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Contribution to the Study of Water Pollution in the Nunez River estuary, (Republic of Guinea)

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ABSTRACT

Bauxite mining offers an important livelihood strategy, a source of economic and social development relevant to countries with this natural wealth. It emerges, from the observations and extensive bibliographical reviews, that this exploitation has direct impacts on estuarine ecosystems through the establishment of ports and mining industries, hence our research theme "Contribution to the study of the impacts of industrial activities on the estuarine ecosystem of the Nunez River" In addition, the observation on the ground tells us that despite the efforts made by the authorities through the competent institutions and the investors, reducing the environmental impacts generated by this mining operation often has problems and insufficient capacity to deal with them, as revealed by our study conducted on the Nunez estuary. The hypothesis of this theme can be summarized as follows: The negative effects of the major pollutants of the Nunez River estuary due to the installation of industrial units, associated with the impacts related to climate change in the locality contribute to the dysfunction of the estuary, in turn to the reduction of opportunities and ecosystem services offered by the Nunez River. Nevertheless, given the high variability of the recorded values of the physicochemical parameters of the estuarine waters (temperature, pH, electrical conductivity, turbidity, salinity, dissolved oxygen, nitrate, nitrite, dissolved solids, suspended solids and phosphate) it seemed necessary to study them. Eleven sampling sites served as a study framework, the CERE/UGANC laboratory, as an analytical framework.

Keywords: Industrial activities, estuarine ecosystems, environmental impacts, pollution.

INTRODUCTION

The integrated coastal and marine zone (ICMA) is invested every day for energy, transport, mariculture, maritime recreation, and therefore more subject to anthropogenic action [1]. This general reality remains relevant with regard to the study area of this work, which is an integral part of the Guinean coastal zone. Urban space now accounts for more than 70% of populations in both developed and developing countries, which has resulted in an accumulation of investments in marine areas and estuaries for several decades. As a result, the control and evaluation of the ecosystems of these anthropogenic environments is a major issue that relates to the control of the risks to which the components of this zone are exposed. The discharges from the city of Kamsar and its industrial and port facilities into the Nunez River estuary are considered one of the main causes of degradation of these aquatic environments.

Note among other things the findings recorded according to the main results after

study and analysis: A disturbance of the physicochemical parameters of the waters of the estuary. The procedure adopted in this methodology is the sampling of water at the various points supposed to be the points of convergence of materials from the city of Kamsar and its facilities for analysis at the CERE/UGANC laboratories for water.

Thus, in **[1]**., the author draws on the American experience to provide a contribution to the understanding of the functioning of integrated coastal and marine zone management (ICZM) and explain its maritimization process, for which he notes a significant advance recorded by the France. His reflection on ICZCM demonstrates the importance of this ecological zone, which is particularly sensitive to human activities. According to him, this area contains most of the planet's biological diversity and more than 60 per cent of the world's population is now living there, representing about 3.8 billion people living there, representing about 3.8 billion people living in a land band that does not exceed 100 kilometers from the shoreline.

It can be estimated, according to this author, by extrapolation of the data available in the countries that have made the calculation that the number of kilometersof natural shorelines disappearing in the world due to development is on average between 5 and 10 kilometers each day. According to **[2]**.in the 1960s develops environmental sensitivity, with the awareness that human activities have an impact on the environment. Burkina Faso is a country whose economy has always been fuelled by agricultural and livestock resources until 2009. Nowadays the country is experiencing an unprecedented mining boom. The international context but also the adoption of its new mining code in 2003 (Law No. 031-2003/AN of 8 May 2003), more favorable to private investment are the main causes of this feat of the country in the mining field. Since 2009, gold has been Burkina Faso's leading export product **[3]**.

The coastal areas of West Africa in general and Guinea in particular are home to important industries, particularly in the mining, agribusiness and tourism sectors, as well as urban and coastal residences, which generate waste and pollution. Many coastal areas do not have adequate waste and wastewater treatment systems. As a result, significant volumes of untreated sewage and waste are dumped into nature, polluting soil and water. Kamsar and its surroundings, wastewater discharges are largely responsible for the degradation of the quality of the coastal environment resulting in the short-term health of continental and marine fauna and flora **[4]**.

As for **[5]**. Guinea's coastline is characterized by 300 km of coastline, mangroves, marine protected areas and significant fish biodiversity. It is the site of various socio-economic activities, including the exploitation of fishery resources. However, these resources are threatened by the construction of many mineral ports. This situation is likely to cause serious damage to fisheries biodiversity in the absence of an adequate effects assessment model to make an informed choice of environmentally sound development scenarios. Large mining operations have the potential to contribute significantly to air pollution, especially in the operation phase.

All activities during ore extraction, processing, handling and transportation depend on equipment, generators, processes and materials that generate hazardous air pollutants. **[6]**

2.2 EQUIPMENT AND METHOD

2.2.1 Monograph of the City of Kamsar:

The city of Kamsar is currently experiencing exponential population growth associated with the effects of modernization, economic and social development. Kamsar, originally a small fishing village, is a town in northwestern Guinea located about an hour and a half north of Conakry, in the Rio Nunez estuary, on the Atlantic Ocean. It is an industrial center of the Company of Guinea bauxite (CBG) in rail connection with the nearby Sangaredi tray, which is one of the world's largest bauxite reserves.

The industrial city of Kamsar is largely owned by CBG. The city of Kamsar is one of the best organized medium-sized cities in the country. Thanks to the establishment of CBG, it has permanent access to electricity and running water. A modern hospital is also available for the population. It is a sub-prefecture with a population that far exceeds those of some prefectures of Guinea and falls under the prefecture of Boké **[7]**.

Figure 1 Sampling station SKB1- SKB11*)*

The Rio Nunez, a name that mysteriously resonates throughout the historical fabric of Kakandé. A river that winds for 80 km all the lowlands north of BOKE. Born from the junction of the Tinguilinta and Bourounao, the two kiss in Baralandé to let emerge this long river-inlet, curiously called Rio Nunez (river of Nunez) by the first Portuguese explorers of the area; In 1444 the explorer Nûno Trûstao had perished there with 20 of his men, mortally marked. Thus, in this estuary, barges of 8,000 tons of 23 are responsible for transporting ore from collection points for the high seas or stationing ore carriers of more than 210,000 tons. Every year, about 100 million tonnes of bauxite are transported by sea **[8]**.

2.2.1.1 Mining ports: Eight **(8)**. Mining ports eat away at this natural potential on a daily basis:

The SMB port of Dapilon:
The SMB port of Katougouma:
The Rusal port of Dougoula:
The Rusal port of Tarensa:
The GAC port of Kamsar: The CBG port of Kamsar:
The port under construction of Ashapura:
The port under construction in Bogoraya:
The port Under construction Ségheriré:

Photo 2.2 CBG and GAC factory and port in Kamsar (aerial view)

2.3 State of water pollution of the Nunez Estuary

2.3.1 Methodology:

The characterization of the waters of the Nunez Estuary was based on the study of the following physicochemical parameters: Temperature (°C), pH, electrical conductivity (µs/cm), turbidity, salinity (S%0), Dissolved oxygen (mg/l), Nitrites(mg/l), Nitrates(mg/l), TDS (mg/l), TSW(mg/l), and Phosphates (mg/l), for the eleven sampling sites in Kamsar and the average of their measurements for the three data collection seasons are recorded in the tables (see Appendix)

2.3.1.1 Sampling: Data were taken during three seasons namely the dry season (January 2020), the rainy season (May 2021) and the shoulder season (November 2021). That's three data collection campaigns and we spent three days per campaign. For each campaign on the first day, our day of arrival at the site and day of preparation for the excursion; the second day, we leave at 6:30 minutes for the left bank, as well as from the control station which is off the sea to go to Kanfarandé

(about 25 km of journey). Arrival at 2:30 pm, a short rest of 30 minutes to leave with the right bank to arrive to arrive at Dougoula port around 7 pm. The next day resumed from 6:30 am from the stopping point of the day before to go to CBG / GAC port near the control station around 11 am. Along this route we have 11 sampling sites. At the level of each site with a multi-parameter device, we take temperature (using a HANNA thermometer model Checktemp1), turbidity (with a Secchi disk), and geographical coordinates (using a dragon-type GPS). Thus, for water samples for the analysis of physicochemical parameters, it is in mini plastic bottles of 33cl well rinsed beforehand then filled and hermetically sealed to then put everything in coolers to send them to the laboratory for analysis.

RESULTS, INTERPRETATION AND DISCUSSION

3.1 Characterization of the pollution status of the Nunez River estuary ecosystem, in connection with industrial activities

3.1.1 State of water pollution of the Nunez Estuary (Physicochemical parameters and averages of their values for the three seasons (data collection campaigns)

3.1.1.1 Water temperature of the Nunez

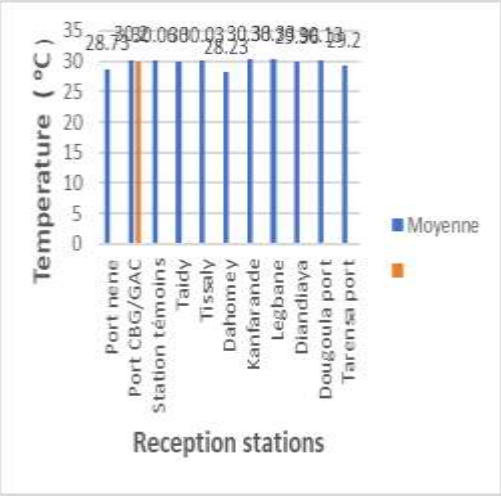

Figure 3.1 Average water temperatures of the Nunez according to the different stations.

Figure 3.1 shows that the lowest average temperature was observed during these three (3) seasons in the Dahomey station (28.23 oc), while the highest in the nearby stations of Kanfarandé and Légbane (30.33 each). Port CBG/GAC, Dougoula port, Control Station, Tissaly (30.2, 30.13, 30.06, and 30.03) have slightly elevated temperature averages compared to the WHO standard (t ≤30). The stations of Taidy, Diandiaya, Tarensa port and Port néné (30, 29.96, 29.2 and 28.73) have temperature averages in accordance with the standard. Thus, the average temperatures recorded on the Nunez River estuary are in the range 28.23 to 30.33°C. They are relatively close to the values obtained by [9], in a study carried out on five rivers in Cameroon, and better are not very far from the WHO standard and cannot, therefore, predict the existence of a risk of accelerated growth of microorganisms and algae that can lead to a pronounced degradation of the receiving environment. According to [10], these values are favorable to good growth of commonly farmed fish species.

3.1.1.2 Potentiel d'Hydrogène (pH)

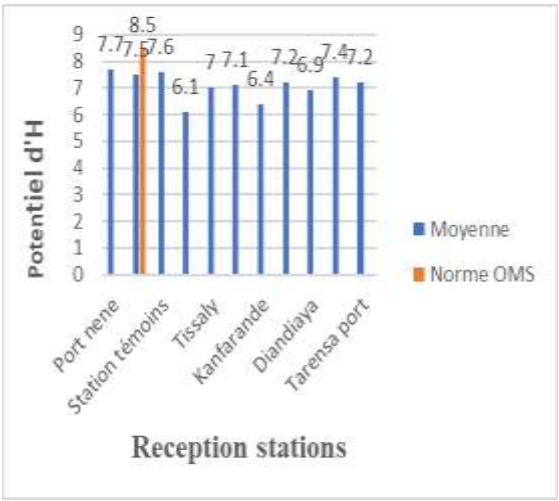

Figure 3.2 Average of the hydrogen potential of the waters of the Nunez according to the different stations k.

Figure 3.2 shows that the lowest average pH was observed during these three (3) seasons in the Taidy station (6.1), while the highest in the Port nene station (7.7). The control station, Port CBG/GAC, Dougoula port,

Tarensa port, Légbane, Dahomey and Tissaly (7.6, 7.5, 7.4, 7.2, 7.2, 7.1 and 7.0) have pH averages approaching the upper limit of the WHO standard (6 to 8.5), while Diandiaya and Kanfarandé (6.9 and 6.4). The average pH values are in the range of 6.10 and 7.70. These same results were found by **[11]**.) in streams. **[11]**.in Cameroon. These near-neutral values are characteristic of the majority of surface waters and therefore do not indicate acid or basic pollution of the waters of the Nunez River estuary. They translate according to the grid of **[12]** Good quality waters and especially for aquaculture

3.1.1.3 Electric Conductivity:

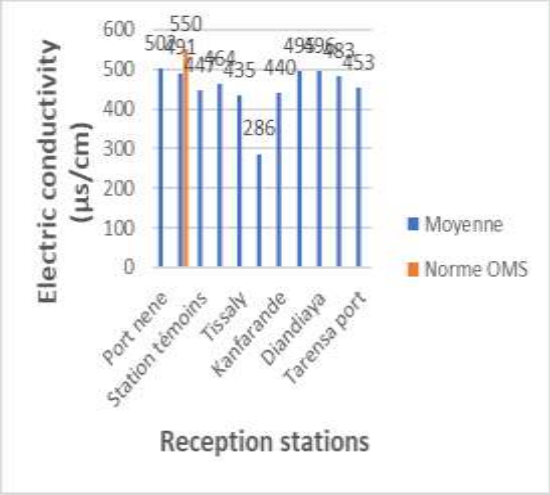

Figure 3.3 Average electrical conductivity of Nunez water according to the different stations

Figure 3.3 shows that the lowest average conductivity was observed during these three (**3)** seasons in the Dahomey station (286), while the highest in the Port nene station (502). Diandiaya, Légbane, Port CBG/GAC, Dougoula port, Taidy and Tarensa port (496, 495, 491, 483, 464 and 453) have mean values that are close to the WHO standard (550). The other stations display averages that are increasingly below this benchmark value, namely the norm. Conductivity refers to the property that a solution has to conduct electric current. This measurement makes it possible to quickly assess the degree of mineralization of a water, i.e. the amount of ionized dissolved substances present in it. The average electrical conductivity of group 1 is 3885.89µS/cm, which shows that the stations constituting this group are strongly Grid-mineralized from **[13]**. It should be noted that these values are much higher than those observed on the waters of the Nunez estuary and by **[14]**.and the limit value of 50µS/cm reported by **[15]**. Thus, the conductivity averages observed on the waters of the Nunez estuary are well below the WHO standard. These shortcomings of these averages compared to the norm can be interpreted as pollution. This may be related to the activities that take place there by promoting environmental pollution

3.1.1.4 Turbidity

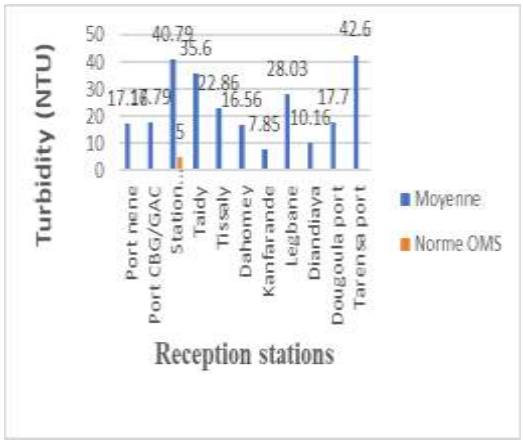

Figure 3.5 Average turbidity of the waters of the Nunez according to the different stations

In this figure 3.5 we note that the lowest average turbidity is noticed during these three (3) seasons in the Kanfarandé station (7.85 NTU), while the highest in the Tarensa Port station (42.6 NTU). Control station, Taidy, Légbane, Tissaly, Port CBG/GAC, Dougoula port, Port nene, Dahomey, Diandiaya, (40.79, 35.6, 28.3, 22.86, 17.79, 17.70, 17.16, 16.56 and 10.16) have average turbidity ranging from two to more than eight times higher than the norm. These disproportionately high averages of the turbidity of the Nunez River estuary compared to the norm indicate that this may be related to the activities that take place there by promoting environmental pollution

3.1.1.5 Salinity

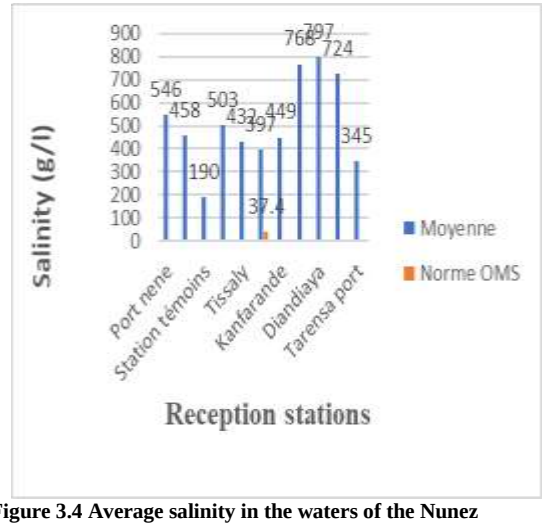

Figure 3.4 Average salinity in the waters of the Nunez according to the different stations

Figure 3.4 shows that the average of the lowest salinity is noticed during these three (3) seasons in the control station (190 g / l), while the highest in Diandiaya (797 g / l). Légbane, Dougoula port, Port nene, Taidy, Port CBG/GAC, Kanfarandé, Tissaly, Dahomey and Tarensa port (768, 724, 546, 503, 458, 449, 432, 397 and 345), have the values of their very high averages compared to the WHO standard (37.4. These disproportionately high averages of the salinity of the Nunez River estuary compared to the norm indicate that the pollution is remarkable and it could be related to the activities of the environment.

3.1.1.2.6 Dissolved oxygen

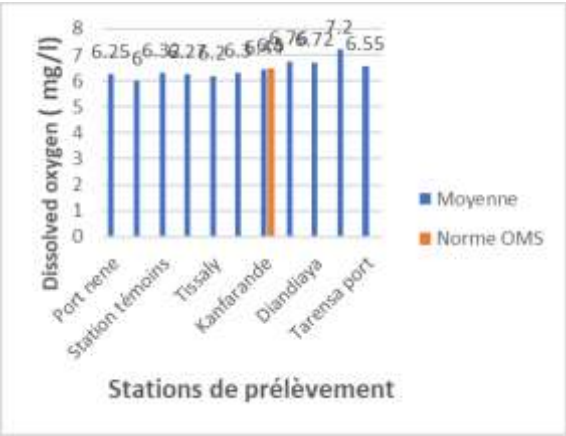

Figure 3.6 Average dissolved oxygen in the waters of the Nunez according to the different stations

Figure 3.6 shows that the lowest average dissolved oxygen is noticed during these three (3) seasons in CBG/GAC port (6.00), while the highest in Dougoula port (7.20). Légbane, Diandiaya, Tarensa port (6.76, 6.72, 6.55) have averages that are higher than the WHO reference standard (6.5 mg/l) for this parameter; Kanfarandé, control station, Dahomey, Taidy, Port nene and Tissaly (6.40, 6.32, 6.30, 6.27, 6.25 and 6.20) have increasingly lower averages compared to this standard. Four stations out of 0nze have high averages of dissolved oxygen and the other seven (7) go digressively from 6.40 to 6.00 a deficiency compared to the standard which tells us that this can be related to the activities that take place there by promoting the pollution of the environment. Note that the averages of dissolved oxygen for the waters of the estuary of \Nunez are all at or slightly below the WHO Standard. Thus, these waters are about to be in danger for living plant animals. To confirm this [16] tell us that the stations of the upper reaches of the river, have high values of transparency and dissolved oxygen of 2.04 m and 7.66 mg / L respectively. Indeed, the clarity of the water affects the amount of oxygen produced by the environment. Clear water will allow light to penetrate more and thus promote photosynthesis. Oxygen values in this range are acceptable for initial and other life stages in tropical ecosystems in accordance with the Canadian Water Quality Guidelines [17]. This parameter is an integral part of ecosystem metabolism. Fish and other animals consume it for the maintenance of their metabolism (phenomenon of breathing

3.1.1.2.7 Nitrates et Nitrites

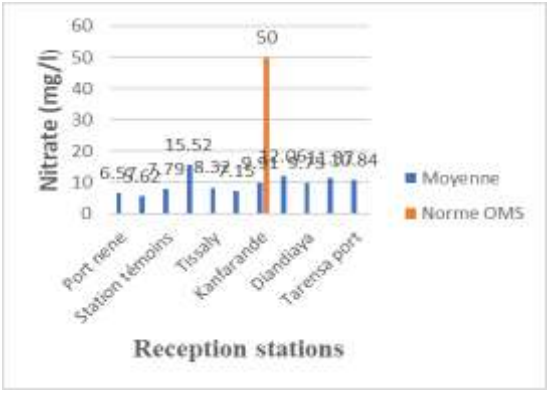

Figure 3.7 Average nitrate levels at different stations

From this figure 3.7 we find that the lowest average nitrate values are noted during these three (3) seasons in CBG/GAC port (5.62), while the highest in Taidy (15.52). Légbane, Dougoula port, Tarensa port, Kanfarandé, Diandiaya, Tissaly, Control Station, Dahomey and Port nene (12.06, 11.37, 10.34, 9.91, 9.75, 8.32, 7.79, 7.15 and 6.57) have averages that are much lower than the WHO standard (50 mg/l). A deficiency compared to the standard that tells us that this can be related to the activities that take place there by promoting the pollution of the environment. These rates are also explained by the anaerobic conditions existing in places by [18] the abundance of macrophytes and favoring a fairly advanced nitrification of organic matter. Total nitrogen has values between 3.91 and 5 mg/L with an average of 4.56 mg/L. Although there is no toxicity criterion for total nitrogen, a concentration higher than 1.0 mg/L in surface waters is considered indicative of an over-fertilization problem in the environment [19] this therefore indicates a critical state of pollution and predisposes above all the waters of the group.

3.1.1.2.8 Nitrite

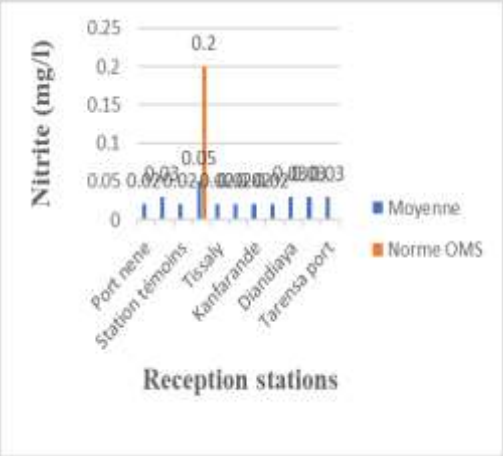

Figure 3.8 Average nitrites in Nunez waters by station

From Figure 3.8 we find that the lowest average nitrate values are noticed during these three seasons in the following stations: Port Nene, Control Station, Tissaly, Dahomey, Kanfarandé with the value (0.02), while the highest in Taidy (0.05). Port CBG/GAC, Diandiaya, Dougoula port and Tarensa port have an identical value (0.03). A deficiency compared to the standard which tells us that this can be related to the activities that take place there by promoting environmental pollution, because nitrites have concentrations between 0.02 and 0.05 mg / L against a normal value of 0.2 mg / L. These low concentrations can affect the development of aquatic species, as water containing nitrites, even at low doses, may be considered suspicious or even lethal to fish [19]

3.1.1.2.9 Taux des solides dissous[1]

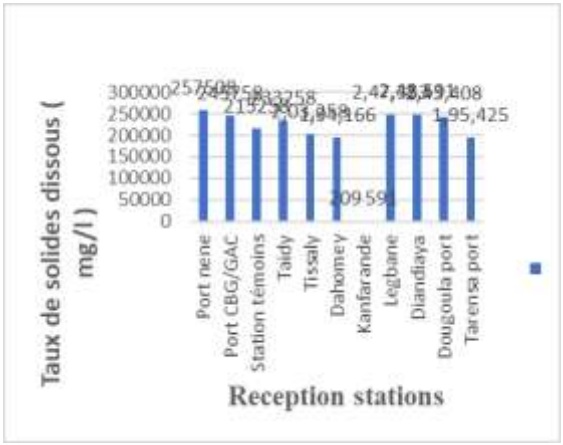

Figure 3.9 Average dissolved solids in Nunez waters across stations

Figure 3.9 shows that the highest average dissolved solids rate is at Station No. 9 and the lowest at Station No. 1. But the WHO standard for this parameter is less than 1000 mg/l. We notice that all stations have very high averages compared to the standard. Therefore, it can be said that this can be related to the activities that take place there by promoting environmental pollution.

3.1.1.2.10 Matières en suspensions

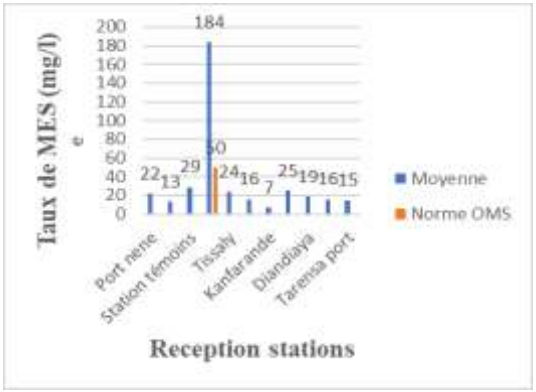

Figure 3.10 Averages of suspended solids in Nunez waters by station

Figure 3.10 shows that the lowest average dissolved solids rate is noted during these three (3) seasons in the Kanfarandé station (7 mg/l), while the highest in the Taidy station (184 mg/l). In all other stations the averages are very low compared to the WHO standard (50 mg/l). These averages range digressively from 29 mg/l to 7 mg/l (see figure No. 3.40) Consequently, it can be said that these stations have shortcomings compared to the standard This may be related to the activities that take place there by promoting environmental pollution.

3.1.1.2.11 Phosphorus

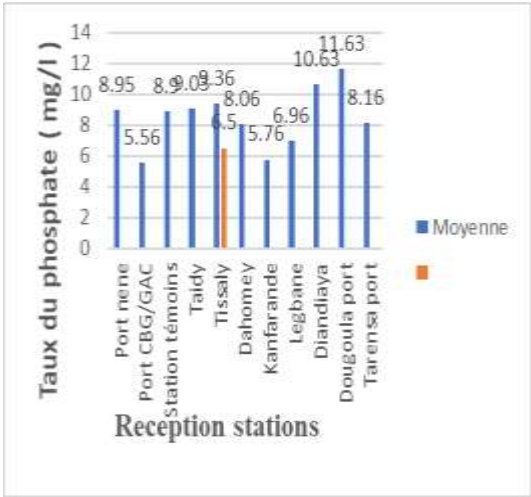

Figure 3.11 Average phosphorus level in the waters of the Nunez according to the different stations

Figure 3.11 shows that the lowest average phosphate level was observed in these three seasons in Port CBG/GAC (5.56 mg/l), while the highest of the averages for these seasons in the Dougoula port station (11.63 mg/l). Diandiaya, Tissaly, Taidy, Port nene, Control Station, Tarensa Port and Légbane (10.63, 9.36, 9.03, 8.95, 8.9, 8.16, 8.06 and 6.96), all have high averages compared to the WHO standard (6.5 mg/l). Kanfarandé (5.76) as Port CBG/GAC has a lower average than the norm. Indeed, orthophosphates result from the degradation of organic phosphate bacteria from the discharge of wastewater (metabolism, washing powders, and food chemical industries) and the use of fertilizers. Assailable by plants and photosynthetic organisms, they play a decisive role in the eutrophication phenomena of watercourses [18]. Therefore, it can be said that these stations have excesses compared to the standard this may be related to the activities that take place there by promoting the pollution of the environment.

CONCLUSION

This research was intended as a contribution to the study of the impacts of industrial activities on the Nunez River estuarine ecosystem. Two types of approach were used in the conduct of this study. The first was the collection of information and samples from various sources in order to identify the environmental and socio-economic aspects likely to characterize the state of vulnerability or resilience of the ecosystem of the Nunez River estuary as well as the variations recorded in climate change. The second stage focused on the analysis of the information and samples collected for the effective verification of the impacts likely to be noticed. The results of the analyses as well as the studies carried out have shown that the estuary of the Nunez River has experienced significant changes in its ecosystem due to the establishment of industrial and port infrastructures combined with a process of climate change during the period 1950-2020. It should be noted that the estuary of the Nunez River has been an industrial area since 1973. Today with the installation of more than ten (10) mining ports (1-SMB ports of Dapilon, 2- SMB of Katougouma, 3- Rusal of Dougoula, 4- Rusal of Tarensa, 5- GAC of Kamsar, 6- CBG of Kamsar 7 under construction of Ashapura. 8- under construction in Bogoraya, 9- under construction Ségheriré ...) and two fishing ports (port fory and port Nene) we note, After studies and analyses:

A disturbance of the physicochemical parameters of the waters of the estuary; an undeniable accumulation with a gradual increase in the stock of waste of several kinds in the Nunez estuary and in addition an increasingly pronounced decrease in fish species and products of the estuary. In

short, after seeing a number of the features of estuaries, we can thus conclude that they are very important ecosystems for living things and are of particular interest for scientific studies. But these estuaries are seen as endangered for human activities, namely industrial and domestic waste, fishing and intensive agriculture are other harmful factors. All kinds of constructions in these surroundings, such as structures used to control the flow of fresh water, such as dams cause an alteration of the natural balance of the system.

Recommendations

The various mining complexes and their port infrastructures in the Nunez Estuary must manage their exploitation activities by taking general measures and specific actions to reduce, eliminate and then compensate for the harmful consequences of these installations on the environment. Ensure safety measures for the protection of the areas of establishment and extension of their installations in order to prevent risks resulting from malfunctions of these installations and possible accidents. Ensure measures to mitigate noise pollution, deterioration of air quality and water likely to be recorded in these places. Make adequate arrangements to ensure the continuity of activities of these industrial and port facilities. Ensure cohabitation, health and free movement of people and machines in the installation areas. Insure

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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