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Physicochemical water from the right bank of Senegal River in Mauritania

K. Ould Med Fadel[1]; H. Taouil[1, 2]; S. Elanza[3]; M. Doubi[1]; A. El Assyry[4]; H. Hanafi[5]; A. Amine[6]; H. Houmani[1], S. Ibn Ahmed[1]

1. Laboratory of Materials, Electrochemistry and Environment. Faculty of Sciences, Département de Chimie, University Ibn Tofail Kénitra, Morocco.
2. Laboratoire de chimie analytique et Physicochimie des matériaux, Département de Chimie, Faculté des Sciences Ben M'sik. Université Hassan II de Casablanca
3. Laboratoire de Synthèse Organique et Procédés d`Extraction, Université Ibn Tofail. Département de Chimie,Faculté des Sciences, Kenitra, Maroc.
4. Laboratoire d'Optoélectronique et de Physico-chimie des Matériaux, (Unité associée au CNRST), Université Ibn Tofail, Faculté des Sciences, Kénitra, Maroc.
5. Laboratoire de Physico-Chimie des Matériaux et Environnement, Université Abdelmalek Essaâdi, Faculté des Sciences, B.P 2121, Tétouan, Maroc
6. Laboratory of condensed matter and renewable energy. Faculty of Sciences and Technology. Hassan II University

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L G Bousiakou
ascder@imdlaboratories.gr
+988338273068

Abstract

The study of the water quality of the Senegal River in Mauritania, allowed us to determine through the spatio-temporal variations of a certain number of physicochemical characteristics. Indeed, water sampling was carried out during four companions in the year 2012. The results of the physicochemical analysis presented in this work showed that the pH is close to neutrality and the values found in Calcium, magnesium, total hardness, sodium, potassium, chloride and sulphate levels meet the WHO standards. On the other hand, the recorded turbidity values remain extremely high at certain measurement points. Thus the NdS and MPo stations have ammonium contents which exceed the standard defined by the WHO. We can also observe in this study that the waters of the Senegal River are very influenced, in terms of their chemical composition, by the geological nature of the soil. Consequently, the use of water without prior treatment could constitute a significant health risk.

1. Introduction

The groundwater contamination in an urban environment is due to the infiltration of domestic untreated wastewater into the natural receiving environment, accentuated by favourable hydrogeological conditions [1]. On the other hand, the pollution of the rivers presents multiple negative impacts, affecting various fields; the quality of natural surface waters may result from natural and man-made constraints, as well as the management and economics of these waters. Mauritania, for example, because of its climate, is a water-deficient country. Indeed, the low rainfall, the importance of the evaporation and the geological nature of the soil make Mauritania poor in water resources [2]. In addition, the Senegal River plays a very important role as a main source of surface water for Mauritania, Senegal and Mali, so the waters of this river are likely to be used as drinking water and water of irrigation [2]. The Senegal River faces constraints that threaten its physical, chemical and bacteriological qualities. At different geographical points, this watercourse receives discharges of domestic or industrial wastewater [2]. In addition, numerous studies have been carried out, specifying different physicochemical and microbiological states of water on the right bank of the Senegal River [3, 4]. In our case, we were interested in the evaluation study and the control of the physicochemical quality of the right bank of the Senegal River.

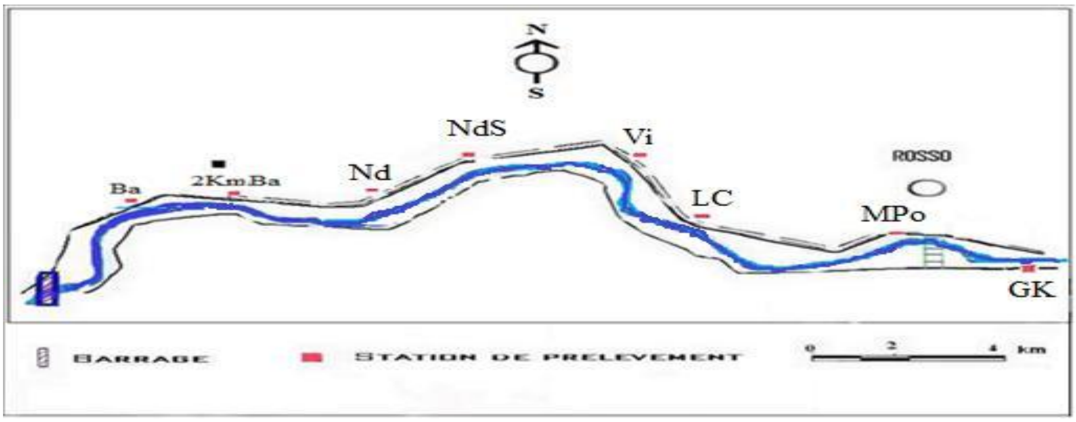

Figure 1: Localisation of water sampling stations of Senegal River

2. Materials and Methods

2.1. *Study environment*

The risk of contamination of the waters of the right bank of the Senegal River by various sources of pollution (domestic discharges, industrial discharges, etc.) and the water table that supplies the whole area with drinking water has been studied [2-4]. For this purpose, our work aims in particular to monitor the state of evolution of the physicochemical quality of the waters of the right bank of the Senegal River, so we chose sampling stations, located on the axis of the river 1). These were chosen according to their accessibility, their proximity to possible sources of pollution. Water withdrawals were carried out during four companions according to the following schedule: August 7, 2012, August 22, 2012, September 13, 2012, and September 25, 2012.

In order to assess and characterize the physicochemical quality of the right bank water in Mauritania and to identify the effect of waste water discharges on the quality of the watercourse, eight stations were selected The main flow axis. These sampling points are chosen as follows:

- Ba: Ring of Rosso, is a station located southwest of Rosso in the site of means of transport (Ring) between Mauritania and Senegal, it is a control station.
- 2KmBa: this is a resort located 2 kilometers from Ring of Rosso.
- N'dourbel: to Rosso noted (Nd); located downstream from domestic wastewater discharges to 3 km from the east of the station
(Ba), represents a place for the discharge of wastewater.
- N'dourbel Station noted (NdS).
- Vi: Station located near the town of Rosso and near the river Senegal.
- LC: Station located about 7 km from the town of Rosso.
- MPo: Station located in the center of town of Rosso at 2 km from Ba, it is an agricultural zone. - GK: Station near Garak: village of fishermen and farmers near the town of Rosso.

2.2. Method of analysis

In situ measurements

On the water samples, we measured certain physico-chemical parameters:

- pH: using a field pH-meter type: HANNA instrument HI 8314.
- Conductivity: using a field conductivity meter type: HANNA instrument HI 8314.
- Temperature: using a field thermometer type: HANNA instrument HI 8733.
- Turbidity: using a Wagtech turbid meter.

Laboratory measurements

From the arrival at the laboratory of water chemistry at the national institute of research in public health in Mauritania (INRSP), we filtered a known volume of water on a filter of porosity 0.45µm, the filtrate is used to The measurement of sulphates, ortho-phosphates, chloride, sodium, potassium, magnesium, calcium, and certain nitrogenous substances. Indeed, the chlorides are measured by Mohr volumetric method in the presence of silver nitrate. The calcium and magnesium ions are metered in with a solution of ethylene-diamine- tetraacetic acid (EDTA) di-sodium salt. The bicarbonates are analyzed by volumetric determination with 0.1 N HCl. For the sodium and potassium ions, we used a Corning flame atomic emission photometer.

3. Results and Discussions

3.1. *Temperature*

Water temperature is an ecological factor that has significant ecological impacts and plays a very important role in increasing chemical activity, bacterial activity and water evaporation. [5] . It affects the density, viscosity, solubility of gases in water, dissociation of dissolved salts, chemical and biochemical reactions, development and growth of living organisms in water and especially microorganisms [6]. The results show that during the month of August, temperatures range from 26.8 ° C to 28.9 ° C (Figure 2), whereas during the month of September temperatures range from 27.2 ° C ° C and 29.6 ° C. Moreover, these values obtained from the water temperature of the right bank of the Senegal River depend on local conditions such as climate, length of sunshine and depth.

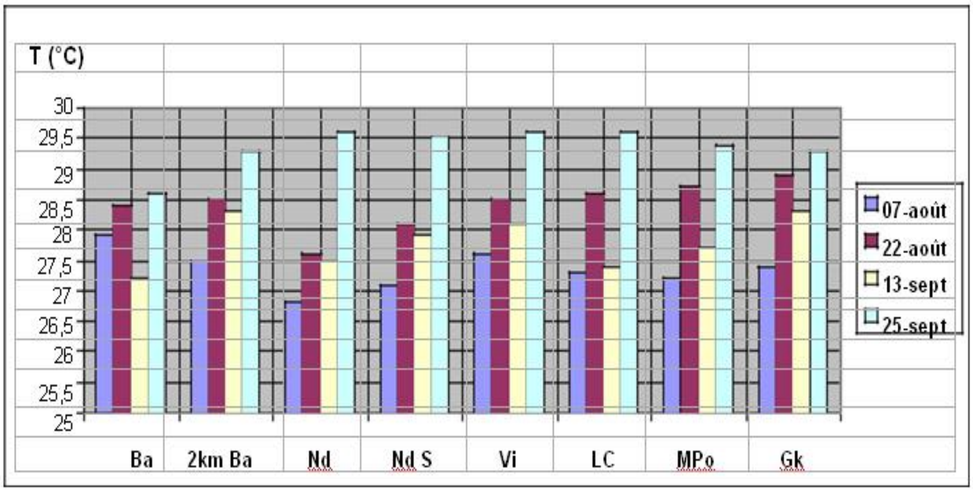

Figure 2: Temporal changes in temperature values

3.2. *Hydrogen potential*

The pH of the water measures the concentration of the H + protons contained in the water. It summarizes the stability of the equilibrium established between the different forms of carbonic acid and is related to the buffer system developed by carbonates and bicarbonates [7]. This parameter characterizes a large number of physicochemical equilibrium. It influences most chemical and biological mechanisms in water. It is very sensitive to temperature, salinity, and respiration of organisms [8]. It is a limiting factor in aquatic ecosystems: if the pH is less than 4.5 or greater than 10 it becomes toxic to living organisms [9]. Thus, FIG. 3 shows that the pH recorded during the month of August oscillates between 6.74 and 8. Similarly, it varies during the month of September, between 6.47 and 7.5. These results show that the pH values are relatively neutral, this observation was confirmed by Diallo [10].

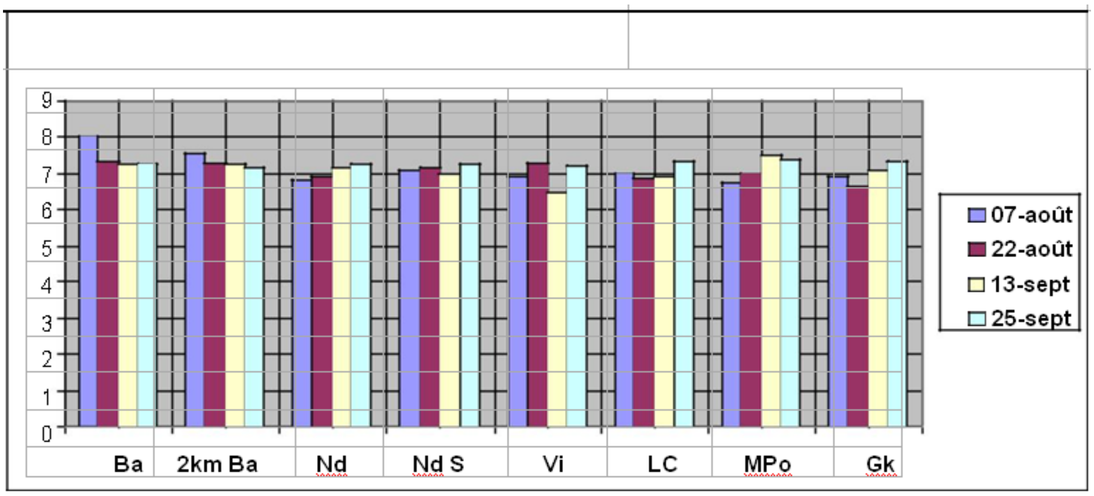

Figure 3: Temporal Evolution of pH values

Moreover, the pH values measured in the waters of the right bank of the Senegal river place the latter in the excellent class of good surface water and show that the waters of the studied stations are waters favorable to irrigation 6.5 <pH <8.5) (Moroccan Standards). These values are also placed within the potability range presented by European standards (6.5 to 9). Furthermore, the pH values found in the different stations studied do not pose a threat to fauna and flora. These results were observed in the case of Wadi Tislit-Talsint in Morocco [11, 12].

3.3. *Electrical conductivity*

Conductivity measurement is a good appreciation of the degree of mineralization of a water where each ion acts by its concentration and specific conductivity. It provides information on the degree of mineralization of the water. In other words, the measurement of the conductivity of the water allows us to appreciate the quantity of salts dissolved in the water. It is more important when the water temperature increases. According to Figure 4, the measures the electrical conductivity of the whole water samples show that they are between 37.5 and 127,8µS/cm was during the month of August. Similarly, the values of the electrical conductivity recorded during the month of September oscillate between 43.2 and 66.2 µs/cm. It notes that these values obtained are very low by input to that reported by TAOUIL et al. [11], whose site different from ours. In addition, the values of the electrical conductivity in the dry season is higher than the rainy season and this may be due to the phenomenon of dilution generated by the Senegal River, this observation was also made by Abdoulaye Demba N'diaye (2014) [3].

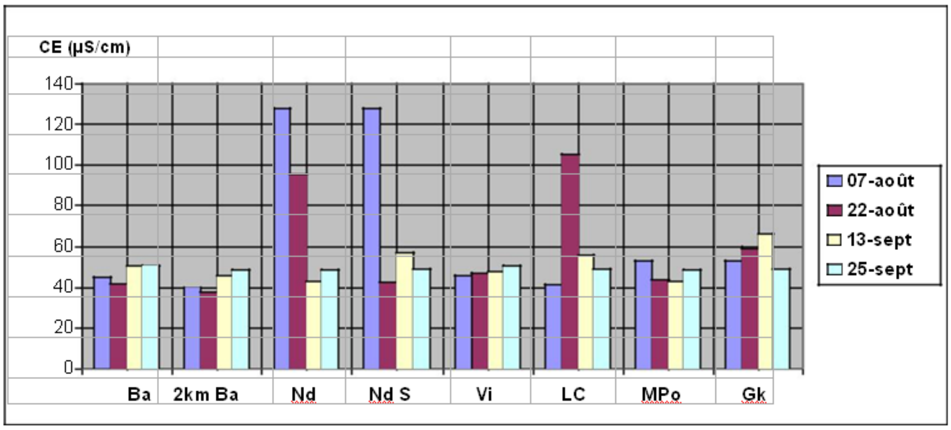

Figure 4: Temporal Evolution of the values of the electrical conductivity

3.4. *Turbidity*

Turbidity of the water is a comprehensive measure that takes into account all the colloidal materials, insoluble, of mineral origin or organic. Of the particles in suspension exist naturally in water, as the silt, clay, organic and inorganic materials in fine particles, and plankton and other microorganisms [13]. The most important health-related effect of turbidity is probably its ability to protect the bacteria and viruses against the disinfection [14]. Thus the reliability and the optimization of the operation of the systems for urban sanitation require the development of methods for the assessment of pollution in continuous: the employment of the turbidimetric for the assessment of pollution of waters is positive and interesting to by its permanent nature and snapshot [15, 16]. In our case and after the figure 5, we note that during the month of August, the maximum value of the turbidity was observed at the level of the station 2km Ba (366 NTU) and the same in the course of the month of September, there is a maximum value of 275 NTU at the level of the stations DFO and GK. According to these results, we find that during the rainy season, with the phenomenon of runoff, the waters of rain to bring with them of the sludge, plant debris, of dead animals, in addition to the leaching of the soil in the region by the waters of the River Senegal, thus making the water of the river very muddy and turbid.

3.5. *Total hardness*

The hardness of a water is due to the presence of divalent metallic elements, Ca^{2+}, Mg^{2+}, Fe^{2+}, Mn^{2+}, Sr^{2+}, etc. The most abundant being the Ca^{2+} and Mg^{2+} ions [14]. The total hardness or hydrotimetric titration of water corresponds to the sum of the concentrations of metal cations with the exception of alkali metals and hydrogen ions [17]. From the results of fig. 6, the analyzes of all the samples taken during the month of July and September show that the values of the total hardness, oscillating from 8ppm to 32ppm. It is found that these values are very low compared to those reported by TAOUIL et al. [11], whose site differs from ours. These values of the total hardness remain below the value indicated by the WHO (200 ppm). Consequently, these values do not pose a danger to the fauna and flora.

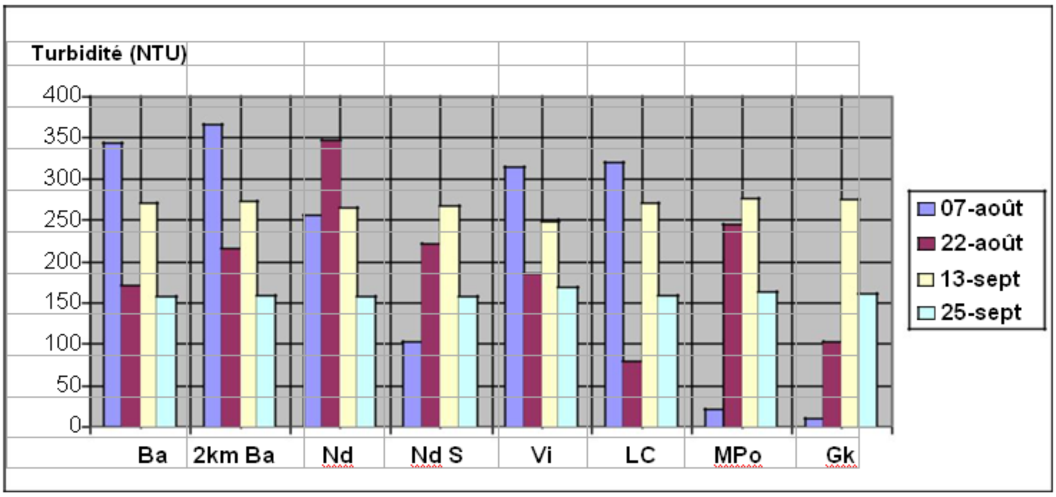

Figure 5: Temporal changes in turbidity values

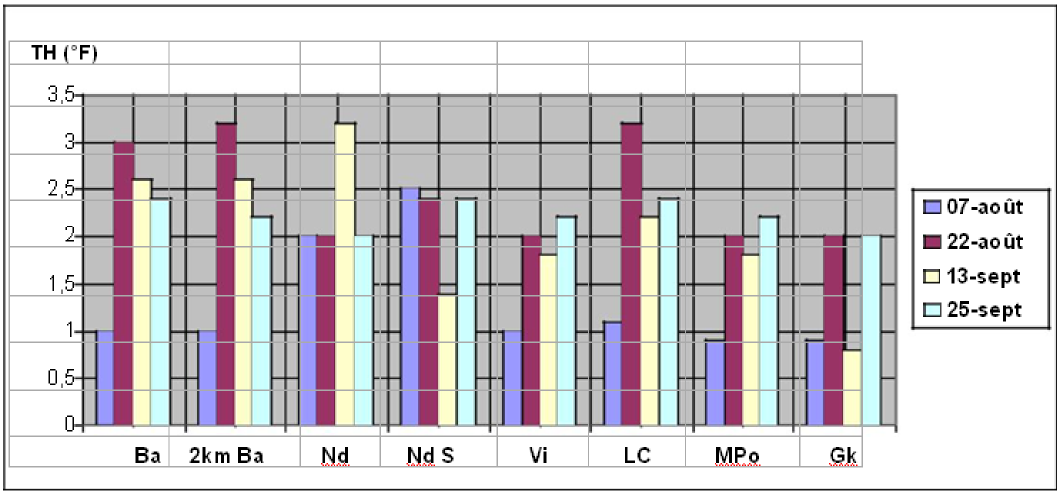

Figure 6: Temporal changes in TH values

3.6. *Calcium and Magnesium*

Calcium is the most widespread element in nature (evaporites, carbonates, etc.), especially in the form of hydrogen carbonates or in the form of sulphates or chlorides [18]. Thus Magnesium is also one of the most prevalent elements in nature. It constitutes about 2.1% of the Earth's crust. This is a significant element of water hardness. The Mg content in water depends on the nature of the soil crossed and can be elevated in the waters passing through $MgSO_4^{2-}$rich soils [18]. In addition, the ions (Mg^{2+}) originate, like calcium ions, from the dissolution of the carbonate formations rich in magnesium. It is these two ions which fix the total hardness of the water. However, water containing Ca^{++} and Mg^{++} ions greater than 200 mg / L can not be used in agriculture [19].

The results of Figure 7 show that the values registered in calcium ions in the four companions oscillate between 0.8 to 25 mg/L. For the magnesium ions, it oscillates between 0.6 to 29.06 mg/L (Figure 8). These values found in calcium ions and magnesium are consistent with the standards of the WHO: 50mg/L for the magnesium and 270 mg/L for calcium.

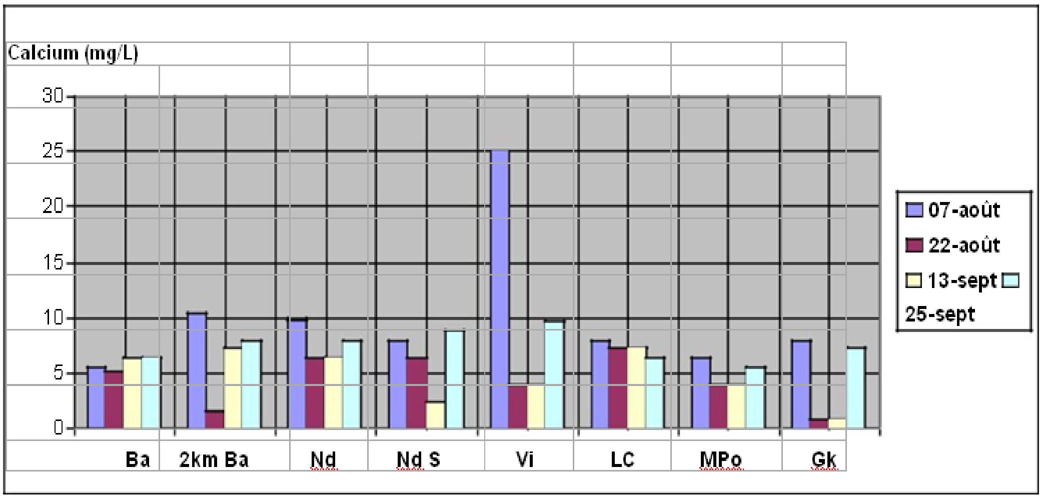

Figure 7: Temporal Evolution of Values in Calcium

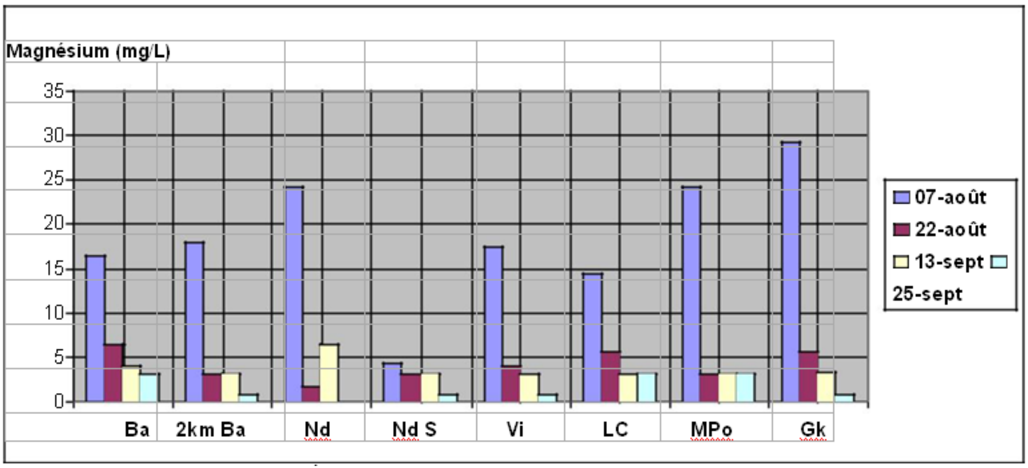

Figure 8: Temporal Evolution of the values in magnesium

3.7. *Bicarbonate*

alkalinity characterizes the capacity that has a water to maintain its pH constant. It is proportional to the load of the water in the hydrogénocarbonates, carbonates and hydroxides of the environment. These types of anions constitute the main buffer of pH of the freshwater systems. They allow for the recovery of initial conditions in the case of pollution by spills acids [18]. As well the main factors that promote the onset of bicarbonates are moving to the high values of pH, temperature and salinity. The set of samples taken show that levels of bicarbonate ranging between 30 and 79 mg/L During the month of August (Figure 9) . For the values recorded during the month of September, they oscillate between 13 and 73 mg/L. The turbidity is very important, as the literature indicates; this high turbidity could be a vector of all the microbes, parasites, and other [20]. As well, these values remain lower than those found by Kourradi [18] whose site different from ours. In effect, this author to observe that the pH studied is more basic and promotes high levels of bicarbonate.

3.8. *Sodium and potassium*

in the nature, the levels of sodium in the water are relatively constant and vary only in the order of a few tens of milligrams per liter [18]. Sodium also contributes directly to the total salinity of the water and can be toxic to sensitive crops such as carrots, beans, raspberries and strawberries [21, 22]. The analysis of samples taken in the different sites of the right bank of the River Senegal shows that the levels recorded in sodium ions oscillate between a minimum value of 2 mg/L and a maximum value of 26 mg/L (Figure 10). As well, these values found remain largely lower than the standard of the WHO (150 mg/L). Therefore, the waters studied in sodium ion meet the standards set by the WHO.

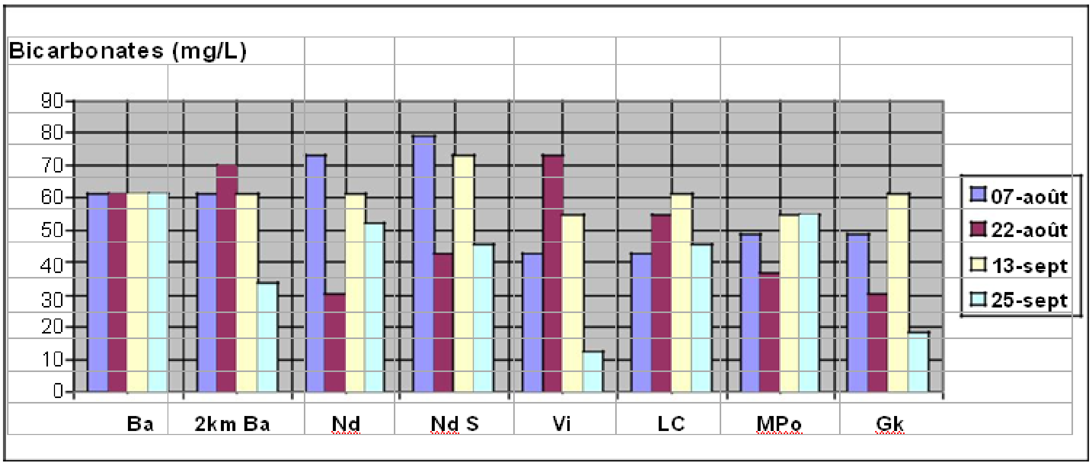

Figure 9: Temporal Evolution of the values bicarbonate

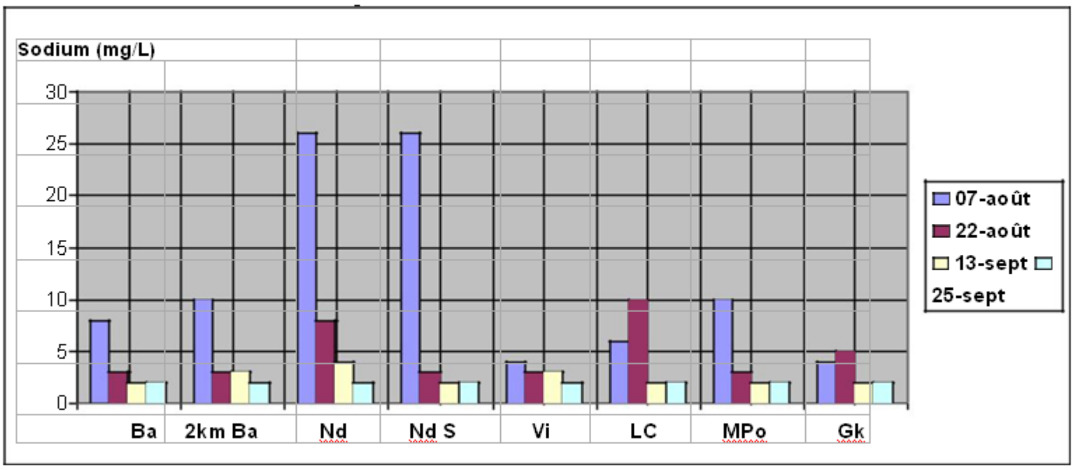

Figure 10: Temporal Evolution of the values in sodium

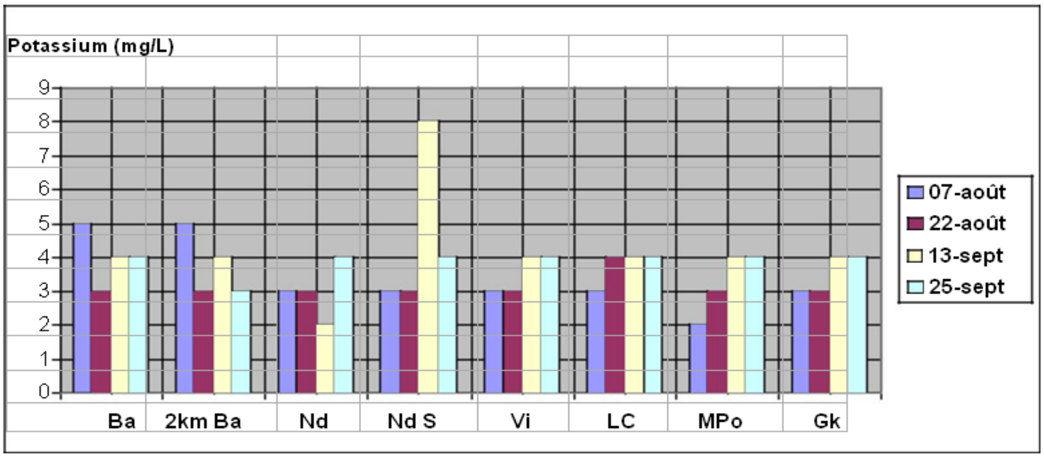

Figure 11: Temporal Evolution of the values in potassium

As regards the potassium, this last is the result of the Alteration of potassic clays and the dissolution of chemical fertilizers that are massively used by farmers [23, 24]. Potassium is a very widespread in nature and can come from leaching of SRG, of clays and phytosanitary products [18]. According to the figure 11, we find that, during the four companions, the levels of potassium oscillate between a minimum value of 2 mg/L and a maximum value of 8 mg/L, these values found remain largely lower than the standard defined by the WHO (12 mg/L). Therefore, the waters studied in K ion meet the standards set by the WHO.

3.9. *The chlorides, sulphates*

Chlorides are of inorganic anions important contents in variable concentrations in natural waters, usually in the form of sodium salts (NaCl) and potassium (KCl). The levels of chlorides of waters are extremely varied and related primarily to the nature of the land crossed, and usually the content of chloride ion of natural waters is less than 50mg/l [25]. As well the set of samples taken ovipositing the four companions, for different sites studied show that the levels of chlorides vary between 3.35 and 24, 85 mg/L (Figure 12). However these levels obtained in chloride ion remain below the standard set by the WHO (200 mg/L).Therefore, the waters studied in Cl- ion meet the standards set by the WHO. As regards the sulphate ions, they are very widespread in natural waters and come primarily from the erosion, factor that constitutes the main agent of enrichment of surface waters by dissolution of gypsum or well by oxidation of the surfaces of the substrates or of the organic matter of the soil [18]. As well, the sulphate can come from bacterial oxidation of reduced compounds of sulfur, including metal sulphides, and organic sulfur compounds. The results obtained in the Figure 13 show that the sulphate ions recorded during the month of August oscillate between 4 and 160 mg/L. Similarly, they vary in the course of the month of September, between 42 and 65mg/L. According to the standards of the WHO (250 mg/L), all stations explored meet the standard set by the WHO. Consequently, the levels found in sulphate may not contribute to the contamination of the waters of the stations studied.

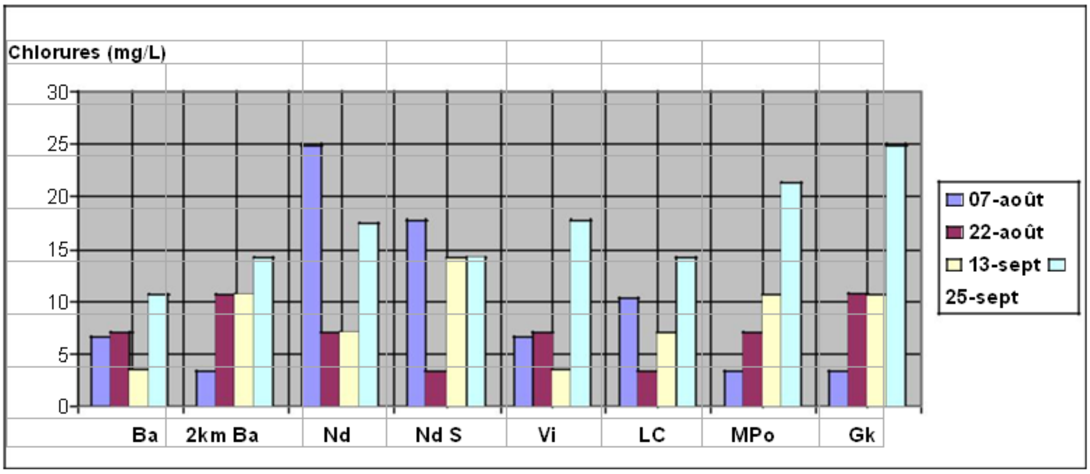

Figure 12: Temporal Evolution of the values of chloride

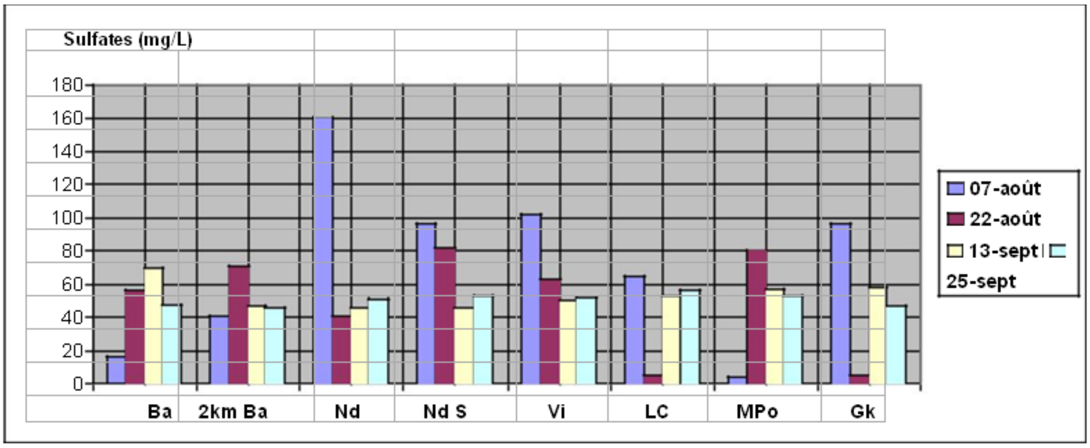

Figure 13: Temporal Evolution of Values in sulphate

3.10. *Nitrates*

Nitrates constitute the nitrogen form the most dominant in the course of the water and in groundwater. They generally come from the decomposition of the organic matter by bacterial oxidation of nitrite and thus constitute the ultimate product of nitrification. The contributions of NO3- come mainly from the flow of the waters on the watershed, the side inputs, cultures (nitrogen fertilizer).

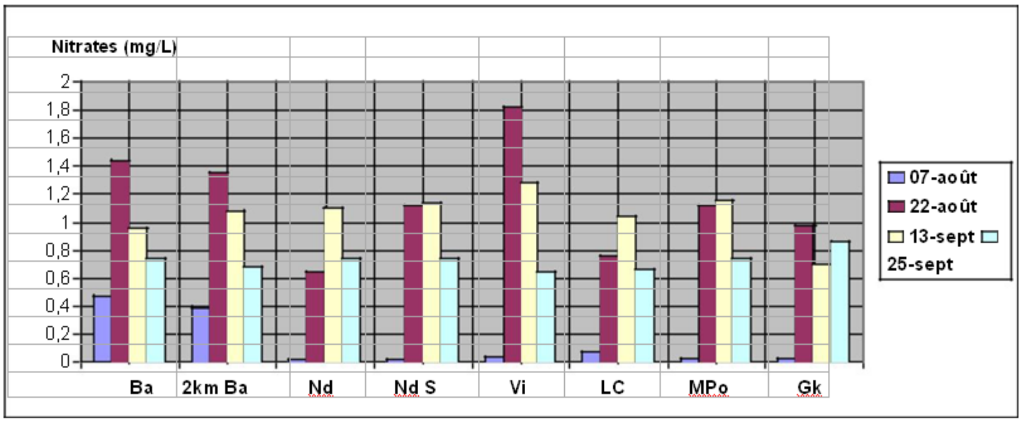

Figure 14: Temporal Evolution of the values of nitrates

3.11. *Nitrites*

Nitrites constitute the most often an intermediate stage little stable between the ammonium ions (NH4) and nitrates (NO3-). As well nitrite can also come to incomplete oxidation of organic materials.

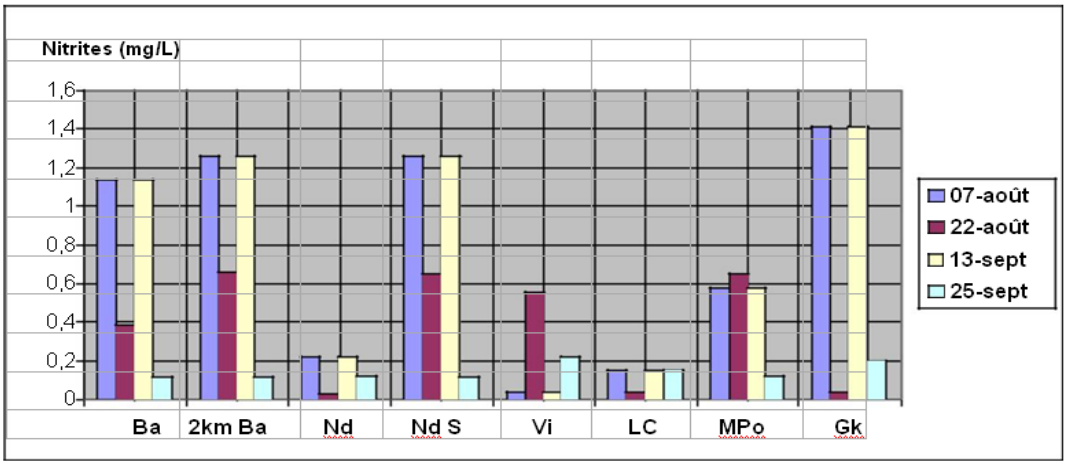

Figure 15: Temporal Evolution of the values of nitrites

The results obtained in the Figure 15 show that the levels of nitrites recorded during the month of August oscillate between 0.04 and 1.4 mg/L. Similarly it varies during the month of September, between 0.1 and 1.4 mg/L. According to these results it is observed that, certain points of measurement to know BA, 2km Ba, NDS, DFO and Gk levels of nitrites exceeds the standard defined by the WHO (0, 1 mg/L), and this may be due that nitrite can be related to the bacterial oxidation of ammonia [27].

3.12. *Ammonium*

In the surface waters, the ammoniacal nitrogen comes from the organic matter and nitrogen gas exchanges between the water and the atmosphere [28]. As well the ammonium is the product of the final reduction of organic substances nitrogen and of the inorganic matter in the waters and soils. The ammonium ions also originate from the degradation of animal proteins, of domestic effluents (urea) and urban runoff [29]. In addition, the ammonium being toxic to the human body, the presence in significant quantity degrades the quality of the water, the more it is an element indicator of pollution. According to the results obtained in the figure 16, the levels of ammonium recorded during the month of August oscillate between zero concentration and 0.55 mg/L (station DFO). Similarly, they vary in the course of the month of September, between 0.18 and 0.62 mg/L (station NDS). We find that some points of measures such as NDS and DFO levels of ammonium that exceed the standard defined by the WHO (0, 5 mg/L), and this can be explained by the discharge of wastewater to the level of the station NdSet by cultivated fields located in the vicinity of the station DFO.

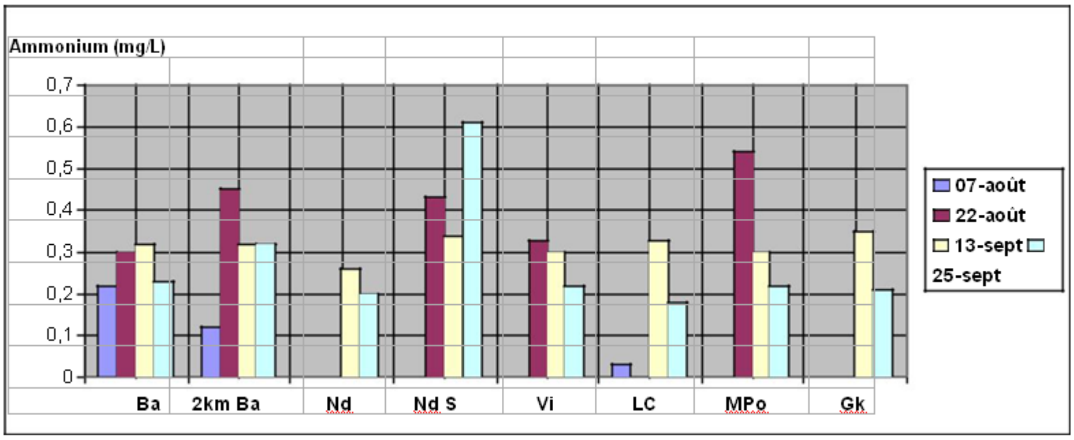

Figure 16: Temporal Evolution of the values of ammonium

3.13. *Orthophosphate*

Ortho-phosphates have more often an urban origin (components of detergents) or agricultural (Leaching of fertilizer); they are such as nitrates, a major nutrient for plants which can, in aquatic environments, lead their proliferation from 0.2 $mg.l^{-1}$ [30]. The results obtained in the Figure 17 show that the levels of ortho-phosphates recorded during the month of August oscillate between 0.1 and 1.8 mg/L. Similarly they vary during the month of September, between 1 and 8.3 mg/L. As well these values obtained are usually higher by comparison with those observed by a recent study [30, 31], in a study area different from ours.

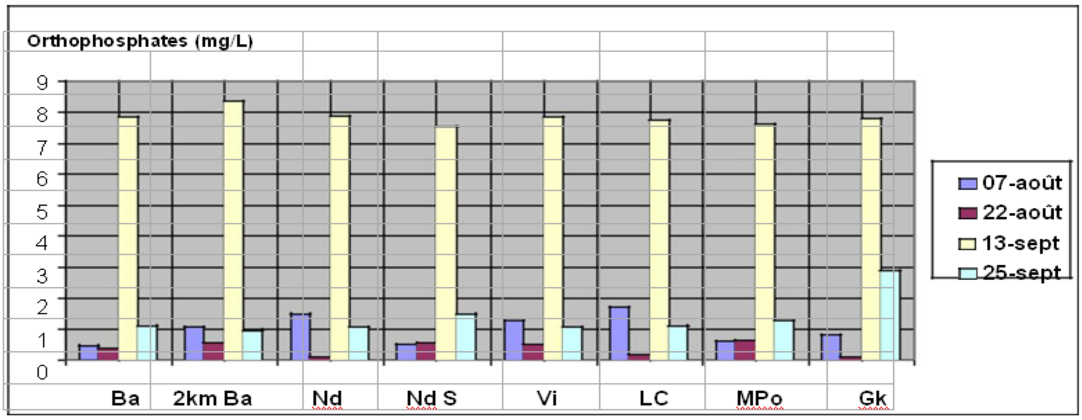

Figure 17: Temporal Evolution of Values in orthophosphate

Conclusion

The present work fits into the framework of the assessment of the quality physico chemical of an ecosystem which is the Senegal River, the case of the town of Rosso and its surroundings (Mauritania). According to the results obtained, it is interesting to note that the values of pH are relatively neutral. In addition, the values of the pH measured in the waters of the right bank of the River Senegal place these last in the class of excellent to good of surface waters. In effect the values found in calcium ions and magnesium are consistent with the standards of the WHO therefore the values of the total hardness respects the value indicated by the WHO, in addition, the waters studied in sodium ions, potassium, chloride and sulphate meet the standards set by the WHO. By contrast, the recorded values of turbidity remain extremely high. Some points of measurement to know NDS, DFO levels of ammonium that exceed the standard set by the WHO. We can also see in this study that the waters of the River Senegal are very influenced, at the level of their chemical composition, by the geological nature of the soil in the region. In fact the very harsh climatic conditions cause its drainage and therefore make it vulnerable to problems of erosion and leaching.

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