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Physico-chemical and microbiological characteristics of water for domestic use in Cotonou in the republic of Benin

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Abstract

Water is the source of life. It is essential for the survival of all living things. However, its alteration becomes harmful to humans. In Cotonou, the main city of Benin, the quality of drinking water is worrying because of many factors such as environmental pollution and poor hygiene around water sources. In fact, poorly ecological management methods of household waste pose risks of contamination of soil and water resources. This study aims to assess the quality of domestic water for households in the city of Cotonou. The methodology adopted is summed up in a physico-chemical and microbiological analysis of thirty water samples taken from households in the 13 districts of the city of Cotonou. The results obtained at the physicochemical level show that, apart from the waters of SONEB at the source, whose turbidity (5.6 NTU) complies with the standard which is 5 NTU, that of other sources is much greater than Standard. This indicates the presence of suspended solids in the water that may harbor microorganisms harmful to humans. With regard to microbiological quality, all the water sampled at household level contains E.Coli, the number of which is much higher than the Benin standard which sets at 0/1 ml of water. In addition, the water sampled from the wells contains high numbers of fecal coliforms. As for SONEB water, the presence of coliforms was determined but with lower numbers than well water (50 / ml at household level and 2 / ml at source level.

Keywords: Domestic water quality; Pollution; Contamination; Cotonou; Benin

1. Introduction

The World Health Organization (WHO) estimates that 7% of the world's deaths and 8% of the global disease burden are due to diseases linked to the quality of drinking water and a lack of sanitation (Adams J ., et al, 2017). According to the United Nations Development Program, half of hospital beds in developing countries are occupied by patients with water or sanitation related illnesses [1]. This state of affairs represents a heavy burden for already saturated health systems [2].

The economic impacts associated with the lack of water, hygiene and sanitation are just as enormous as the health impacts. Indeed, the lack of water, hygiene and sanitation costs about 340 million US dollars to households and 7 billion US dollars to national health systems [3]. The problem of water in quantity and quality in the African context imposes the need to find sustainable solutions adapted to the socio-economic, technical and financial realities of the countries [3].

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In Benin, the lack of hygiene and sanitation compromises the quality of drinking water. Insanitary conditions in homes pollute drinking water and facilitate the spread of infections linked to the hydro-oro-fecal peril and the human-to-human transmission of these infections [4]. diarrhea and intestinal infections, which are serious conditions.

The situation with regard to the availability of quality water in the city of Cotonou, although not alarming, is worrying. We note the presence of a water supply system from the National Water Company of Benin (SONEB) in almost all the districts. But 91.6% of respondents practice the storage of water from the public network; 82.6% use private subscribers-resellers or public points of sale (water kiosk). The water is taken from the tap or from barrels without a cover. Regarding protective measures, 68.9% of transport containers are uncovered while at household level, 89.5% is covered during storage [5]. These conditions of access to drinking water largely contribute to the prevalence of hydro-faecal diseases in the city of Cotonou. There is a link between certain conditions from which the populations in the study environment suffer and the conditions of access to drinking water. Evidence of this is insalubrity, the lack of latrines in homes, cohabitation with garbage and the lack of drinking water. This portrait is sad and distressing, especially since the health impacts are considerable. It is therefore necessary to pay particular attention to it. Certainly, efforts have been made to fight against water-borne diseases at the international and local level through basic hygiene and sanitation programs. However, a better knowledge of the peculiarities of this environment will undoubtedly contribute to the reduction of the prevalence of these affections. It is in this perspective that this work on: Physicochemical and microbiological characteristics of water for domestic use in Cotonou in the Republic of Benin falls.

2. Material framework and study methods

2.1. Study framework

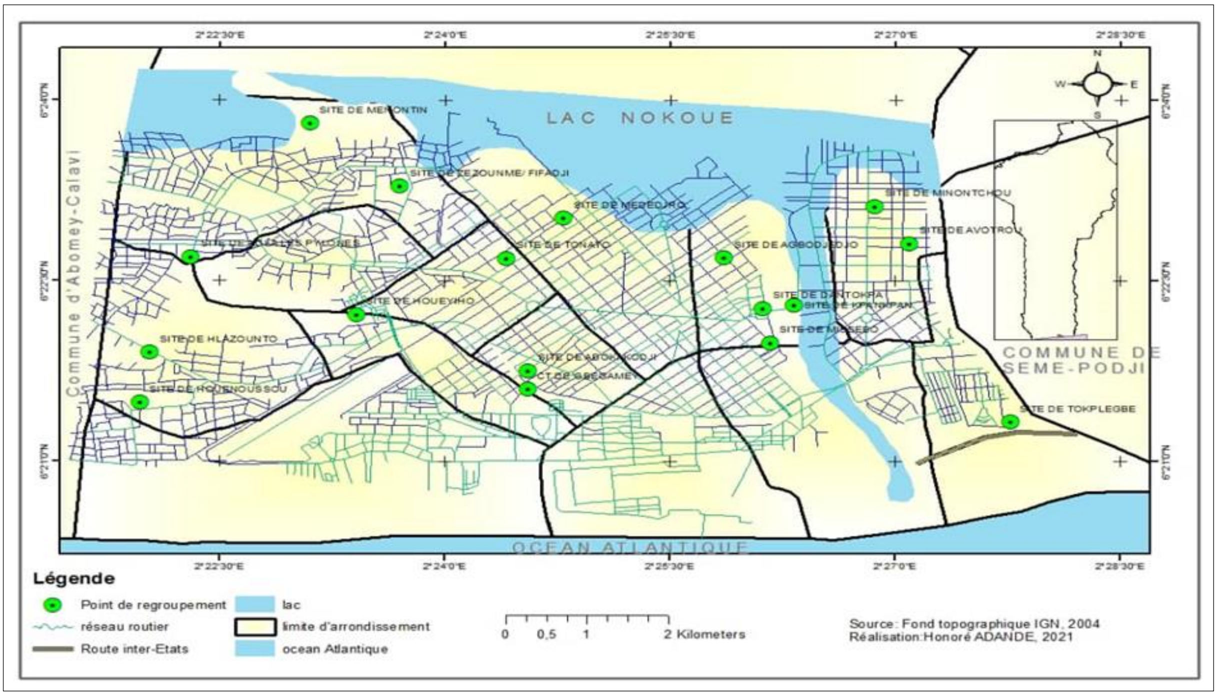

Figure 1 Geographical location of the city of Cotonou The city of Cotonou does not have a watercourse, but Lake Nokoué (85 km²) and some swamps constitute the city's water reservoirs. During the flood due to the descent of waters from the north and especially the great rainy season, the city is threatened by serious flooding (low level, strongly influenced by variations in the level of water bodies; maximum flood level: 1 , 50 meters). The geographical location of the city of Cotonou, which does not have a large area, is a constraint in the management of household waste, where the swamps and the banks of Lake Nokoué constitute the places of waste dumps for the populations and certain structures for the pre-collection of waste. solid household.

The city of Cotonou is located between 6 ° 20 'and 6 ° 23' north latitude and 2 ° 22 'and 2 ° 30' east longitude. It represents the only Municipality of the Littoral Department and is limited to the North by the Municipality of Sô-Ava and Lake Nokoué, to the South by the Atlantic Ocean, to the East by the Municipality of Sèmè-Kpodji and to the West by that of Abomey-Calavi (figure 1). It covers an area of 79 km² (0.07% of the national territory), 70% of which is located to the west of the channel (Monograph of the Municipality of Cotonou, 2006: P.9). It is the only department in the country with a single municipality, with 13 districts and 143 city districts. Cotonou is the economic capital of Benin and alone concentrates almost all the administrative and political functions of the country. The city of Cotonou benefits from important infrastructures and several socio-economic activities are developed there. It has a road network that includes a fairly dense road network with more than 600 km of tracks and a currently inoperative rail network.

2.2. Study materials and methods

2.2.1. Type of studies

This is a cross-sectional, descriptive and analytical study that took place in the city of Cotonou from April to July 2021. It aims to assess the effects of household waste management methods on water for domestic use. in the city of Cotonou in Benin. 2.2.1. Study population and sampling Within the framework of the present study, the households of the city of Cotonou constituted the main target surveyed. The sample size is determined according to the formula of Schwartz, (1995). It is calculated with a 95% confidence level and a margin of error of plus or minus 5%.

$$N = z\alpha^2 . \, p \, q \, / \, d^2$$

N = sample size;

Zα = deviation set at 1.96 corresponding to a confidence level of 95%;

P = Subscription rate of households to pre-collection structures in the era of COGEDA / DST

Q = 1-P; d = margin of error which is equal to 5%. , N = 754 households

2.2.2. Study data

⎫ physicochemical and microbiological data: these are the physicochemical and bacteriological parameters of water for domestic use. They are obtained through the physico-chemical and microbiological analysis of samples of well water and running water, obtained in certain concessions in the city of Cotonou

⎫ demographic data: these relate to statistical data from the results of the last general population and housing census in 2013, obtained from the National Institute for Statistics and Economic Analysis (INSAE). These data made it possible to sample the households surveyed;

2.2.3. Data collection techniques and tools

The research was carried out along the following three axes: documentary research, field survey and direct observation, and physico-chemical and microbiological analyzes.

Literature search

It concerns research which has made it possible to compile information available in reports and studies on waste management in general and household waste in particular. Articles and comments posted on the Internet are also among the main sources of documentation used, as are DEA and thesis papers on the subject. This research made it possible to synthesize knowledge on the subject. Documents on waste management in Cotonou such as, legislative and regulatory texts relating to hygiene and sanitation, and environmental protection were also consulted nationally and internationally.

Field work

Two types of analyzes were carried out on a total of 30 samples of well water, and running water, which constitute the main sources of water supply for the populations of Cotonou. These are physico-chemical and bacteriological analyzes. They are basically summarized in the determination of pH, conductivity, turbidity, color, dissolved oxygen, ammonium, fecal coliforms, E. Coli. The samples were sent as soon as possible to the Quality Control Laboratory of the Public Hygiene Service in the Republic of Benin in containers which guarantee freshness. The waters were collected in sterilized bottles of 500 ml. These vials were washed, rinsed and dried in the laboratory. They were wrapped in aluminum foil and sterilized at 121 ° C for 20 to 30 minutes in the laboratory. Figure 9 shows the map of the sampling sites for the water sampled.

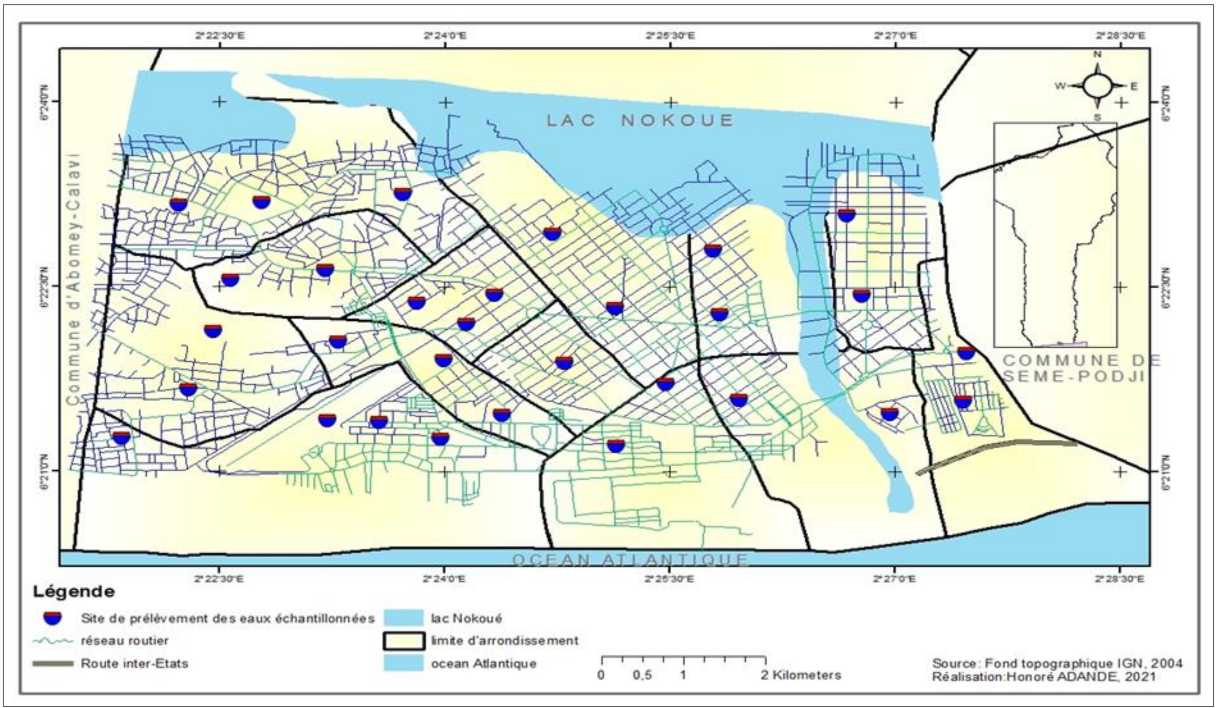

Figure 2 Distribution map of the sampling sites for the water sampled; (Source: Fieldwork 2021)

2.3. Data collection materials

These are devices such as: pH meter, turbidimeter, conductimeter, molecular absorption spectrophotometer, Water bath, oven, autoclave, bacteriological hood, filtration manifold. The chemical elements were assayed using specific kits for each element.

2.3.1. Data processing and results analysis

The data were entered in the Sphinx 4.5 software then exported into the Excel 2013 spreadsheet for the creation of graphs and tables. The values obtained from the assay were interpreted in relation to the standards in force in Benin. The Arcgis 10.3 software is used to project the geographic coordinates of the water sampling sites sampled onto a base map of the research sector. The qualitative data synthesis was made and presented in written form with Microsoft Word 2013.

3. Results

3.1. Physico-chemical characteristics of water used in households

The results of physico-chemical analyzes of household water in Cotonou are as follows:

3.1.1. Hydrogen potential

Figure 3 shows the average pH of the water samples taken as a function of the sources of supply.

The pH of water represents its acidity or alkalinity. At pH 7, water is said to be neutral, at pH less than 7, water is said to be acidic and at pH greater than 7, it is said to be basic [6] (Rodier, 2009). The analysis of fig 32 shows that the average pH of the well water (6.8) is less than 7 while the water from the SONEB at the source and at the household level (7.2) are all higher. to 7. The average pH values of the sampled water are close to 7 and correspond to the standard which is 7.

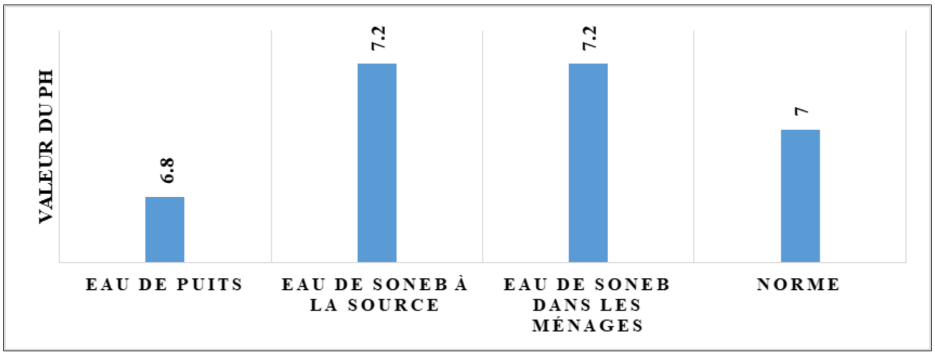

Figure 3 pH of the sampled water; (Source: Field data, Cotonou, Adandé, 2021)

3.1.2. Conductivity

Electronic conductivity refers to the ability of water to conduct an electric current [7](Derwich et al., 2010). According to [6]Rodier J. (2009), measuring the conductivity of water makes it possible to quickly assess the overall mineralization of the water and to follow its evolution. Contrasts of conductivity make it possible to highlight pollution, areas of mixing or infiltration of polluted water. Figure 4 shows the average values of the conductivity of the water sampled.

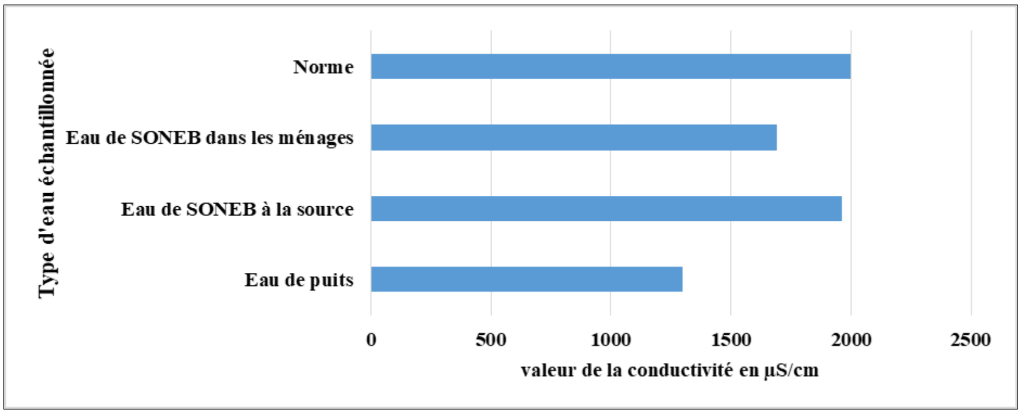

Figure 4 Conductivity of the sampled water; (Source: Field data, Cotonou, Adandé, 2021)

All the sampled waters have conductivity values lower than the standard which is 2000 µS / cm. These waters are then weakly mineralized. The analysis of the figure shows that the waters of SONEB at the source have a higher conductivity (1961.28) than that of well water (1299.75) and of SONEB at the household level (1691.38).). This highlights the pollution of these water sources by seepage of wastewater.

3.1.3. Color

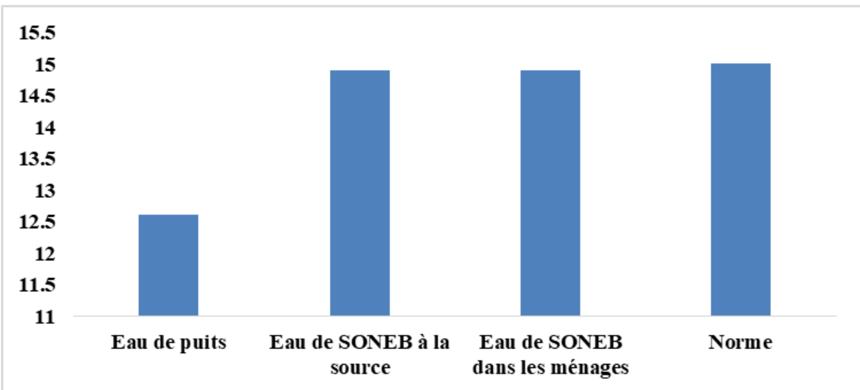

Figure 5 Color of the water sampled; (Source: Field data, Cotonou, Adandé, 2021)

Color is one of the parameters that indicates the quality of the water. It has no effect on health but allows you to appreciate the aspect of water. The different values of the color of the sampled waters are illustrated in Figure 5.

All the color values of the water samples are within the required standards which is 15 ptCo.

3.1.4. Turbidity

The turbidity of water is a measure of how cloudy it looks. It reflects the presence of particles in suspension in the water (organic debris, clays, silts, grains of silica, microscopic organisms, etc.) [6] [6](Rodier, J., 2009). According to the WHO, turbidity greatly affects the potability of drinking water. Figure 6 shows the results of the turbidity of the sampled water.

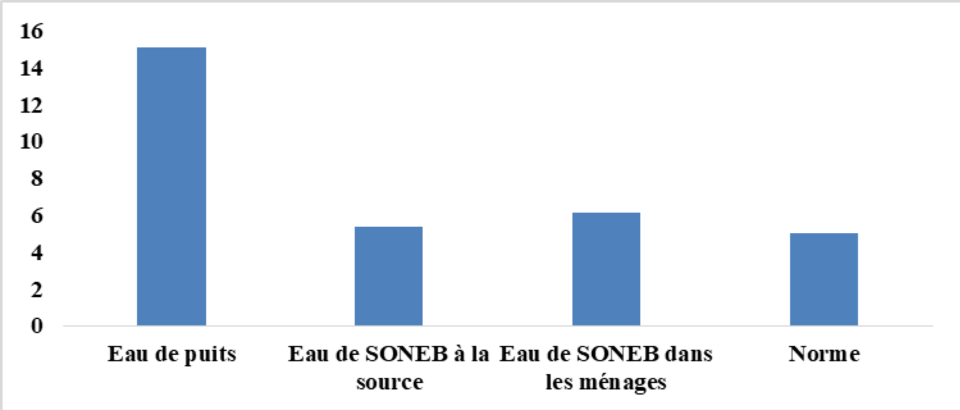

Figure 6 Turbidity of the sampled water; (Source: Field data, Cotonou, Adandé, 2021)

Apart from SONEB water at the source, the turbidity of which (5.6 NTU) complies with the standard which is 5 NTU, that of other sources is much higher than the standard. This indicates the presence of suspended matter in the water and the risk of exposure of populations to pathologies insofar as strong turbidity can allow microorganisms to attach themselves to suspended particles. These particles can be nutrients for microorganisms that they could use to grow. This can therefore cause disease in populations [6] (Rodier, J., 2009).

3.1.5. Dissolved oxygen

Indispensable for organ respiration, it facilitates the degradation of detrital organic matter and the completion of biochemical cycles (Hamdi et al, 2008). It is one of the most important indicators of the degree of water pollution [7] (Derwich et al, 2010). Highly aerated water is generally supersaturated with oxygen, while water loaded with organic matter degradable by microorganisms is undersaturated. Indeed, the strong presence of organic matter in a body of water, for example, allows microorganisms to develop while consuming oxygen. Figure 7 shows dissolved oxygen in the sampled waters.

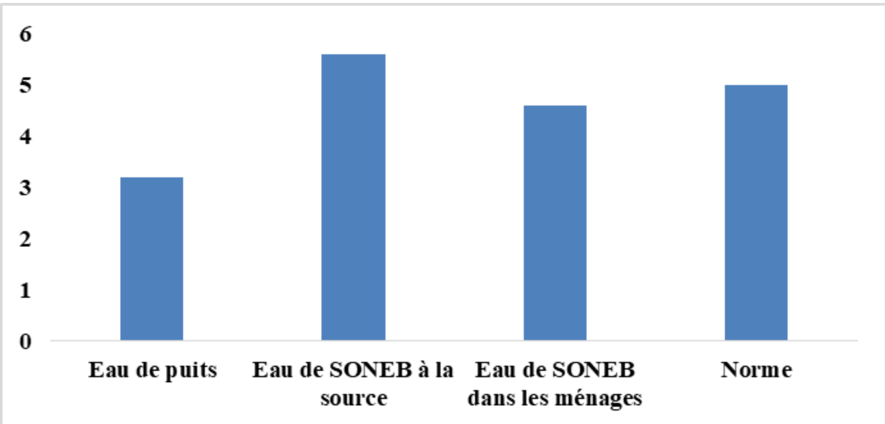

Figure 7 Dissolved oxygen of the sampled water; (Source: Field data, Cotonou, Adandé, 2021)

Apart from SONEB water at the source, none of the other water samples has a normal dissolved oxygen value (greater than or equal to 5 mg / L). The low dissolved oxygen content in these waters could be explained by the presence of microorganisms that use it for their biological activities and ensure their multiplication.

3.1.6. Ammonium

Ammonium is the final reaction product of nitrogenous organic substances and inorganic matter in water and soils. It also comes from the excretion of living organisms and the biodegradation of waste, without neglecting inputs from domestic, industrial and agricultural sources [7] (Derwich et al, 2010). It is used by phytoplankton as a source of nitrogen and oxidized by nitrifying bacteria. Ammonium in surface water can originate from plant matter in rivers, animal or human organic matter [6] (Rodier 2009). In general, ammonia converts fairly quickly to nitrites and nitrates by oxidation. The ammonium content in the water samples taken is shown in Figure 8.

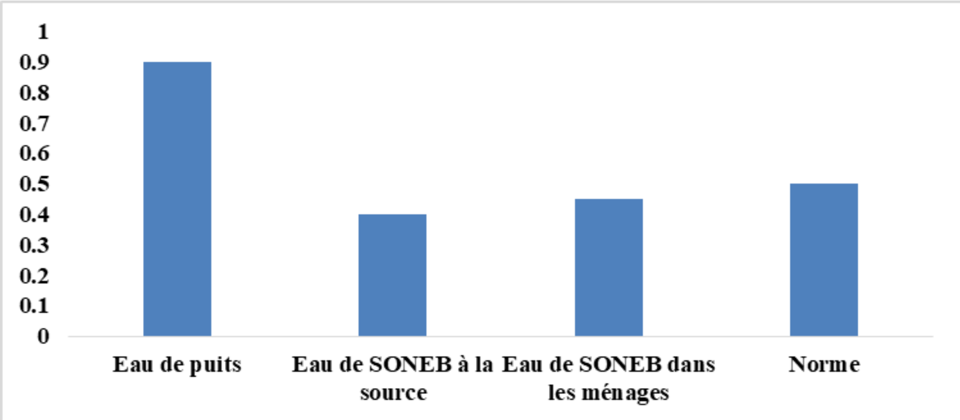

Figure 8 Ammonium content of the sampled water; (Source: Field data, Cotonou, Adandé, 2021)

The ammonium content of well water greatly exceeds the standard (0.5 mg / L). We can then conclude that the process of incomplete degradation of organic matter is very strong in the wells sampled. As for SONEB water at source and in households, their levels are lower than the standard.

3.2. Microbiological characteristics of water used in households in Cotonou

The results of microbiological analyzes of household water in Cotonou are as follows:

3.2.1. Fecal coliforms

Usually, groundwater is free from pathogens. The presence of pathogens in well water can be the result of seepage of sewage. But their presence in surface water is linked to animal droppings and the human faeces that are released there. Figure 9 reports on the presence of fecal coliforms in the water sampled.

Figure 9 Fecal coliform content of sampled water; (Source: Field data, Cotonou, Adandé, 2021)

Analysis of Figure 9 shows that the sampled well water contains large numbers of fecal coliforms. These numbers greatly exceed the Benin standard of 0 faecal coliforms per 1 ml of water. As for SONEB water, the presence of coliforms was determined but with lower numbers than well water (50 / ml at household level and 2 / ml at source level.

3.2.2. Escherichia Coli

The presence of E. Coli in water and in food not only indicates recent contamination with faeces, but also the likely presence of pathogenic bacteria and protozoa (Health Canada 2006). This is then the best indicator of faecal pollution. The E. Coli content in the sampled waters is presented in Figure 10.

Figure 10 Water and vegetable content sampled in *E. Coli*; (Source: Field data, Cotonou, Adandé, 2021)

Considering the bacteriological criteria of the Beninese standard which sets at 0/1 ml of water, well water and SONEB at household level contain E. Coli, the number of which is much higher than the standard.

3.3. Quality of drinking water in households in Cotonou

The average pH values of the water sampled are close to 7 and correspond to the standard which 7. These waters are then weakly mineralized. This highlights the pollution of these water sources by seepage of wastewater. All the color values of the water samples are within the required standards which is 15 ptCo. Apart from SONEB water at the source, the turbidity of which (5.6 NTU) complies with the standard which is 5 NTU, that of other sources is much higher than the standard. This indicates the presence of suspended matter in the water and the risk of exposure of populations to pathologies insofar as strong turbidity can allow microorganisms to attach themselves to suspended particles. These particles can be nutrients for microorganisms that they could use to grow. This can therefore cause disease in populations [6] (Rodier, 2009). Apart from SONEB water at the source, none of the other water samples has a normal dissolved oxygen value (greater than or equal to 5 mg / L). The low dissolved oxygen content in these waters could be explained by the presence of microorganisms that use it for their biological activities and ensure their multiplication. The ammonium content of well water greatly exceeds the standard (0.5 mg / L). We can then conclude that the process of incomplete degradation of organic matter is very strong in the wells sampled. As for SONEB water at source and in households, their levels are lower than the standard. Well water sampled contains large numbers of fecal coliforms. These numbers greatly exceed the Benin standard of 0 faecal coliforms per 1 ml of water. As for SONEB water, the presence of coliforms was determined but with lower numbers than well water (50 / ml at household level and 2 / ml at source level. Considering the bacteriological criteria of Beninese standard which sets at 0/1 ml of water, well water and SONEB at household level contain E. Coli, the number of which is much higher than the standard. The presence of these coliforms in these waters indicates a strong pollution of the environment in these wells and in households by faeces, which are the primary source of faecal pollution (Gomez et al, 2009). The presence of faecal coliforms indicates faecal contamination without specifying whether this contamination is old or recent. But the presence of E. Coli indicates that the pollution is recent or in progress. Observing figure 10, the number of E. Coli in wells and households is very high. This high rate of fecal coliforms and E. Coli d n these samples reveal the lack of hygiene in the houses and around the wells.

4. Discussion

The main mode of drinking water supply in the research environment is that of SONEB (97%) [8] (INSAE, RGPH-4, 2013). According to this source, 51% of households have SONEB water at home while 46% get it elsewhere. However, a minority of households (3%) use wells as a source of drinking water. In addition, most households have wells which constitute water reserves for them. Most of the time, the water from these wells is used for laundry, dishes, baths and more. However, given the proximity of the underground water table in Cotonou, it is likely that these water points will be impacted due to health and sanitation practices in the research community.

From the era of COGEDA / DST to SGDS, sanitation and sanitation practices in Cotonou have caused environmental damage. Regarding the sources of water supply, the physicochemical and bacteriological composition of the water samples collected showed organic pollution due to the presence of microorganisms in these waters compared to the standards required for drinking water. These results could be explained by the disposal methods of solid household waste, domestic wastewater and excreta in Cotonou during several years of management of this waste by COGEDA / DST.

However, component B of PUGEMU, relating to solid waste management, one of the objectives of which is to limit the negative impacts of solid waste on the environment in the cities of Cotonou, Porto-Novo, Abomey-Calvi, Sèmè-Podji and Ouidah in its implementation, should lead to an increase in the rate of pre-collection, the improvement of technical capacities and activities carried out by NGOs in charge of pre-collection and technical services of the municipalities concerned [9] (PUGEMU , 2016, p. 4-5). In addition, the inadequacy of wastewater management measures, which has still not found a sustainable solution for years in Cotonou and remains an environmental problem. The populations thus pour liquid effluents into gutters. However, this practice is a violation of article 26 of Decree n ° 2001-109 of April 4, 2001 fixing the quality standards of wastewater in the Republic of Benin, [10] (Republic of Benin, Presidency of the Republic, 2001, p.13) which stipulates that the discharge of domestic wastewater into stormwater drainage channels is prohibited. With regard to the healthiness of the living environment in Cotonou, the degradation of the environment caused by the management methods of the DSMs causes frequent flooding following the filling of certain alleys by the DSMs and by extension a proliferation of responsible anopheles mosquitoes. malaria and the spread of amoeba responsible for waterborne diseases such as cholera, dysentery, diphtheria, gastritis and enteritis. Similar results were found by [11] Dan, T. (2020) in the commune of Aguégués where 65.6% of households live in a very unsanitary environment, 26.3% live in an unsanitary environment and 8.1% live in a healthy environment. In this municipality, the management methods adopted by households are: landfilling, dumping waste on empty spaces and banks, incineration. These management methods, which are at the origin of the proliferation of dumps, and defecation in nature in the study environment, and are part of the growing unsanitary conditions observed.

5. Conclusion

The results obtained highlight the organic, chemical and microbiological pollution of common water used in households in Cotonou and constitute a warning to the populations. The discharge of waste into nature damages the soil and water resources. Several measures are currently being taken into account in Cotonou by the SGDS to limit odor and visual pollution and the contamination of water resources in order to guarantee a healthy environment and better well-being for the population. However, it is important to succeed in convincing the populations to change their behavior in terms of disposal of their household waste, the burial of which constitutes a danger for well water because of the water table in Cotonou.

Compliance with ethical standards

Acknowledgments

We thank everyone who contributed to the writing of this manuscript.

Disclosure of conflict of interest

The writing of this manuscript is without conflict of interest. Each of the authors contributed to the success of this manuscript.

References

[1] UNITED NATIONS DEVELOPMENT PROGRAM. World Human Development Report 2016, Beyond Scarcity: Power, Poverty and the Global Water Crisis. New York. 2006; 43.

[2] HEALTH 'CANADA. Guidelines for Canadian Drinking Water Quality: Technical Document ". Escherichia coli.

[3] Landeou Rc, Akpoyete Dh, Azonhe T, Houssou Cs. Consequences of poor management of human excreta and domestic wastewater on the environment and human health in the municipality of Dassa-Zoumè. Beninese Center for Scientific and Technical Research 03 BP 1665. 2019.

[4] GAO Affo. Inventory of hygiene and sanitation in the municipality of Bassila in Benin", Master's thesis in Environment, Health and Sustainable Development. University of Abomey-Calavi. 2013.

[5] Hounsounou, Espérance Olive, Agassounon Micheline, Tchibozo, Djikpo, Ayi-Fanou Lucie, Agbossou Euloge. “Water chain of the public network in some precarious neighborhoods of the sixth district of Cotonou-Bénin”, VertigO - the electronic journal in environmental sciences. December 2017; 17(3).

[6] RODIER J. "The analysis of water" DUNOD. Paris, France. 2009; 1579.

[7] Derwich E, Benaabidate L, Zian A, Sadki O, Belghity D. Physico-chemical characterization of alluvial water from the upper Sebou downstream from its confluence with wadi fes. Larhyss Journal, ISSN 1112-3680, n ° 08, June 2010; 101-112.

[8] INSAE, RGPH-4. Cahier des villages et neighborhoods de ville du Département du Littoral. 2016; 18.

[9] PUGEMU. Harmonized solid waste management strategy in Grand-Nokoué, General report. 2016; 80.

[10] REPUBLIC OF BENIN / PRESIDENCY OF THE REPUBLIC. Decree n ° 2001-109 of 04 April 2001 Setting the quality standards for wastewater in the Republic of Benin, Cotonou. 2001; 17.

[11] DAN Toussaint Cokou. Waste management and sanitation in the Lake Commune of Aguégués in southern Benin", doctoral thesis, UAC / EDP-ECD, Geography and Environmental Management. 2020; 275.

[12] Adams J, Bartram J, Yves C, Jackie S. School water, sanitation and hygiene standards in resource-poor settings. Geneva: World Health Organization. 2017; 79.

[13] Hamdi Ms, Ait M. Contribution to the study of the physico-chemical and bacteriological parameters of the mouth of the Beni-Messous river. Applied University Study Thesis (DEUA) in marine science, ISMAL. 2008; 57.

[14] WORLD HEALTH ORGANIZATION / UNITED NATIONS CHILDREN'S FUND. Monitoring (JMP) Progress in sanitation and water supply. 2010; 57.

[15] Ottawa. 2006; 39.