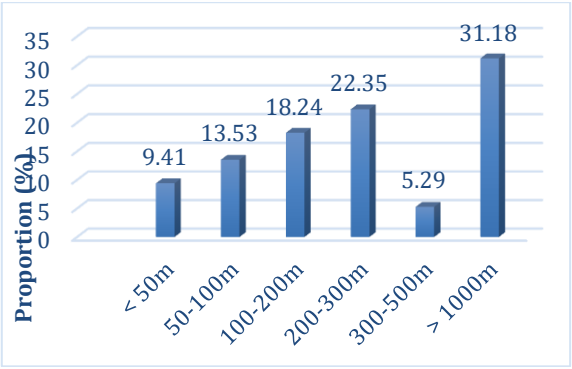

Figure 4: Distance from water points to dwellings. **Source:** Field Survey Result, 2015.

Figure 4 estimates the distance between water points and dwellings by household surveyed. The observation of this figure shows that 41.18% of respondents survey less than 200 meters to access the water works. However, nearly 28% estimate that they travel at least 200 to 500 meters to stock up while 31.18% travel more than 1000 meters. It is still considerable distance. This could justify the small amounts of water consumed per day.

3.2.4. The time taken to fetch water

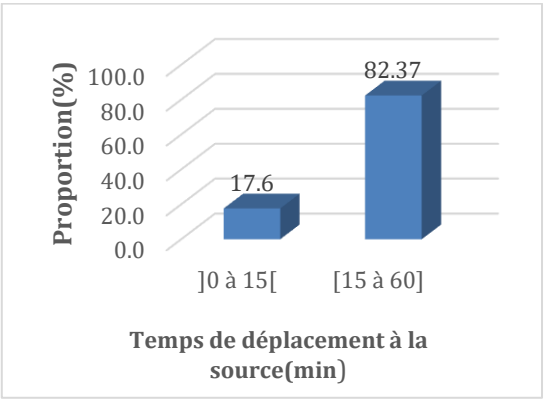

Figure 5: Travel time to water source by households. **Source:** Field Survey Result, 2015.

The observation of the figure shows that 17.63% of the surveyed households are less than 15 min to fetch water. In contrast, 82.37% of households use 15 to 60 minutes to obtain water. This situation perfectly illustrates the insufficiency of the number of water points or their bad spatial distribution.
In addition, of the households surveyed, 81.76% find that they save time by buying from the river instead of going to the pump or the standpipes while only 18.24% find that they prefer the waters of the pumps.

3.3. Management of drinking water by the population

3.3.1. The transport of water

The transport of drinking water by the population is done either in basins or in cans or buckets without lid. To clean the transport containers, 33.18% of the respondents use simple water. 65.12% use water and soap and only 1.7% use bleach (a disinfectant). The washing frequency of these transport containers varies by household. Thus, 19% rarely wash them against 63% wash them a few times and 18% wash them sometimes. However, all respondents know that not washing the container very often is a risk of water pollution.

3.3.2. Water conservation

All the households surveyed proceed to a storage of water before consumption. The means used to do this differ from one household to another and are divided according to the material (jars, cans and buckets) used for the conservation of water (Table I).

Table I : Distribution of storage equipment for drinking water

Number of households		Percentage
Jars	55	32,35 %
Cans	40	23,53 %
Buckets	75	44,12 %

The analysis in Table 1 shows that 32.35% of the surveyed households keep drinking water in jars. 23.53% and 44.12% respectively use cans and buckets inside dwellings. In addition, among respondents, only 33% often wash their storage containers while 77% wash containers a few times or rarely.

The shelf life of drinking water varies by household. Only 18.24% of households keep the water for 24 hours against 81.76% who store water for a period ranging from 2 to 15 days. This long shelf life combined with the low frequency of washing the storage containers probably has an influence on its quality.

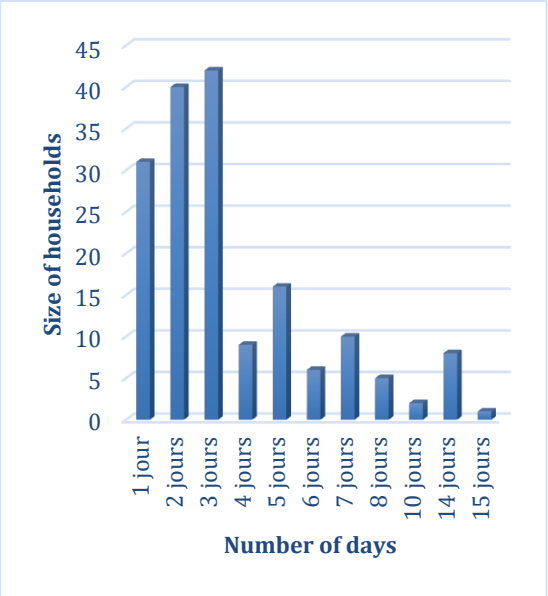

Figure 6: Duration of water conservation by households. **Source:** Field Survey Result, 2015.

3.3.3. Methods of water treatment.

Of the respondents, only 10.59% say they treat water before drinking. The others do not care about it, no matter where the water comes from and say the water is clean.
The treatment methods consist of boiling, heating, disinfection by Aquatab and filtration. For respondents who treat water, 39% opt for boiling, 17% for heating, 22% for Aquatab and 22% for filtration. As a result, few of them practice an effective method that effectively destroys pathogens.

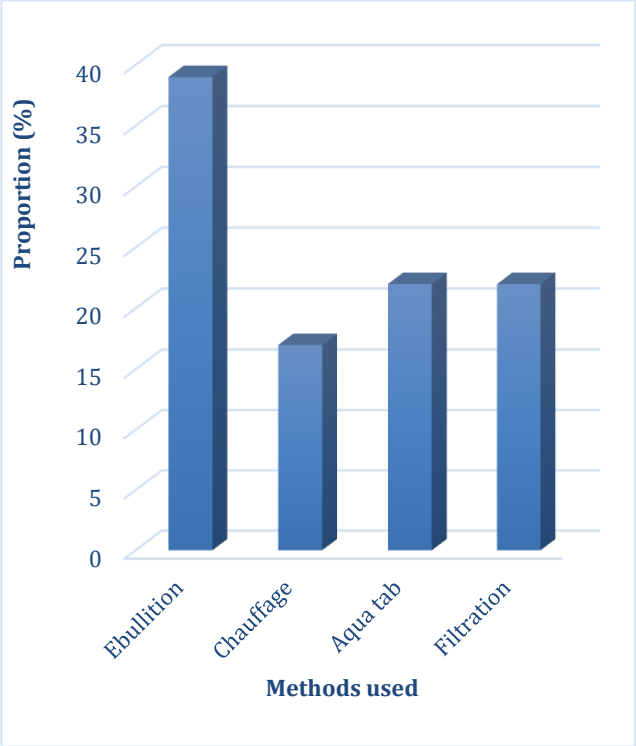

Figure 7: Water treatment methods. **Source:** Field Survey Result, 2014.

3.3.4. The utensils used to collect and drink water.

Results from surveys show that 61.76% of households use cups to drink water compared to 38.24% who use bowls. In almost all households, the same container is used by several people. All the households surveyed wash the containers used to drink water. The washing frequency varies from one household to another. Only 32.94% wash them almost always. More than two-thirds wash them seldom, sometimes or often.

3.4. Listed waterborne diseases

The morbidity rate for diarrheal diseases in a given year indicates the number of cases of diarrheal diseases per population unit. The examination of the health statistics in Table II indicates that the lakeside commune of Aguégués has a number of cases related to diarrheal diseases three times higher than the municipality of Porto-Novo. The commune of Porto-Novo is one of the municipalities at risk for cholera. These same statistics reveal that in 2016, Porto-Novo recorded 86% of cases of cholera in its health zone against 24% of this same case nationwide.

Table II : Data on diarrheal diseases and cholera between 2007-2016

years	Aguegues	
	Diarrheal diseases	Cholera
	Cas	Cas
2007	2982	914
2008	3034	1125
2009	3487	869
2010	3323	1071
2011	3305	1062
2012	2776	754
2013	2494	491
2014	3171	869
2015	3033	1071
2016	2147	519

Source: DDS / OP Health Statistics Yearbooks, 2016.

The water consumed is a source of many diseases. Of the 468 households surveyed, 47% reported having at least one case of diarrhea in the last three months prior to the survey. The different conditions that have been reported by households are shown in Figure 12.

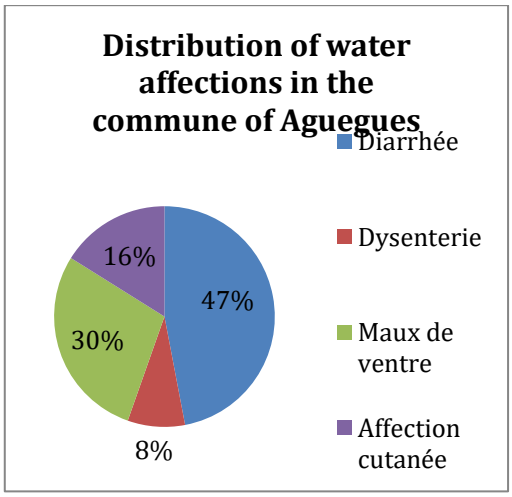

Figure 8: Main household-reported diseases, 2014 Source: Field survey result, 2015.

An analysis of the data in Figure 8 showing the main household-reported illnesses from our surveys reveals that 84% of reported conditions

are likely to be caused by the consumption of polluted water (Diarrhea, dysentery, stomach ache). The most common water condition is diarrhea (47%).

Discussion

Domestic water is needed for drinking, cooking, personal hygiene and food hygiene. All these elements help to guarantee the nutritional status of a person. Drinking water is crucial for human nutrition. In some countries, water itself is considered a nutrient and is therefore treated by the same standards and regulations as food. The results of the study show that the populations surveyed in the municipality of Aguégués use the majority of water from conventional sources (the national water company of Benin (54%), drilling (34%), bollard (5 %), managed sources (5%), and to a lesser extent those from alternative sources (traditional wells (1%) and river (1%)) to cover their water needs. The availability and accessibility of this precious resource have been evaluated in seventeen (17) out of the twenty-one (21) villages in the Aguégués commune. Accessibility according to WHO is defined in terms of the availability of the resource, permanence, distance between the household and its water point and its quality.

It should be remembered that the distance to the water point is a first order given that it partly determines the quantities available for domestic use and for hygienic purposes in particular. In the commune of Aguégués, in the dry season as well as in the rainy season, households travel an average of 700 meters to obtain supplies directly from collective water points. However this figure hides great differences depending on the habitat area. Thus, it is necessary to go by canoe, only 25% of households have access to good quality water, in reference to the typology of Howard and Bartram (2003), having a drinking water point to 100 meters or less of the dwelling. Half of the households in these two lake districts have a water point 200 meters or less from their residence, whereas this median value in the unplanned periphery is 400 meters. However, a study in Bangladesh conducted by Prost in 1996 showed that beyond a distance of 200 meters between the dwelling and the fire hydrant, the health impact of the water supply ceases to be sensitive.

The results of this research reveal that only 41.18% of populations travel less than 200 meters to access water. Comparing this distance with the WHO standard (200 meters), it can be said that households in Aguégués commune do not have easy access to water supply points. Only 41.18% of households have reasonable access to water. Referring to the typology of Howard G and Bartram J (2003) [6] that reasonable or relatively good accessibility to water is defined as having a drinking water source at 100 meters, we find that only 23% of households have easy access to water.

The water sources used by the people surveyed were observed by focusing on the presence of excrement, the presence of waste and the presence of animals. The existence of a roof above and the existence of a grid around the source were also examined. Waste around the water source is the most problematic. Very few sources are protected by a roof or perimeter security fence. With regard to the volume of water used per day and per capita, the results of our study reveal that only 5.88% of households use at least 20 liters of water per day for basic needs. Comparing this value with the WHO standard (20 liters), we can reaffirm that households in Aguégués commune do not have access to a sufficient quantity of water. This is explained by the fact that households travel long distances by canoe to access water. For Kombassere (2007) [7], all the constraints that households face daily affect the amount of water actually consumed per day per person. However, the low average volumes of consumption could have important health consequences, especially diarrhea. Interventions to improve the amount of water available per person per day have more positive impacts on diarrhea control than those that advocate for supplies that meet high standards of purity (Cairncross S., 1990, cited by Curtis V. et al, 2000) [8]. Several studies confirm the preponderance of the quantity of water available in relation to its quality in reducing the prevalence of diarrhea (Esrey S.A. et al, 1991, cited by Curtis V., et al, 2000) [8]. To be convinced of this, it is important to quote Satterhwaitte D. (1995) [9] who assesses the impact of the lack of water on the environmental health and the health of populations quite well in these terms: "The time and effort required to

transport water a significant distance means that the further away the source is, the less water will be used (...). The limitation of this quantity means, in turn, a lack of water for washing and personal hygiene, as well as for washing foodstuffs and kitchen utensils". Insufficient water creates conditions that allow the development of diseases related to fecal peril, including diarrhea. The inhabitants of the study area consume less water overall. This low volume of water consumed per person per day highlights the acute problems of water supply. The time taken to collect water is mentioned by 81.76% of households. This declaration perfectly illustrates the insufficiency of the number of water points or their bad distribution in the commune of Aguégués. Difficulties of exhilarating the water to the drilling can be considered as a factor aggravating this insufficiency.

91.40% of the people surveyed use a can of transport of drinking water compared to 7.7% who use a basin. This container used to carry water in the majority of cases is not easily washable and could retain microbes. A bucket with lid for the transport of drinking water is used by 1.7% of respondents. Yet 13.3% of respondents have a bucket with lid that could be used for transporting drinking water. The volume of containers is usually 36 liters (40%), 35 liters (13.5%), 30 liters (14.3%) and 25 liters (16.8%).

For example, the average filling time of a 30-liter can with drilling is estimated at two minutes against 20 seconds at the fountain. Long queues at standpipes or boreholes equipped with a human powered pump mean time and fatigue, especially for women who are most often in charge of the chore some water. In addition to its corollary of under-consumption, this waste of time prevents women from going about other occupations likely to improve their living conditions. During transport, populations by their behavior contribute to the pollution of water.

In more than two-thirds of households, transport containers are poorly maintained. Almost 70% of the respondents do not clean the drinking water container before going for drinking water. Only 9 people (1%) clean it at the water point, before taking water, which would be ideal for transporting water in a clean container. If the container is cleaned at home, it could get soiled again on the way from home to the water source.

However, the poor hygiene conditions of these containers present a risk of water pollution. For Adjadjo (1998) [10], in Africa, uncontaminated water at the source quickly loses its original quality from transport to home storage. For him, the factors of this pollution are among others the use of unwashed containers. In addition, the use of basins used by households is a risk of pollution. Insofar as these containers are not covered, they are exposed to dust and flies. Generally without handles, they are hoisted on the head so that fingers can soil the water. This practice exposing water to fecal pollution may pose a risk of diarrhea and other waterborne diseases observed in the area. In fact, a recent WHO study of 400 households in a refugee camp in Malawi indicated that the mere fact of using a covered container with a spout significantly reduced water contamination and reduced water consumption 31% of cases of diarrheal diseases in children under five (WHO, 2007) [11]. In addition, the results of the study show that 81.76% of households conserve water for a period ranging from 2 days to 15 days. This long duration of water conservation further influences its quality. It is also noted a lack of hygiene of the storage containers. According to Monjour L (2006) [12], if the water is drinkable when collected at drinking water points (0 CF / 100 ml), it becomes a true microbial broth in storage jars (30 000 CF / 100 ml). A 2017 study by Requillart found that 100% of the beakers and 62% of the storage vessels had a fecal coliform pollution rate of more than 206 units per 100 milliliters, despite a drinking water supply (Requillart JC, 1985). [13] According to Ouedraogo FC (1993) [14], it is the man who by his ignorance and / or lack of hygiene directly and indirectly ensures the pollution or contamination of water.

For Kombassere (2007) [7], distance is a risk of water pollution. For Prost (1996), the risk of pollution of water increases simultaneously with the distance from the water point. Many studies such as Kombassere have shown that households contribute to the degradation of water quality. According to Kombassere (2007) [7], the storage of drinking water is an important step in the preservation or degradation of water quality.

Only 26% of households have access to a latrine. Of these, almost all are frequent (95%). Adults use it much more frequently than children.

4. Conclusion

The transport and hygienic storage of drinking water and the washing of hands with soap and water at critical moments are important behaviors to reduce the rate of diarrhea. However, the results concerning the state of health and the behaviors studied show the importance of a change of attitudes towards hygiene in the population. Several psychological determinants of the hygienic behaviors studied have been identified and intervention strategies designed to influence them favorably have been defined.

Apart from the behaviors studied, access to a latrine or household waste management has also proved problematic and it would be important to carry out further studies to find a solution to this problem.

This study assessed availability, accessibility, water management and its potential impact on nutrition.

The analysis of the data shows that the populations of the town of Aguégués do not have easy access to drinking water. The conditions of access to water remain marked by several constraints that are the long time to stock up and the long distances traveled.

These different constraints significantly reduce the amount of water used by residents daily. This lack of safe water near households has a lot of effects on nutrition. In many cases, households have no choice but to drink unhealthy water from unprotected sources. This situation does not allow good food hygiene practice. In households, the non-washing of hands, the duration of storage of drinking water, the lack of coverage of storage containers and the low frequency of washing of storage containers are major indicators of the risk of pollution of the water. The use of this water for hygiene and food preparation will make them dirty. Its direct consumption by the population is at the origin of the waterborne diseases recorded in the commune.

This research paves the way for a more general reflection on the need to develop new approaches for better access to drinking water in lake environments.

5. Recommendations

a. The various authorities include in the contract farmers and / or managers of the AEP sources the obligation to maintain the equipment and organize the monitoring and evaluation of the actions. Therefore, the obligation must be made to the producers / water distributor to develop and implement the Water Safety Management Plan (WSSP). Different authorities must also encourage people to change their behavior to adopt good hygiene and sanitation practices.

b. Incorporate a technical sheet for the regular cleaning of the interior of the pump spouts in the WPM SWMP development guide.

c. Study the possibility that all new AEVs to be realized are equipped with a reliable system of continuous chlorination.

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Photo 1: Use of river water by the population

Photo 2: Children bathing in the river

Photo 3: Human-powered drilling

Photo 4: People around a human-powered borehole, each waiting for his turn