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Physico-Chemical and Microbiological Qualities of Porto-Novo Lagoon Water

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Abstract

This research aims at analyzing the physicochemical and bacteriological characteristics of lagoon's waters in Porto-Novo. To reach this goal, a methodology is used based on documentary research, followed by data collection sampling and analysis of water samples, and surveys with the target populations. The water quality is assessed on the basis of physico-chemical and bacteriological analysis of collected water samples. The findings of the surveys on the physico-chemical assessment of the water's suitability reveal that the temperature varies between 30.21 and 30.92°C, exceeding the norms (25°C), the conductivity varies between 109 µS/cm and 145 µS/cm, and the salinity varies between 0.05 and 0.07 psu. pH values are beyond the norm (5.86; 6.15; 6.27 and 6.28). The dissolved oxygen, total dissolved solids, suspended solids, chemical oxygen demand and biochemical oxygen demand vary respectively between 0.33 mg/L and 1.93 mg/L; 54 mg/L and 73 mg/L; 6 mg/L and 12 mg/L; 12 mg/L and 20 mg/L; 5 mg/L and 8 mg/L. The pollution caused by metals such as cadmium and plumb range respectively from 0.0195 to 0.219 mg/L and 0.03 to 0.065 mg/L, exceeding the guide values of the national standard (0.5 mg/L and 0.05 mg/L). Microbiologically, all the water samples contain very high quantities of faecal enterococci and Escherichia coli. These results show that human activities seriously pollute surface water resources and contribute to their decay.

Keywords: Quality, physico-chemical, bacteriological, lagoon, Porto-Novo.

1. Introduction

Water is a vital resource for humanity and its most basic needs. Its functions are varied and vital: dedicated to agriculture, it is the basis of human nutrition, contributes to numerous economic and industrial activities and is an important link in the biological and ecological balance (Brand, 1995; p 23). The issue of sustainable management of urbanization is closely linked to the issue of

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water management in its global dimension, from its mobilization to its discharge through its distribution to the various uses and its treatment before and after its use. But since the middle of the 20th century, water resources have increasingly been under pressure from agricultural and industrial activities and demographic expansion, mainly in developing countries. This situation is coupled with untreated discharge into rivers, lakes and lagoons, resulting in serious health problems (Adjagodo et al, 2016, p7). Pesticides, toxic chemicals and heavy metals can induce mutations, diseases and behavioural changes, enter the marine food chain and ultimately end up in our dishes (IAEA, 2011, p. 4). Nowadays, air pollution remains a major public health problem despite the various regulations that have been introduced and the progress that has been made in controlling emissions through the development of pollution control technologies. Protecting these natural resources from all forms of pollution, whether urban or industrial, is crucial to maintaining their quality. Human activities disperse various chemical compounds in natural environments (Derradji, F, et al; 2007, p 14). The lagoon of Porto-Novo, the third most productive wetland in southern Benin after Lake Nokoué and Lake Ahémé, therefore suffers from the impact of human activities and poor waste management in Porto-Novo city. The abundance of fishing-related activities is one of the characteristics of this river. With the growth of the lake dwellers, people's lifestyles, climatic hazards, fishing techniques (acadja) and farming practices, environmental problems have arisen, pollution being among the most significant (Agonkpahou E, 2006, p.6). Indeed, urban effluents are discharged daily without prior treatment, and the river is a reservoir of fish products for a large community. It is estimated that 2 million tonnes of waste are discharged into receiving waters every day, including industrial effluents and chemicals, faecal matter and agricultural waste such as fertilisers, pesticides and pesticide residues (UNESO-WWAP, 2003, p. 9). It goes without saying that the world's wastewater production is estimated at around 1,500 km³. The current global pollution could reach 12,000 km³ if we assume that 1 litre of wastewater pollutes 8 litres of freshwater. Poor water quality can be induced by human activities, mainly pollution, as well as poor sanitation and hygiene of water sources (Torkil, 2004; Nanfack et al., 2014) cited by (O.Y. Sokegbe et al, 2017, p. 2). The transport of smuggled petroleum products, residues of industrial and pharmaceutical products, as well as agricultural inputs and pesticides from neighbouring regions and even far away, also contribute to the pollution of this ecosystem (Youssao et al., 2011; Hounkpatin et al., 2011; Mègnon et al., 2011; Yèhouénou et al., 2013) cited by M. Vodougnon, 2015, p. 15). Water resource managers therefore have to deal with the problems of pollution and poor water management (E. Vissin, 2007, p. 12). It is therefore crucial to analyze the sources of water pollution in the lagoon so as to establish a sound planning and management tool. The current study aims to analyze the quality of the lagoon's water in this context.

2. Overview of the Study Area

The lagoon of Porto-Novo is located in the department of Ouéme. Covering an area of about 35 km², the segment of the lagoon in the Municipality of Porto-Novo lies between 6°25' and 6°30' of north latitude and 2°30' and 2°38' of east longitude. It flows northwards into the Oueme river via a multitude of tributaries from which it receives freshwater and alluvial deposits during flood periods, and south-westwards into Lake Nokoue through Totche canal, and further eastwards into the Atlantic Ocean at Lagos, from which it receives salt water during the dry season (Akogbeto et al, 2018, p. 4). To the east, the lagoon of Nigeria is the natural outlet for Porto-Novo lagoon supplied with freshwater from Ouéme delta to the north and seawater from Totché canal (Hem et al, 1990, p. 5).

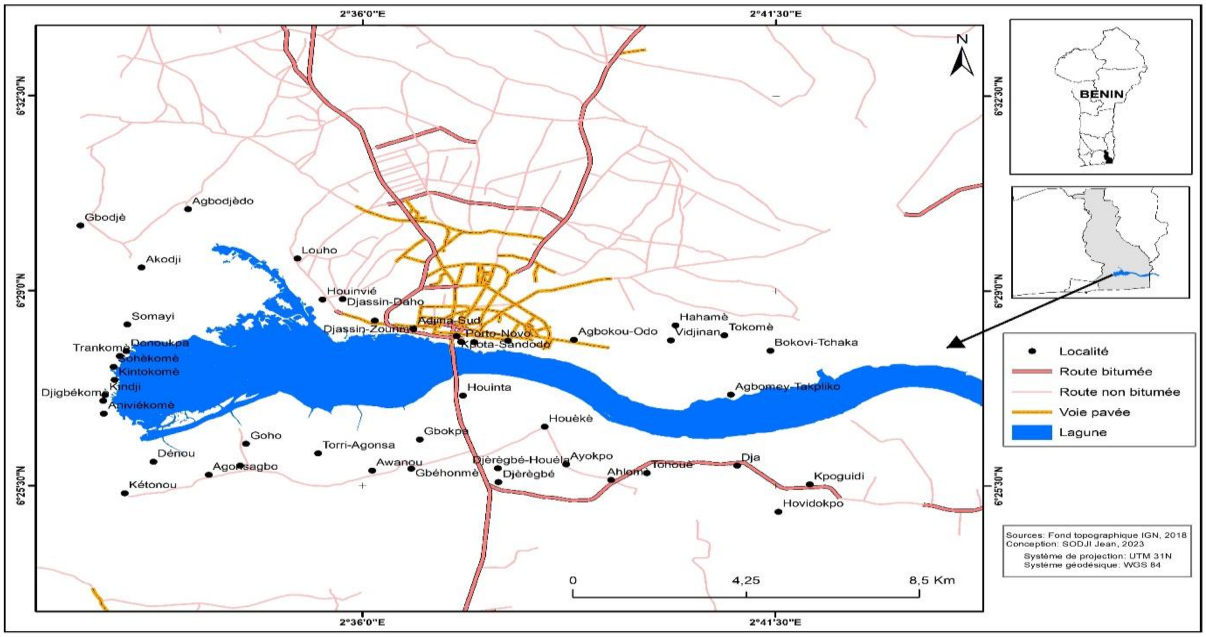

Figure 1. Location of Porto-novo lagoon
Source: survey data, June 2022

The lagoon benefits from a sub-equatorial climate with two dry and two wet seasons. Geologically, the Porto-Novo lagoon was formed during the last transgression. The Lake Nokoue complex and Porto-Novo lagoon form a large lagoon complex located at the junction of three geological and geomorphological structures, namely:

- The sub-horizontal shelves of the Continental Terminal to the east and west,
- The indentation in the lower Ouémé-So basin, 90 km long and 20 km wide in its southernmost part,
- Ogolian and Holocene barrier beaches to the south.

3. Materials and Methods

3.1. Water Sample Analysis Procedures

The laboratory analyses the physical, chemical and microbiological parameters of the samples taken. They are carried out in the laboratory of the National Water Quality Control Agency. Their purpose is to check the quality of surface water. Coliforms and faecal enterococci were tested quantitatively. The same applies to certain specific physico-chemical parameters, namely dissolved oxygen (O_2), Total Dissolved Solids (TDS), total Nitrogen (NTK), Plumb (Pb) and Cadmium (Cd).

Four sampling sites were chosen for this study: Agbokou, Djassin, Maria-Tokpa and Beau Rivage. The choice of sampling sites was governed by several factors in order to cover the study area spatially. These include the diversity of the level of development, the socio-cultural diversity of the populations and the places where activities are concentrated along the lagoon.

3.2. Collection Equipment for Microbial Analysis of Water

The following materials are used for microbial analysis:

- Incubators preset at 44°C and 37°C for incubating the seeded media;
- An autoclave for sterilizing culture media;
- An autoclave for destroying culture media after enumeration,
- A sensitive precision balance (10-3) for weighing culture media ;
- A heating and stirring plate for preparing culture media;
- A water bath to maintain the culture media at a supercooling temperature of 47.5°C;
- A filtration ramp with six (06) stations for filtering a volume of 100ml.

3.3. Collection Equipment for Physico-chemical Analysis

Table I summarizes the materials and methods used to analyze each parameter.

Table I. Materials and methods used to analyze each parameter

Parameters	Units	Symbols	Equipment	Method
Temperature	-	°C	Multimeter pH/EC/TDS/ Salinity / Oxygen	Electrometric
Hydrogen potential	-	pH		Potentiometric
Electrical Conductivity	µS/cm	CE		Electrometric
Total dissolved solids	mg/L	TDS		Electrometric
Salinity	‰	-		Electrometric
Dissolved oxygen	mg/L	O_2		Electrometric
Turbidity	NTU	-	Turbidimeter	Photometric
Suspended matter	mg/L	MES	Four	With flame
Total Kjeldahl nitrogen	mg/L	NTK	Molecular absorption spectrophotometer (DR 3900)	at NESSLER after mineralisation
Total phosphorus	mg/L	$P\text{-}PO_4^{3-}$		with molybdenum after mineralisation
Chemical Oxygen Demand	mg/L	DCO		Colometric
Biochemical Oxygen Demand	mg/L	DBO5	Thermostated enclosure	Respirometric
Plumb	mg/L	Pb^{2+}	AAS	with flame
Cadmium	mg/L	Cd^{2+}	AAS	with flame

Source: Laboratory results, November, 2022.

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3.4. Microbiological Parameter Analysis Method
3.5. 3.4.1 Preparing the premises

The laboratory is cleaned and the bench properly disinfected with a disinfectant solution (chlorine-based solution or 70% alcohol).

3.6.3.4.2 Work equipment and culture media preparation
The culture medium used to test for Coliforms (faecal total and E. Coli) is rapid'E. Coli, Baird Parker for Clostridium aureus and SLANETZ-BARTLEY for faecal Streptococci. REC, Baird Parker and Slanetz powder are made up according to the manufacturer's instructions:

3.4.3 Reconstitution of Rapid E coli powder (REC)
- Add 37g of powder to 1L of distilled water;
- Bring gently to the boil until completely dissolved;
- Autoclave for 15 minutes at 121ºC;
- Leave to cool to around 50°C;
- Mix well and dispense into sterile petri dishes.

3.4.4 Reconstruction of Slanetz-Bartley agar for faecal enterococci
- Add 41.5 g of powder to 1L of distilled water;
- Bring gently to the boil until completely dissolved;
- Autoclave for 15 minutes at 121ºC;
- Allow to cool to around 50° C;

When the medium cools, it is necessary to:
- ✓ Prepare the petri dishes (for samples to be inoculated by incorporation) by writing down the numbers, date, medium and incubation temperature;
- ✓ Prepare the petri dishes to pour the medium on which the cellulose membrane will be deposited;
- ✓ Sterilize the filtration manifold (stainless steel) using a Bunsen burner or gas gun;
- ✓ Prepare the forceps, the 0.45µm cellulose membrane and other elements essential for handling.

Start incorporating and filtering as soon as everything is nearly ready.

3.4.5 Seeding method
Waters were incubated by the method of filtering 100 ml of sample and incorporating.

3.4.6 Incubation
Samples are incubated at 37°C for faecal Enterococci and 44°C for Escherichia coli in incubators preset to the temperatures indicated above. The petri dish is turned upside down (lid down) before incubation to prevent water vapour from dispersing the colonies formed, thus preventing a correct reading.
After 24 hours incubation, Escherichia coli colonies are purple. Faecal Enterococci appear red on Slanetz-Bartley medium after 24 to 48 hours.

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3.2 Physico-Chemical Parameters Analysis Method

3.5.1 Cadmium measurement

First step: HACH mineralisation

- Measure 40 mL of liquid sample into a 100 mL digesdahl flask. Add 3 mL of concentrated sulphuric acid and heat to 440°C on the mineraliser.
- Allow to char for 3 to 5 minutes.
- Using a capillary funnel, add 10mL of 30 or 50% volume hydrogen peroxide. Continue adding 5mL fractions if the sample is not completely clear.
- Allow the hydrogen peroxide to evaporate completely and remove the flask from the mineraliser.
- After cooling (approx. 15 min), make up to the 100 mL mark with distilled water.

Second step: Cadmium and plumb measurement using the "Dithizone" method

3.5.1.1 Plumb measurement

First step: the mineralization is carried out in the same way as for cadmium**.**

Second step: Plumb is measured using the "Dithizone" method

Method principles

Dithiver reagent is a stable powder form of dithizone. Plumb ions in basic solution react with dithizone to form a pink to red plumb-dithizonate complex, which is extracted with chloroform.

3.5.1.2 Measurement of physico-chemical parameters

Physico-chemical parameters are measured using potentiometric (pH), electro-metric (colour, turbidity, conductivity/TDS), respirometric (Biochemical Oxygen Demand) and colorimetric (Chemical Oxygen Demand) methods.

3.5.1.3 Determination of phosphorus, NPK nitrogen and metals

- **HACH mineralisation (refer to cadmium method)**
- **Neutralisation of mineral residue**

A precise volume of the mineral residue is neutralised with 5N NaOH and made up to twice the starting volume with distilled water. The pH to be obtained depends on the parameter to be investigated.

For phosphorus: between 2 and 10 ;

For NPK: the pH cannot be corrected, otherwise the Nessler method requires the addition of KOH 12N.

✓ **Dosage**

Take a comparative reading of the sample without the reagent and the sample containing the reagent on the DR 2800 Molecular Absorption Spectrophotometer.

- Phosphor detection limits = 0,01 mg/L ;
- Nitrogen detection limit = 0.1 mg/L.

4. Results and Discussions

4.1 Physico-chemical quality of water in Porto-Novo lagoon

Determining the physico-chemical parameters of the lagoon's surface water is an important step in assessing its quality. It remains one of the means of identifying possible cases of contamination through chemical substances. Several analyses were carried out in order to assess the influence of the quality of human activities on the aquatic environment.

4.1.1 Variation in pH of water in Porto-Novo lagoon

Figure 2 shows the variation in pH of the water in Porto novo lagoon

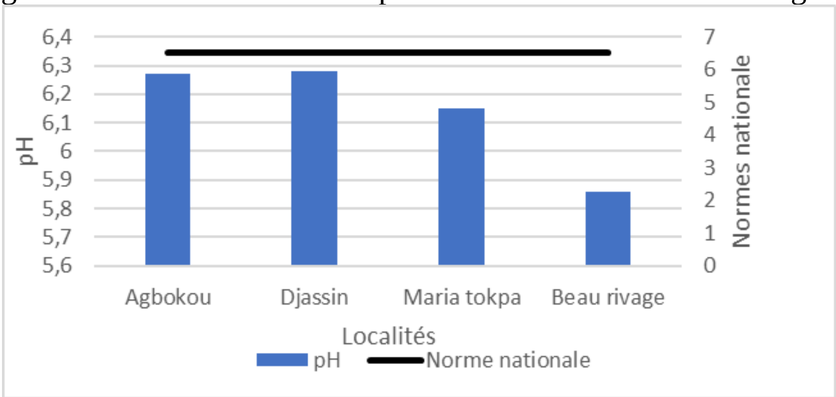

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Figure 2. Variation in pH of water in Porto-Novo lagoon

Source: survey data, June 2022

The pH of lagoon water varies from one spot to another. The water in rivers and lakes is often influenced by many factors including the surrounding rocks and soil, land use, chemicals washed or dumped into the water, aquatic animal excrement and decomposing organic matter. All these elements can make the water in rivers, lakes and streams slightly acidic (up to pH 6.5) or slightly basic (up to pH 8.5). The pH values obtained in the lagoon range from 5.86 to 6.28, with an average of 6.07. The highest values are registered in Djassin and Agbokou, while Maria Tokpa and Beau Rivage have the lowest values. These values are below the standard required by the WHO and national standards in the aquatic environment. All the water has a pH below 7, showing that the lagoon's waters are acidic. The pH value recorded at Beau Rivage (5.86) clearly shows this acidity. This acidity could have an impact on the development of certain fish species, leading to the collapse of the food chain in the most extreme cases.

4.1.2 Dissolved oxygen content

Dissolved oxygen is a measure of the quantity of gaseous oxygen contained in the water. Figure 3 shows the level of dissolved oxygen in the lagoon waters.

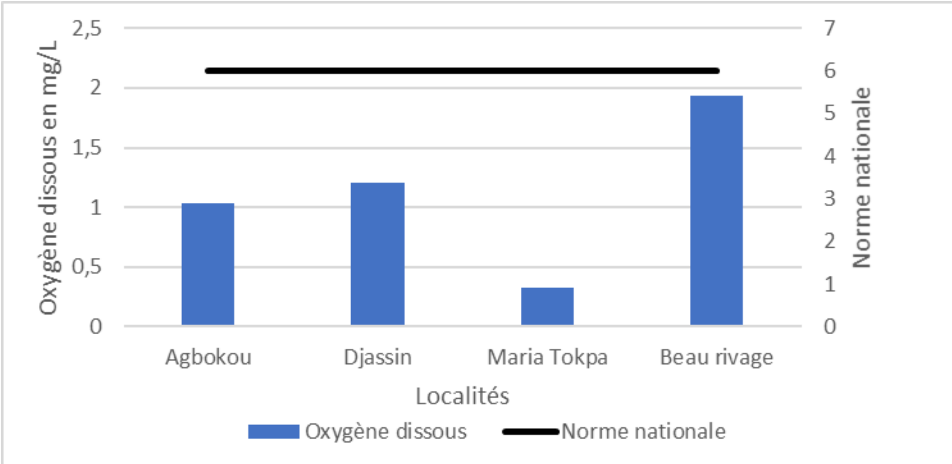

Figure 3. Dissolved oxygen in analyzed surface water
Source: survey data, June 2022

Dissolved oxygen levels depend on many factors: whether the water is flowing or still, whether there are rocks or other obstacles over which the water can flow, how many plants can be found in the water, water temperature, ice cover and depth. Dissolved oxygen levels are higher in very cold water than in very warm water. The highest value is observed at Beau Rivage. It is 1.93 mg/L. The lowest value was observed at Maria Tokpa (0.33 mg/L). The various values observed in the surface waters studied are in line with the WHO standard and the national standard, which recommend at least 6 mg/L of dissolved oxygen in freshwater. The low values recorded show an anaerobic environment that is detrimental to aquatic life. One of the environmental factors influencing oxygen concentration is the presence of aquatic plants: this is the water hyacinth phenomenon which reduces the chances of water productivity.

4.1.3 Suspended Solids (SS)

Suspended solids (SS) are all the solid mineral and/or organic particles contained in natural or polluted water. It shows particles larger than 0.45 µm in the water column. This particulate organic matter is made up of silt, detritus, faeces from livestock or disintegrated foodstuffs. Figure 4 shows the suspended solids (SS) in the water in Porto-Novo lagoon’s waters.

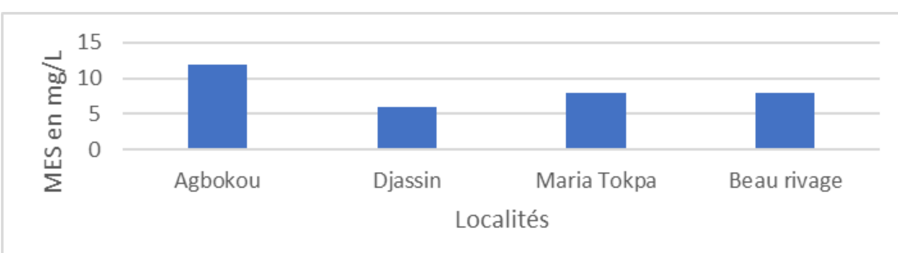

Figure 4. Suspended Solids (SS) in surface water
Source: survey data, June 2022

The presence of both suspended and organic matter affects water quality. They serve as an indicator of water quality and turbidity. These suspended solids are generally settleable matter in the form of sludge.

The values from water analyses show that the highest and lowest values are respectively 12mg/L and 6 mg/L. The values obtained at Maria Tokpa and Beau Rivage are the same (8 mg/L). The various values show that the MES found in the water is of anthropogenic origin due to urban, agricultural, rural domestic and industrial discharges.

4.1.4 Turbidity

Turbidity is a widely used water parameter that is representative of water quality. It expresses, clearly and quickly, the concentration of suspended matter and some other specific types of contaminant present in a water sample. Generally speaking, water is said to be turbid when the quantity of contaminants (suspended solids and others) is high and their presence affects the clarity and transparency of the water. Figure 5 shows the turbidity levels of surface water at the sampling points.

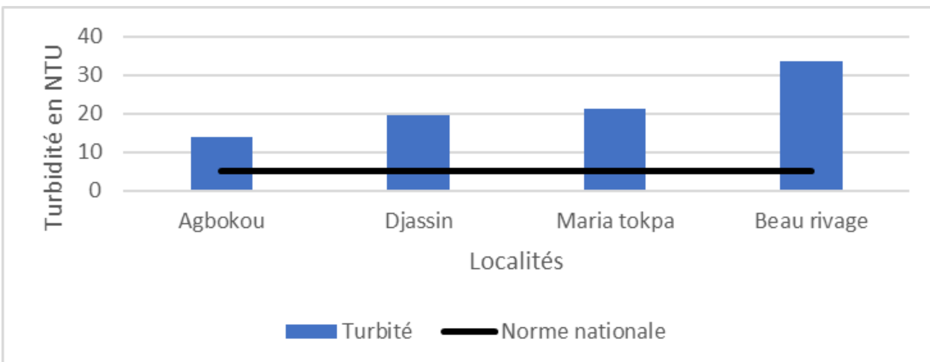

Figure 5. Turbidity of analyzed surface water
Source: survey data, June 2022

Surface water turbidity values are well above the WHO standard and the national standard of 5 NTU. The highest value was recorded at Beau rivage (33.5 NTU), with the lowest value at Agbokou (13 NTU). This high turbidity can cause a reduction in the light used by aquatic plants for photosynthesis. Turbid water can also present risks in its natural state. Whether turbidity is caused naturally or by human activities, its presence has an impact on the amount of light that passes through bodies of water. This reduction in light will have an impact on photosynthesis. Since photosynthesis is responsible for a good percentage of the dissolved oxygen found in water, the reduction in photosynthesis will have an impact on the quantity of dissolved oxygen.

4.1.5 Biochemical oxygen demand (BOD5)

Biochemical oxygen demand is a measure of the amount of oxygen required to oxidize organic matter (plant, animal, etc.) as well as inorganic matter (sulphides, ferrous salts, etc.) in an aqueous sample. This parameter is widely used to monitor organic pollution from industrial and urban effluents, as well as from pulp and paper mill discharges. Figure 6 shows changes in BOD5 in all the sampled surface waters.

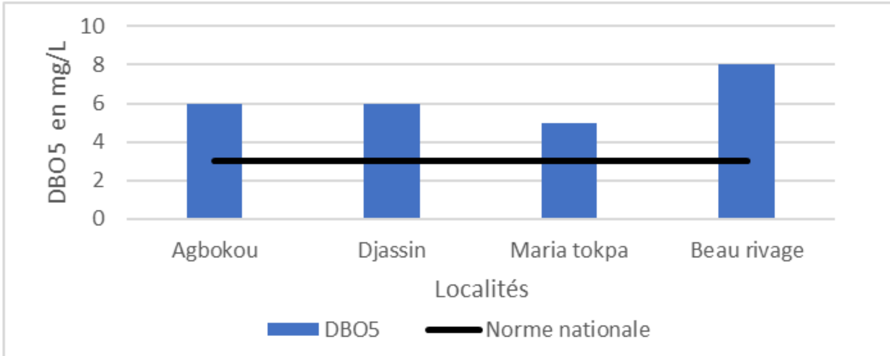

Figure 6. BOD5 in all sampled surface waters
Source: Survey data, June 2022

Recorded BOD 5 values are not high. The lowest value is 5 mg/L and the highest is 8mg/L. The maximum BOD5 value (8mg/L) far exceeds the value recommended by the basic quality standard for public water set at 3 mg/L. There is therefore water pollution in the target areas.

4.1.6 Chemical Oxygen Demand (COD)

Figure 7 shows the variation in COD in all the studied surface waters.

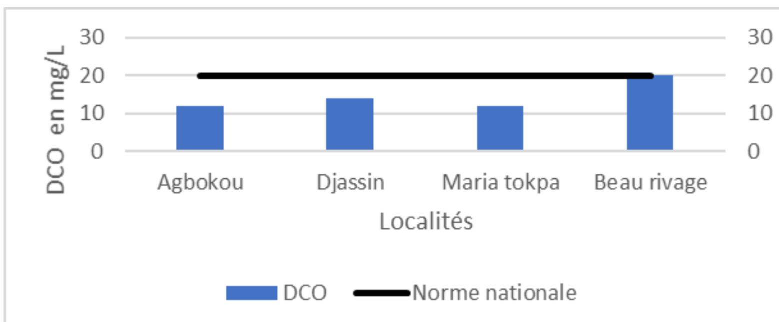

Figure 7. COD in all the studied surface waters
Source: Survey data, June 2022

Figure 7 shows that the highest COD value is recorded at Beau rivage (20 mg/L) and complies with the WHO and national standard value according to which unpolluted water must have a COD of less than or equal to 20 mg/L. There is therefore no organic pollution in the lagoon.

4.1.7 Plumb content

The presence of plumb in water is a real health hazard for consumers. In fact, the plumb is a heavy metal whose particles, when ingested, settle in the body. Plumb ingestion is responsible for diseases such as poisoning, childhood defects and mental delays. Figure 8 shows the evolution of plumb in all the sampled surface waters.

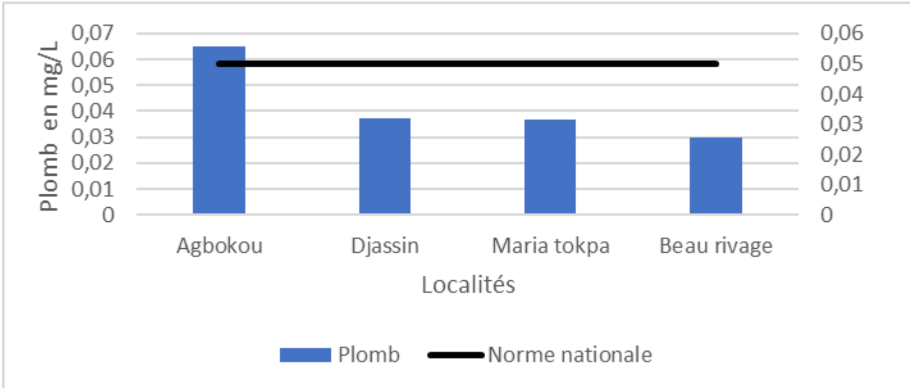

Figure 8. Plumb contained in all sampled surface waters
Source: Survey data, June 2022

Figure 8 shows the plumb variation in the sampled surface waters. An analysis of this figure shows that the values recorded at Djassin (0.0371 mg/L), Maria Tokpa (0.0368 mg/L) and Beau Rivage (0.03 mg/L) are in line with the value set by the WHO and national standards (0.05 mg/L). Only Agbokou (0.065 mg/L) is slightly above the standard because of discharges of wastewater from its soap factory into the lagoon.

4.1.8 Cadmium content

Cadmium is a metal present in the environment in its elemental form or in the form of various salts. It is often associated with lead, copper and zinc ores. Cadmium can naturally leach into water sources (from the soil), as a result of human activity (in the form of refining by-products or through its use in technological applications) or through leaching from certain types of pipes and well components. Figure 9 shows the variation in cadmium in all the analyzed surface waters.

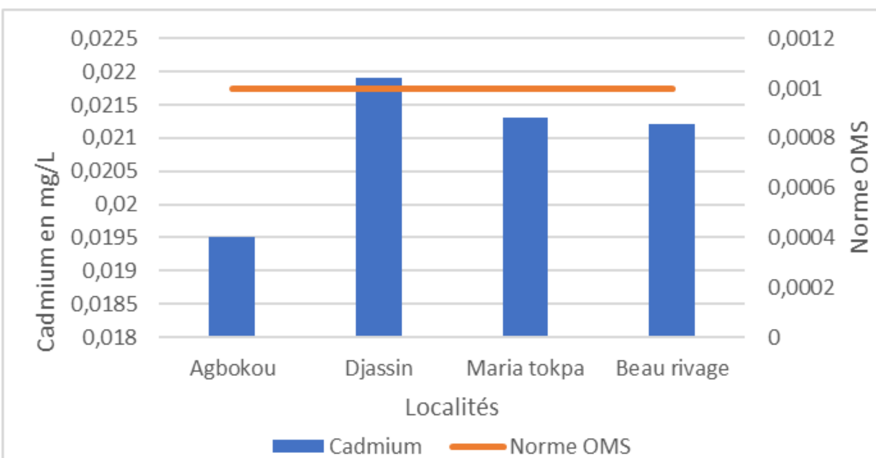

Figure 9. Cadmium content of the analyzed surface waters.
Source: Survey data, June 2022

Figure 9 shows that the highest cadmium value is registered at Djassin (0.0219 mg/L), which far exceeds the WHO standard of 0.001 mg/L and the national standard of 0.005 mg/L. Surface

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water is therefore contaminated by the metallic trace elements of cadmium. Highly toxic, cadmium is a threat to the fishes because it emerges from industrial waste, the use of fertilizers and waste incineration.

4.2 Microbiological quality of water in Porto-Novo lagoon

Bacteria can enter surface water through run-off. Animals such as pigs and poultry often carry salmonella and the bacteria can easily enter the water whenever they have access to water. It is true that the immune systems of villagers who always drink contaminated water are often adapted. However, the risk is still high for children, the elderly and pregnant women whose immune systems are weaker and who drink water contaminated by faecal bacteria. The risk of transmitting diseases such as cholera and gastroenteritis is still high for all consumers of water contaminated by bacteria of faecal origin. This surface water does not meet the required standards, which recommend that surface water should contain neither escherichia coli nor faecal enterococci. Table 2 summarises the microbiological results of analyses carried out on surface water in the lagoon of Porto-Novo.

Table 2. Summary of microbiological results of analyses carried out on surface water in Porto-Novo lagoon

SURVEYS	**STRATEGIES**	**RESULTS**				**STANDARD**
		Agbokou	Djassin	Maria Tokpa	Beau rivage	
Escherichia coli per 100 mL CFU	NFV-08-05. Rapid-E Coli medium (24h at 44°C)	316	684	470	316	0 UFC/100ml
Faecal Enterococci per 100 mL CFU	NFT-90416. SLANETZ medium. (24h-48h at 37°C)	155	264	143	58	0 UFC/100ml

Source: Laboratory results, November 2022.

Surface waters nearby domestic discharges and receiving run-off record high concentrations of faecal Enterococci (between 58 and 264 CFU/100 mL), and Escherichia coli (between 316 and 684 CFU/100 mL). According to the EU and WHO's classification of national standards for surface water, the registered values (> 0 CFU/100ml) classify these waters as of poor quality. The concentrations of Escherichia coli are also very high compared with those of faecal Enterococci. The high presence of Escherichia coli shows that the water is contaminated by faeces. These contaminated waters contain microbes. The values recorded at Djassin show high contamination because of its very high concentration of Escherichia coli. In other words, the surface water of the lagoon at Porto-Novo is contaminated by bacteria of faecal origin. This water contamination could be explained by the neighboring human activity (bathing water, laundry, agriculture and domestic wastewater). Discharges of wastewater and solid waste without prior treatment are the main source of microbial pollution.

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5. Discussion

The physico-chemical and bacteriological analyses of water samples at various sites show that waters have physico-chemical and bacteriological characteristics that exceed national and international standards at all points in the lagoon.

The pH results in the recorded water samples range from 5.86 to 6.28 pH units, indicating that the lagoon's waters are acidic and therefore above the WHO standard of between 7 and 9. This acidity of the water causes physical problems for local residents who practice swimming. These results corroborate those obtained by Chouti W K et al (2017) who found that the pH values of Porto-Novo lagoon's water vary from 6.4 to 6.81 with an average of 6.61. The highest value is observed at station 2 (Douane Tokpa) and the lowest is recorded at station 1 (Djassin pier).

The highest conductivity value is recorded at Agbokou (145 µS/cm). This is below the WHO drinking water standard of 2000 µS/cm. The conductivities are 115 µS/cm, 109 µS/cm and 121 µS/cm respectively at Maria Tokpa, Beau Rivage and Djassin. It can therefore be concluded that the water from Agbokou bank has an accentuated average mineralization, therefore highly conductive, while the water at the other 3 aforementioned sites have a low and average mineralization. DOVONOU, F.E et al (2017) had found similar values in the lagoon which vary from 146.8 to 527 µs / cm with an average of 343.25 µs / cm in the Municipality of Abomey calavi.

Dissolved oxygen has a maximum admissible value of 1.93 mg/l. These analytical results do not comply with the standards that require the dissolved oxygen concentration to be greater than 7 mg/L. These results are similar to those by (Mouzouvi, A, 2012) who found that the lagoon's surface waters of Porto-Novo have dissolved oxygen concentrations below the standard.

The values recorded at local level were 30.92°C, 30.66°C, 30.53°C and 30.21°C respectively. These results exceed the WHO standard of 25°C; and are not very consistent with those found by (Dovonou et al, 2011), who recorded temperature variations ranging from 25.4°C to 34°C in June.

All the sampled waters have plumb and cadmium levels that do not meet the standard set by the WHO. These results are similar to those of Vodougnon (2015) who recorded a value of 0.114 mg/L for plumb; and those of Sohounnon (2017) who recorded a value of 0.003 mg/L for cadmium.

The microbiological analysis of the lagoon's surface water show that all the tested surface waters have high levels of common germs compared with the norm. The presence of these common germs in the well water could be due to a lack of hygiene. This could be explained by unsanitary conditions around the lagoon. Escherichia coli levels in the sampled water ranged from 196/100ml to 470/100ml. This reveals the presence of microbial indicators in the surface water. These results are in line with those found by Adjagodo et al. (2018). It appears from the bacteriological analyses of water samples from the River Ouémé taken in the Municipality of Aguégués that these sampled waters recorded a high bacterial load. In short, the germs (total coliforms, thermotolerant coliforms and E. coli) counted in the water samples during the high-water period are beyond the norm.

6. Conclusion

Due to its location, the lagoon of Porto-Novo represents an ecological and economic potential that should be exploited both for the Municipality of Porto-Novo and for downstream municipalities. Safeguarding its ecological and biological characteristics will help to maintain people's well-being. Unfortunately, this body of water is subject to both physical and bacteriological forms of pollution. Much of this pollution is due to human activity.

The study reveals that most of the parameters do not comply with WHO standards in physical and chemical terms. Likewise, the results of this study show that the lagoon water in Porto-Novo is polluted by faecal enterococci and faecal contamination germs (E. Coli). The faecal contamination germ is very high in the lagoon water; and this because of discharges of domestic wastewater, defecation in the lagoon water, washing clothes and dishes on the banks of the lagoon. It is therefore imperative for authorities and populations alike to take steps so as to remedy this disgraceful situation.

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