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# Trophic state evalutation of Mono River at Athieme using physico-chemical parameters (South-East Benin)

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## Abstract

*This paper deals with the assessment of the physicochemical quality and trophic status of the Mono River in the commune of Athiémé. The sampling campaign was conducted in August 2017. The samples were taken a few centimeters below the surface of the water. Metal analysis was performed with using a HACH LANGE DR2800 spectrophotometer. Copper is determined by the Bicinchroninate method and zinc by the Zincover method. The physicochemical analysis revealed that this water is not mineralized, contains no salt at all, is highly oxygenated, is very turbid and is not rich in nutrients such as nitrate, nitrite, ammonium and phosphates. Regarding the concentration of metallic trace elements, namely copper and zinc, it does not constitute a risk for humans but represents a high risk for aquatic organisms present in the Mono River. As for the study of the trophic evaluation it reveals that the river is oligotrophic that is to say is poor in nutrients and therefore does not run the immediate risk of the phenomenon of eutrophication.*

**Keywords:** Mono River, eutrophication, metals, Athiémé, oligotrophic.

## Introduction

Water is the most valuable land resource since it is vital for humans. It is also poorly distributed among states, depending on their location and the physical characteristics of their territory. About 98% of these waters are marine waters. The remaining 2% is continental waters represented by rivers, lakes and ponds. Because of their multiple uses, these inland waters are of great importance for domestic activities (consumption and recreation), agriculture and industry. Continental aquatic environments provide a variety of goods and services to humans, giving them irreplaceable economic value[1,2]. The water of rivers causes erosions, serves as a living environment for plant and animal organisms; it is used for food and feed, irrigation of cultivated plants, inland navigation, energy production, the realization of many industrial processes. Drinking water is probably the most valuable asset because it is a scarce and vital resource. Inland waters attract and concentrate many populations for their activities, which in turn must ensure their management and sustainability. In the face of the current population explosion, we realize that freshwater resources are exhaustible, and that human activities are one of the major causes of the stress of aquatic ecosystems[3-5]. The deterioration of the water resource results essentially from point and non-point source pollution and the modification of physicochemical characteristics[6]. Insofar as the distribution of organisms colonizing aquatic environments is mainly dictated by autoecological processes[7,8], anthropogenic disturbances have a very strong impact on aquatic biodiversity[9].

Benin has a fairly large network of more or less permanent rivers. These streams are small in flow, length and irregular flow. They are spread across the country in five river basins, the Mono (100km long with a seasonal flow of 0 to 300$m^3$/s), the Couffo (190km long with a seasonal flow of 10 at 900$m^3$/s), from the Volta represented by the Pendjari (380km long with a seasonal flow of 0 to 400$m^3$/s) and the Ouémé (510km) which forms the largest basin.

Mono is a river crossing Togo and Benin, approximately 467km long and draining a watershed of about 25000$km^2$. It has its source in Togo, between the city of Sokodé and the border with Benin, and heads south. Near its mouth, it forms the border between Togo and Benin. Finally, it flows into the bay of Benin through an extensive system of brackish lagoons and lakes (including Lake Togo). This river serving as border between Benin and Togo makes it possible to pass products from one country to another and is also used by the neighboring populations for the agriculture, the breeding and the fishing. The use of pesticides and chemical fertilizers in or near waterbeds releases long-lived, highly resistant molecular chemical compounds that are infiltrated or drift into the water table or stream[10]. Metals such as lead, mercury, copper, zinc, nickel, arsenic and chromium accumulate in the environment. All these pollutants are stable and toxic, they are not degraded by plants and animals. They are concentrated in aquatic mosses, accumulate in the flesh of fish and can thus harm the natural environment or humans. Other products such as soaps, detergents used to wash motorcycles and cars directly around waterways also contribute to degrading the quality of aquatic environments[10]. Some discharges, for example excreta and the decomposition of plant or animal matter cause a contribution of organic matter to the surface water resources. Nitrogen and phosphorus are fertilizers. They come mainly from agricultural and urban inputs. These compounds are usually naturally present in small amounts in the water of the rivers. When their concentration becomes too great, it can disrupt the balance of aquatic environments and cause, in some cases, their eutrophication. This phenomenon, which is manifested by a proliferation of algae, can sometimes lead to the deoxygenation of water. With the pace of ecosystem degradation and the disappearance of some aquatic species, it would be difficult to preserve it sustainably. In view of the long-term management of this resource, it has proved necessary to develop a systematic approach to study the river to characterize the state of these water bodies, in order to define priorities for actions (protection, restoration). It is to meet this requirement that the present work finds its justification.

The present study aims to use the physico-chmeical parameters to assess the trophic state of the water of the Mono River at the commune of Athiémé.

## Materials and methods

**Study area:** The district of Athiémé is located between the parallels 6°34'60" North and 1°40'0" East about 8km from the city of Lokossa (by axis Lokossa, Athiémé, Cotonou) and 104 km of the city of Cotonou. It covers an area of 238km$^2$ or 14.83% of the Mono Department. It is bounded on the North by the Municipality of Lokossa, on the South by the Commune of Grand-Popo, on the East by the Commune of Houéyogbé and on the West by the Togolese Republic with which it shares a natural border which is the Mono River. The Mono River originates in northwestern Benin in the Kura Mountains, Bassila region. Long of 530 kilometers, it serves as natural border between Togo and Benin on its last 100 kilometers. Its catchment area covers an area of 25000km$^2$ between latitudes 6°10' and 9°00' North and longitudes 0°30' and 1°50' East[11].

**Sampling:** This is the most important part of our work. It allowed us to collect some samples in order to make adapted analyzes to enrich our work. It was carried out in August 2017. The choice of sampling points was made on the basis of human activities and the river's water level, since we are in a period of high flood. A total of 5 samples were collected and kept cool in the Laboratory of Inorganic Chemistry and Environment of the Faculty of Science and Technology of the University of Abomey-Calavi. Plastic bottles of 1.5 liters were filled after 3 rinses with the water to be taken. For all new samples, the bottles are rinsed with distilled water.

**Physical and chemical analysis procedure:** Such parameters as pH, conductivity, temperature, turbidity, and dissolved oxygen were determined in situ using a DKK-TOA Water Quality meter multi-parameter. For each measurement, the probe is first rinsed with distilled water and then with the sample. The probe was then immersed in the sample of water taken and the various parameters are read and recorded. Transparency was determined using a Secchi disk. The Secchi disk depth was determined using a weighted metal disk, attached to a graduated rope. The measurements were carried out 3 times at each sampling station, making it possible to have an average value which is retained as the value of the Secchi disk depth.

**Table-1:** Sampling sites and coordinates.

| Sampling sites | Coordinates | Geographical coordinates in UTM | |
|---|---|---|---|
| | | X coord | Y coord |
| Site-1: Adjassincondji | 06°34’47.6’’N 001°39’55.6’’E | 352455 | 727504 |
| Site-2: Agniwédji | 06°34’46.6’’N 001°39’57.6’’E | 352517 | 727473 |
| Site-3: Athiémé | 06°34’29.5’’N 001°40’03.5’’E | 352697 | 726947 |
| Site-4: Lokossavi | 06°34’33.4’’N 001°40’04.0E | 352712 | 727067 |
| Site-5: Djonougoui | 06°34’02.7’’N 001°39’51.3E | 352320 | 726104 |

**Metals dosing procedure:** Metals were assayed with a HACH LANGE DR2800 spectrophotometer. Copper is determined by the Bicinchroninate method and zinc by the Zincover method.

**Chemicals analysis procedure:** The determination of the chemical parameters was carried out with a HACH LANGE DR2800 spectrophotometer. Nitraver 5 has been used to determine nitrate, nitrite 3 for nitrite, Rochelle and Nessler salt for ammonium, and Phosver 3 for phosphate.

**Trophic state assessment procedure:** The measurements taken at the different sampling sites were laid out in the grid of the diagnostic tool of the five Ifremer eutrophication states[12]. A gradient of color from blue to red reflects the evolution of a very good to a bad state of the water vis-à-vis the eutrophication. We are in the columns (Very Good, Good, Average, Poor or Bad) of the Table-2. The determination of the trophic state is then to look for the most colored column or the dominant color. It is thus the mention that carries the most colored column which represents the trophic state of the sampling point.

**Data analysis:** The statistical data collected in the field and those obtained from the determination of chemical parameters and metallic trace elements were processed using the Microsoft Excel 2016 software. The Principal Component Analysis (PCA) and the correlation matrix were performed by the XLSTAT software version 2013.3.02.

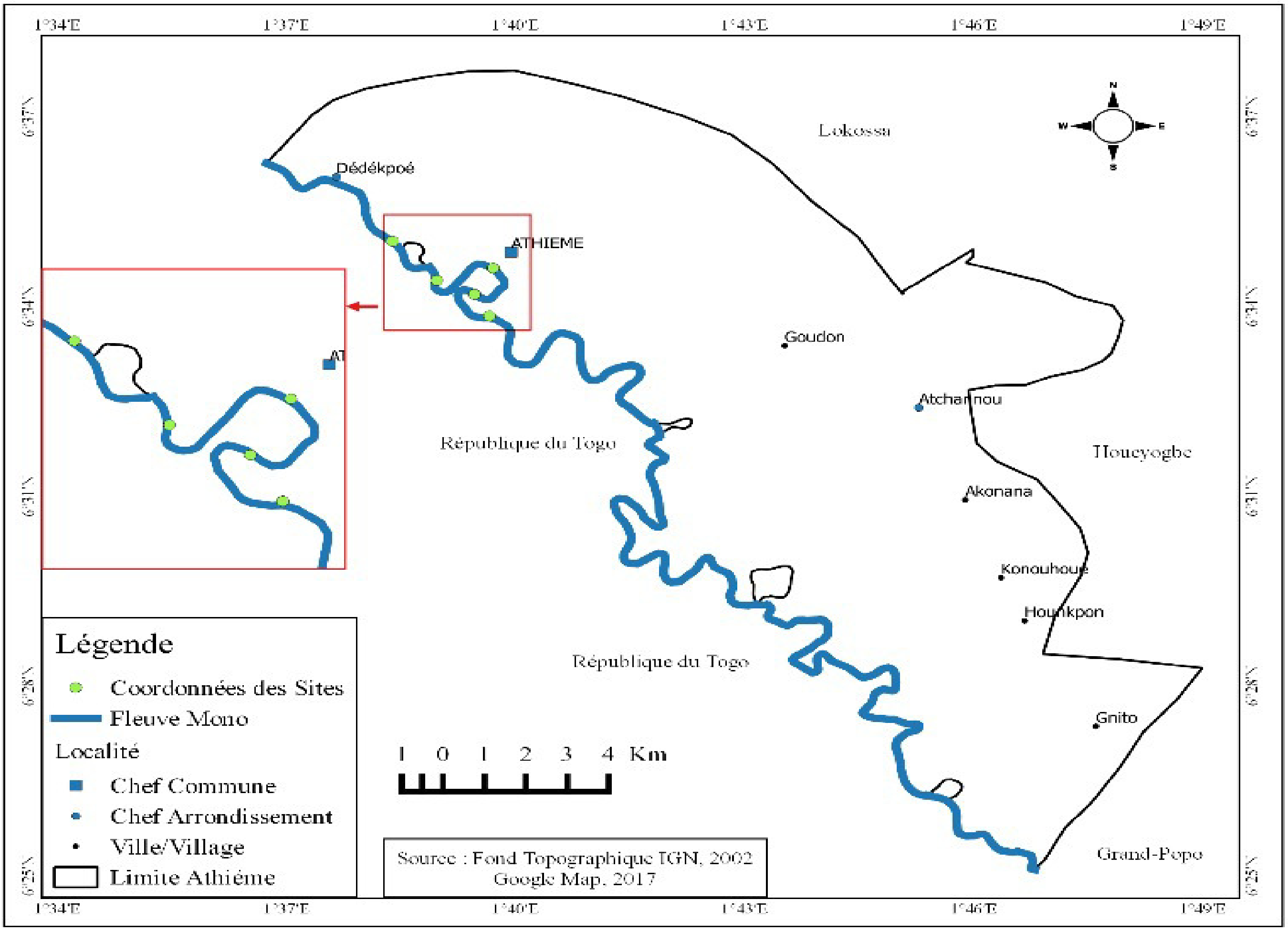


**Figure-1:** Location of the study area and sampling points.

**Table-2**: Reading grid of the water column[12]

| Variable | Unit | Very good | Good | Average | Poor | Bad |
|---|---|---|---|---|---|---|
| % $O_2$ Sat | - | 0 | 20 | 30 | 40 | 50 |
| Turbidity | NTU | 0 | 5 | 10 | 25 | 40 |
| $PO_4^{3-}$ | µM | 0 | 0,3 | 1 | 1,5 | 4 |
| Nitrite | µM | 0 | 0,3 | 0,5 | 0,75 | 1 |
| Nitrate | µM | 0 | 1 | 3 | 5 | 10 |
| Ammonium | µM | 0 | 1 | 3 | 5 | 10 |
| Chl-a | $mgM^{-3}$ | 0 | 5 | 7 | 10 | 20 |
| NT | µM | 0 | 50 | 75 | 100 | 120 |
| PT | µM | 0 | 0,75 | 1,5 | 2,5 | 4,5 |

## Results and discussion

**Physical and chemical parameters: Temperature and Hydrogen potential (pH):** The temperatures recorded at the various sites vary between 26.8 and 28.3°C (Figure-2). The highest value was found at site 4 while the lowest value was found at site 1. Regarding Hydrogen potential (pH), the values are all close to 7. The lowest value 6.72 was recorded at sites 1, 2 and 4, while the highest 7.24 was recorded at site 5.

**Electrical Conductivity and Salinity:** The analysis of the Figure-3 shows that the values of the conductivity of water at the sites are not negligible. Indeed, the highest value (302µS/cm) was recorded on site 4 and the lowest value (83.9µS/cm) was recorded on site 1. As far as salinity is concerned, it is zero at all stations.

**Dissolved oxygen and Transparency:** Analysis of the Figure-4 shows that the dissolved oxygen content in the river is quite high. Its value is between 6.49 and 8.6mg/L with an average of 7.57. The highest value is recorded at site 3 (8.6mg/L) and the lowest value at site 2 (6.49mg/L). Note that the transparency values are not very high. They vary between 0.25 and 0.35cm with an average of 0.29cm.

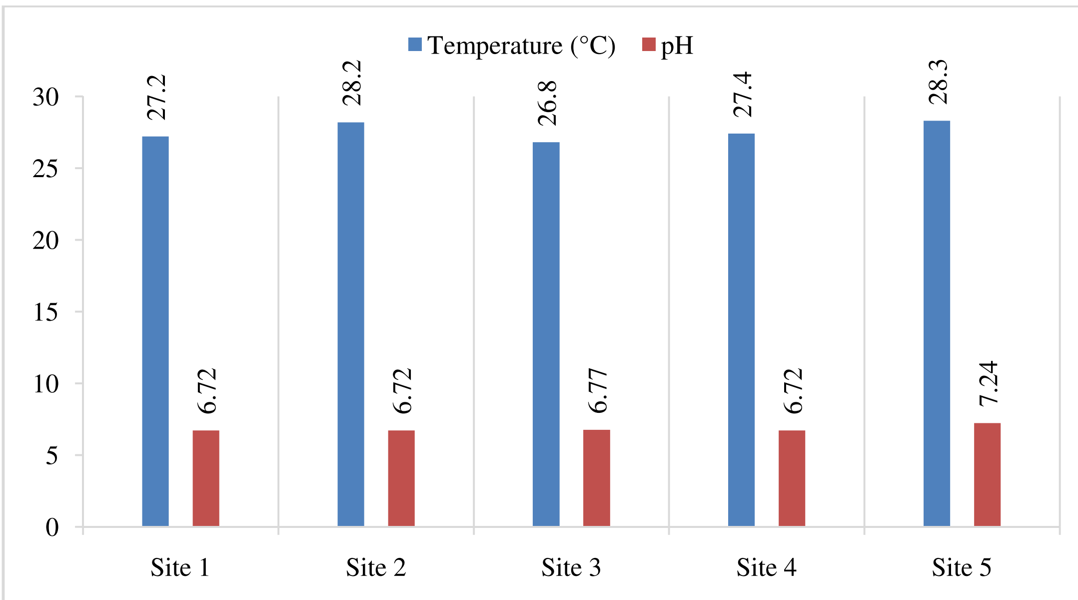


**Figure-2:** Variation of Temperature and Hydrogen Potential Values.

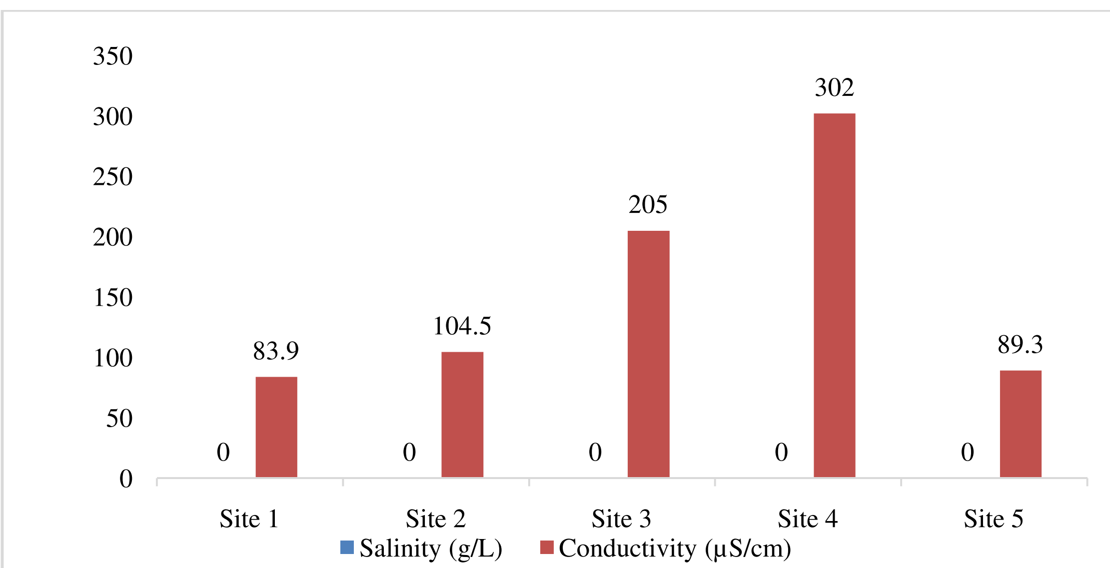


**Figure-3:** Variation of the electrical conductivity and salinity at the different sites.

**Suspended Substances (SS) and turbidity:** The concentrations of suspended solids (SS) recorded at the sites show that the highest value (111mg/L) is observed at site 2 and the lowest value (10mg/L) is observed at site level 3 (Figure-5). Similar for turbidity, the highest value (87NTU) is observed at site 2 and the lowest value (15NTU) is observed at site 3.

**The color:** This graph shows that the water at sites 2, 5 and 3 is more colored than at site 1 (Figure-6). The highest value is 1440 PtCo (Site 2) and the lowest 173 PtCo (Site 3).

**Nitrates:** Figure-7 shows a low presence of nitrates in the river's waters. The nitrate concentration in these waters ranges from 2.35 to 3.67mg/L respectively at stations 5 and 4.

**Nitrites:** Nitrite comes from the reduction of nitrate under the influence of bacteria. Figure-8 shows the variations in the nitrite content of water at the different sampling sites. The nitrite values measured at the different sites are between 0.001 and 0.012mg/L. These values are relatively very low on all sampling sites. The highest value (0.012mg/L) of nitrite was observed at site 2.

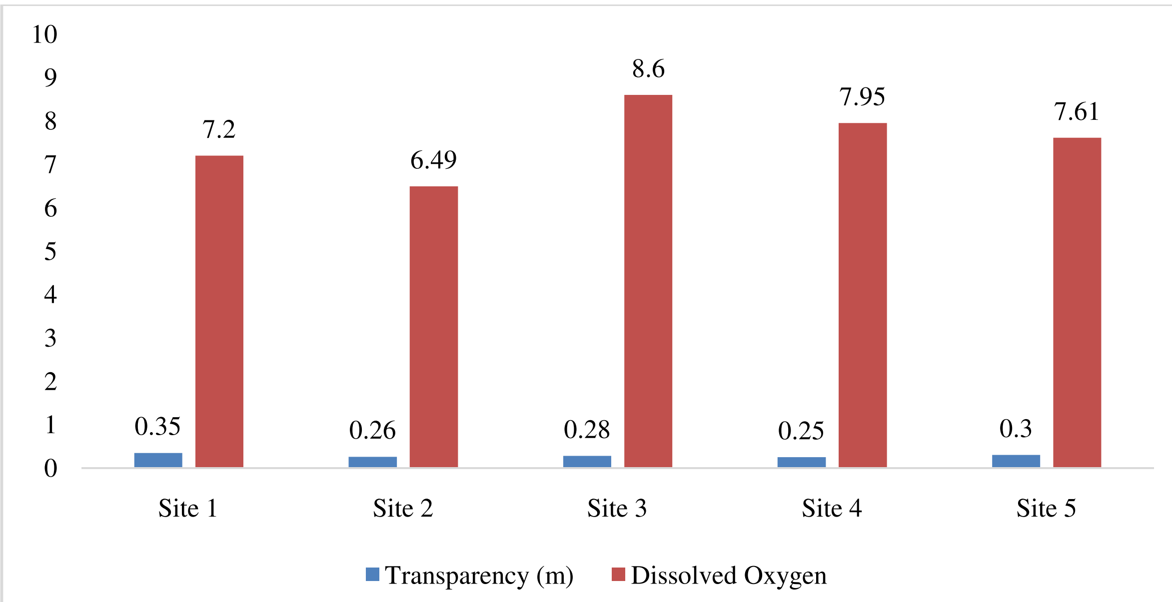


**Figure-4**: Variation of dissolved oxygen and transparency at different sites.

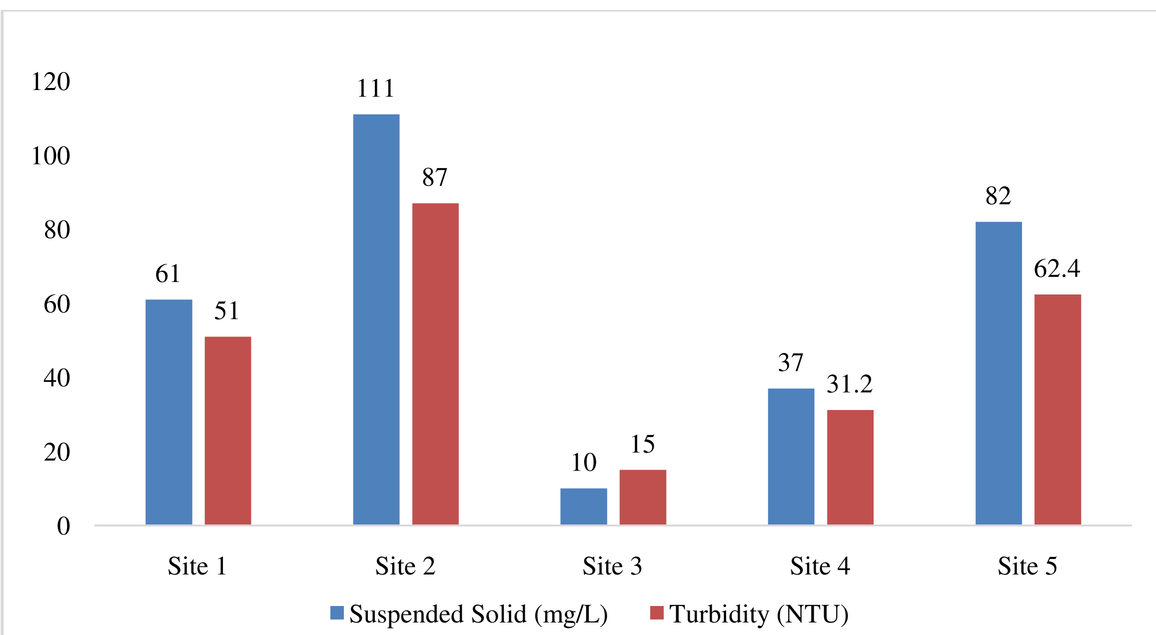


**Figure-5:** Variation of suspended solids and turbidity at different sites.

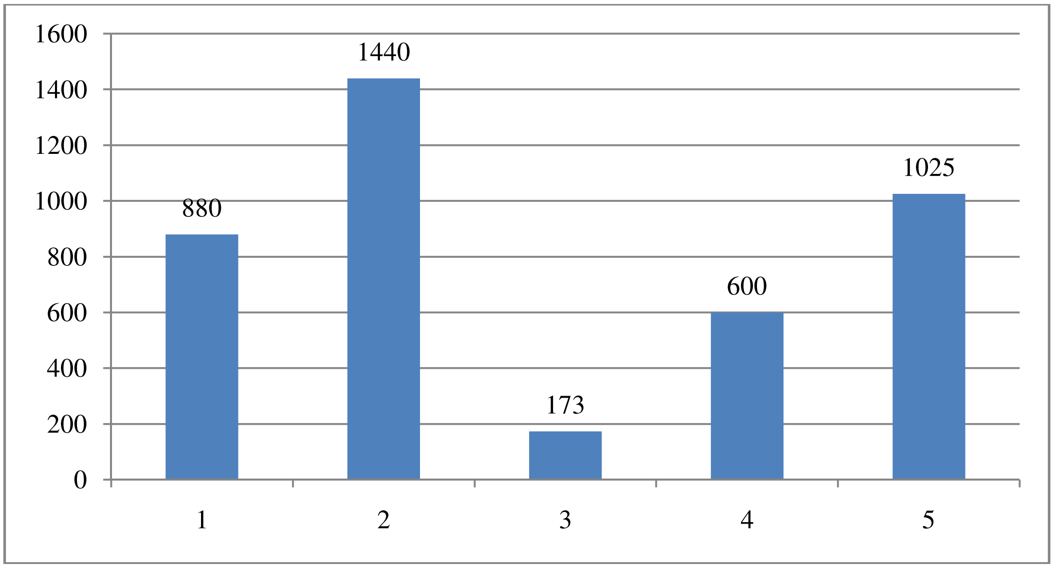


**Figure-6:** Variation of color at different sites.

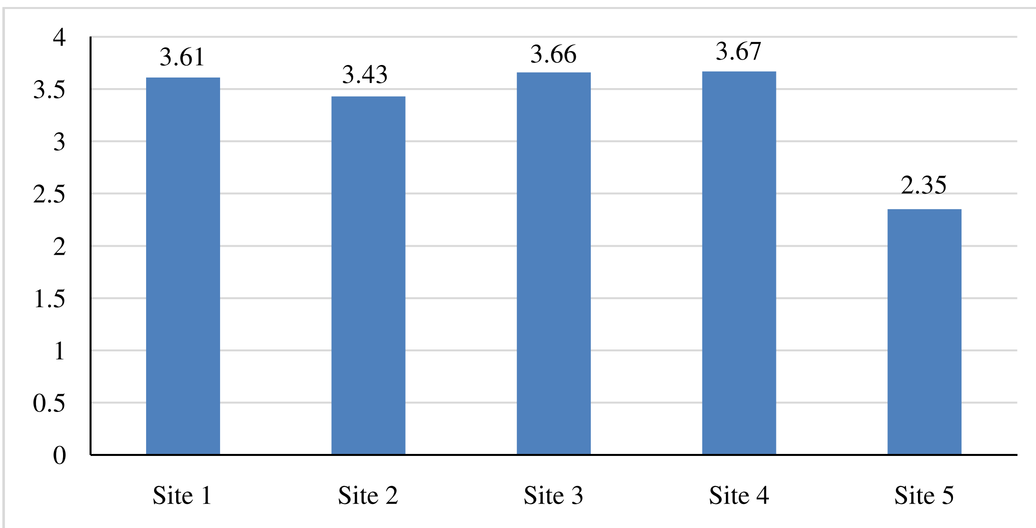


**Figure-7**: Variations in nitrate concentration.

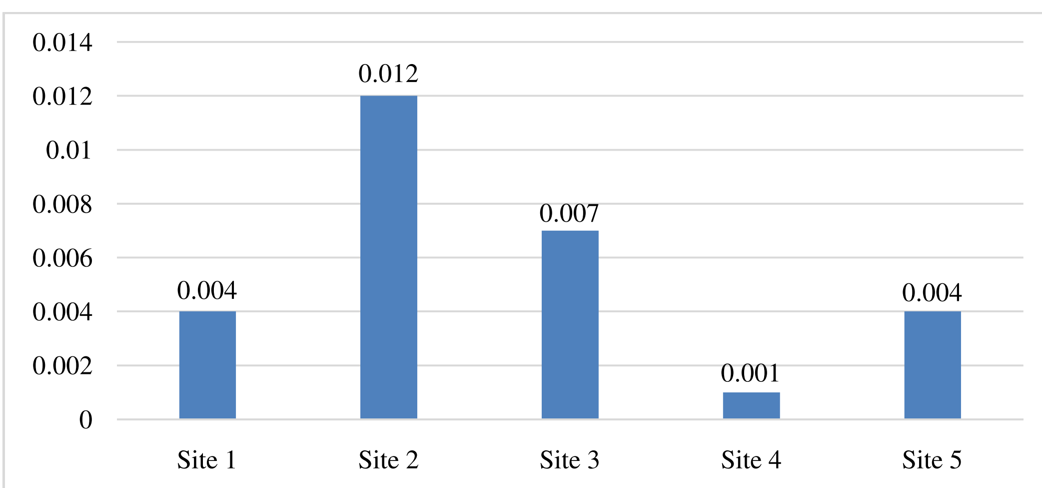


**Figure-8:** Variations in nitrite contents.

**Ammonium:** The ammonium values measured at the different sites are between 0.12 and 0.83mg/L (Figure-9). These values highlight the low level of ammonium present in the river. The highest value was recorded at site 5 (0.83 mg/L).

**Orthophosphates:** The graph of orthophosphate variation shows low values except at site 4 where a very large increase is observed compared to the other values obtained (Figure-10). The highest value is 1.96mg/L while all other values are around 0.1mg/L.

**Copper:** The graph of copper variation shows values between 0.5 and 1.42mg/L (Figure-11). These values are not very high but can represent a danger. The highest value (1.42mg/L) was recorded at site 1.

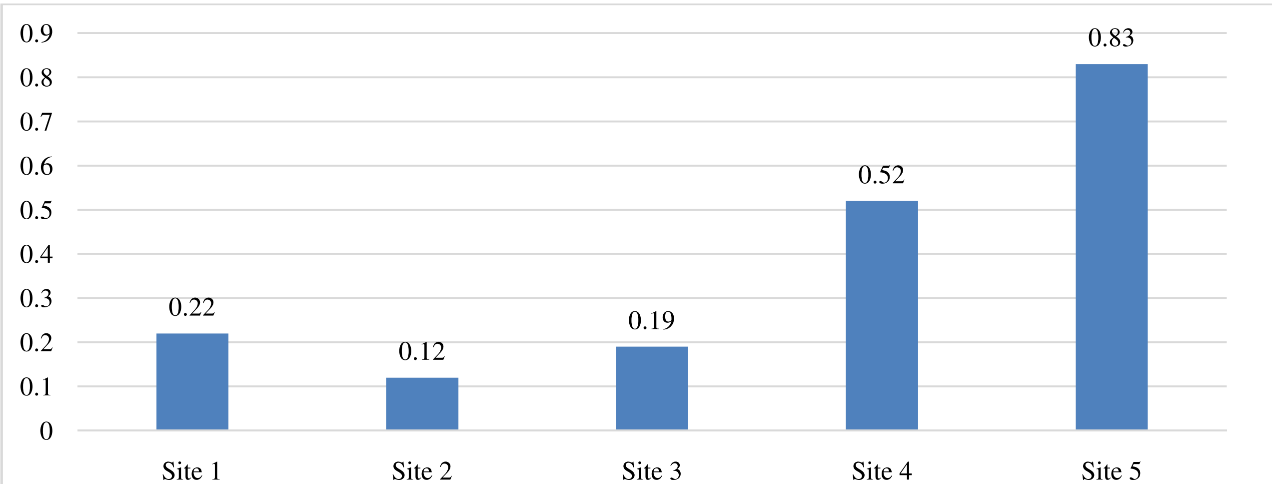


**Figure-9**: Variations in ammonium contents.

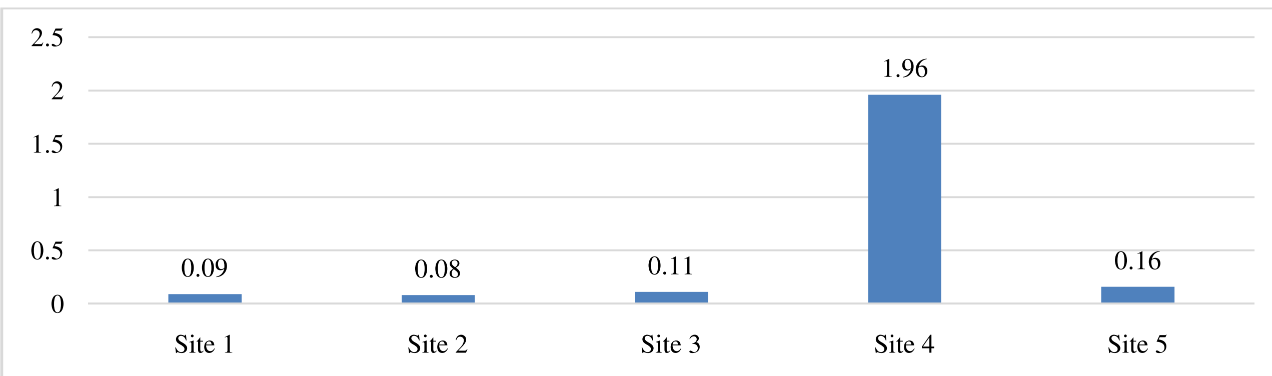


**Figure-10:** Variations in orthophosphate concentration.

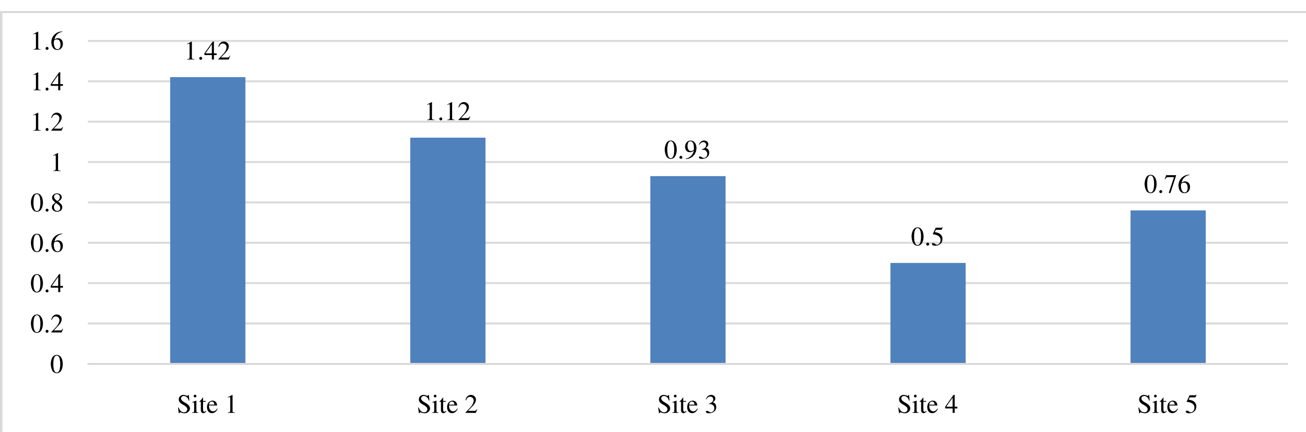


**Figure-11:** Variation in copper concentration.

**Zinc:** The graph of zinc variation shows values between 0.82 and 1.29mg/L (Figure-12). These values are not very high but can represent a danger just like copper. The highest value (1.29 mg/L) was recorded at site 1.

**Heavy metal:** Copper: These obtained values vary between 0.5 and 1.42mg/L and are all below the limit allowed by the Canadian standard for the Criteria of Prevention of the Contamination according to the Aquatic Organisms only (CPC_O) is 38mg/L whereas for the Criteria of Prevention of the Contamination according to the quality of the Water and the aquatic Organisms (CPC_EO) is 1mg/L the values obtained at the sites 1 and 2 are superior to the norm. But, they are above the limit allowed by the Canadian Standard for Chronic Effects of Chronic Effects (CVAC) 0.0085mg/L and for the Life Protection Criteria Aquatic Acute Effects (CAAT) either 0.0127 mg/L. We can already point out that the copper concentrations in the Mono River are not within the tolerable limit for the survival of aquatic organisms either according to the acute or chronic effects. This water is not of good quality and cannot ensure good growth of aquatic organisms. In the same way, the consumption of its organisms or this water would constitute a risk for the man. These obtained values can also impinge on the availability of living organisms in the river. High copper values were recorded at sites 1, 2 and 3.

Zinc: The zinc concentrations obtained on the river vary from 0.82 to 1.29mg/L. These values are below the CPC_O is 26mg/l and the CPC_EO is 5mg/l and above the CVAC is 0.11mg/L and the CVAA is 0.11mg/L. Zinc concentrations do not constitute a risk for humans; but they represent a risk for the organisms present in the river. The peak was recorded at site 1.

**Eutrophication state of the river:** The trophic state of the different sampling points is summarized in Table-5. In total, the trophic status of the waters of all sampled sites is good as indicated in this table for the majority of four (4) parameters indicating a very high good trophic level out of eight (8) indicators namely: the percentage of dissolved oxygen saturation, the turbidity, the ions phosphates, nitrites, nitrates and ammonium, the total nitrogen and the total phosphorus.

**Table-5:** Summary of eutrophication states (according to the IFREMER grid)

| Sampling sites | Eutrophication states |
|---|---|
| Site 1 | Good |
| Site 2 | Good |
| Site 3 | Good |
| Site 4 | Average |
| Site 5 | Good |

**Principal Component Analysis (PCA): Correlation matrix:** Table-6 presents the Pearson correlation matrix showing the values of the $R^2$ coefficients of determination for a 5% rejection threshold. Analysis of this table shows a strong positive correlation between SS, turbidity and color. This implies that these three parameters evolve proportionally. It is also true for temperature, SS, turbidity and color, which have strong positive correlations with each other. Orthophosphate, conductivity and TDS have a strong positive correlation. Dissolved oxygen is strongly and negatively correlated with turbidity, SS and color. Between nitrate and pH, there is also a strong negative correlation. This means that these parameters are inversely proportional to each other.

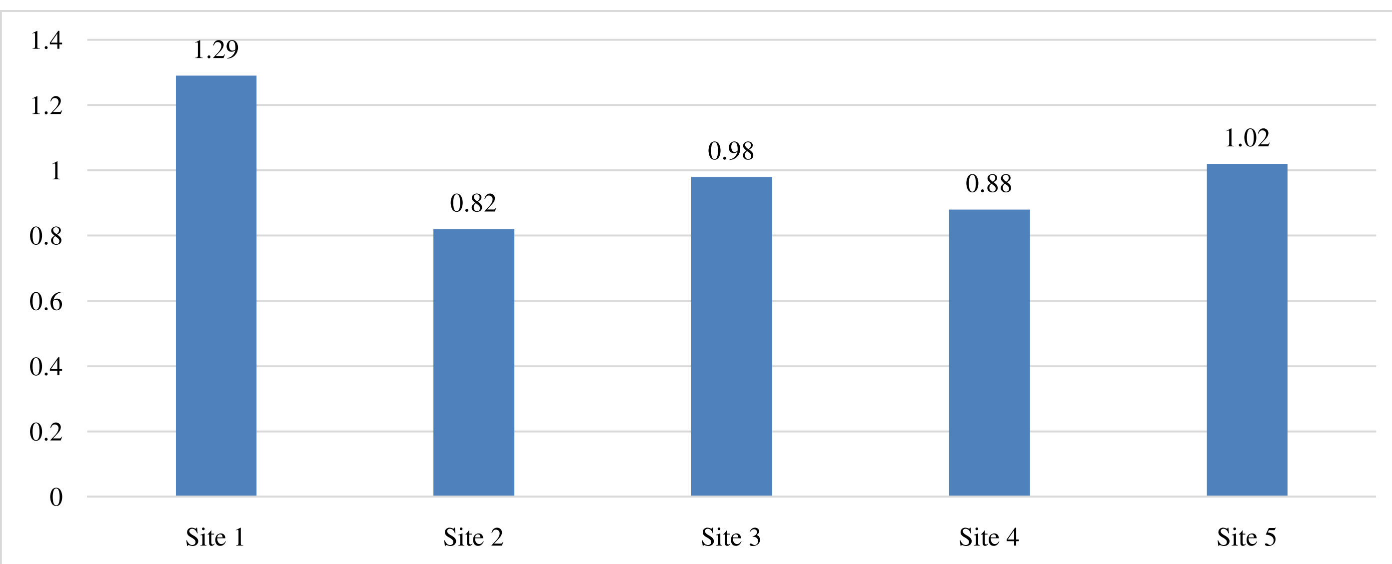


**Figure-12:** Variation in zinc concentration

**Table-6:** Correlation matrix.

| Variables | Temp | pH | Cond | TDS | Turb | MES | Col | Trans | Oxydiss | $NO_3^-$ | $NO_2^-$ | $NH_4^+$ | $PO_4^{3-}$ | Cu | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp | **1** | 0.566 | -0.475 | -0.475 | **0.859** | **0.888** | **0.856** | -0.186 | -0.667 | -0.729 | 0.292 | 0.450 | -0.143 | -0,125 | -0,361 |
| pH | | **1** | -0.379 | -0.379 | 0.200 | 0.248 | 0.167 | 0.162 | 0.100 | **-0.974** | -0.201 | 0.839 | -0.245 | -0,306 | 0,064 |
| Cond | | | **1** | **1.000** | -0.687 | -0.672 | -0.633 | -0.650 | 0.617 | 0.494 | -0.450 | 0.054 | **0.853** | -0,728 | -0,457 |
| TDS | | | | **1** | -0.687 | -0.672 | -0.633 | -0.650 | 0.617 | 0.494 | -0.450 | 0.054 | **0.853** | -0,728 | -0,457 |
| Turb | | | | | **1** | **0.998** | **0.993** | 0.038 | **-0.941** | -0.415 | 0.546 | -0.006 | -0.369 | 0,348 | -0,157 |
| MES | | | | | | **1** | **0.994** | 0.028 | **-0.927** | -0.459 | 0.500 | 0.060 | -0.335 | 0,298 | -0,165 |
| Col | | | | | | | **1** | 0.031 | **-0.955** | -0.384 | 0.463 | 0.024 | -0.270 | 0,312 | -0,148 |
| Trans | | | | | | | | **1** | -0.119 | -0.143 | -0.203 | -0.022 | -0.534 | 0,710 | **0,973** |
| Oxydiss | | | | | | | | | **1** | 0.122 | -0.508 | 0.229 | 0.284 | -0,503 | 0,038 |
| $NO_3^-$ | | | | | | | | | | **1** | 0.070 | -0.788 | 0.292 | 0,223 | -0,009 |
| $NO_2^-$ | | | | | | | | | | | **1** | -0.616 | -0.635 | 0,461 | -0,372 |
| $NH_4^+$ | | | | | | | | | | | | **1** | 0.306 | -0,638 | -0,017 |
| $PO_3^{4-}$ | | | | | | | | | | | | | **1** | -0,734 | -0,362 |
| Cu | | | | | | | | | | | | | | **1** | 0,616 |
| Zn | | | | | | | | | | | | | | | **1** |

Figure-13 shows that most of the explanatory variables are close to the correlation circle except for transparency, zinc, pH and nitrites. These variables are well represented. But those cited above are to a lesser extent. Turbidity, color and SS have not only a strong positive correlation between them but also a strong negative correlation with the F1 axis (also called F1 factor or main component F1). This leads to the conclusion that the F1 axis contrasts the very turbid sites with the highly mineralized and oxygenated sites.

Sampling sites combined with variables: Figure-14 shows the distribution of the sampling sites combined with that of the explanatory variables.

We can conclude that: i. The river water at site 1 has the high values of metals (copper and zinc) recorded and is low mineralized. This water contains some nitrates and nitrites but very little ammonium and orthophosphate compared to other sites. ii. The river water at site 2 is very turbid and is charged with SS. iii. At site 3, the water is somewhat rich in copper and zinc, slightly mineralized and contains the highest nitrate levels compared to other sites. iv. At Site 4, the water is mineralized, low in copper and zinc, rich in ammonium and contains the highest level of orthophosphate compared to other sites. v. At the site 5, the water is a little turbid, has the highest values of temperature and pH, a little ammonium.

**Discussion:** The temperature values recorded on the Mono River vary from 26.80 to 28.30°C. These temperature values obtained would be favorable to good growth of fish from these aquatic environments. Indeed, according to Pouomogne[13] and Dèdjiho[14], temperatures between 24 to 35°C are favorable for good growth of fish species currently high. However, it is necessary to point out that these temperatures could be partly related to pollution of the complex. Indeed, according to Beaux[15], the high temperatures of aquatic enclosures presage pollution, especially when they are above 30°C.

The pH values measured for the different water samples ranged from 6.72 to 7.4 with an average of 6.83. These pH values are within the tolerable limit (5 to 9) for most plant and animal species in the environment and particularly fish[16] and would be favorable for the farming of aquaculture species find in this complex. Aquaculture environments with a pH between 6.5 and 9 are good in aquaculture[17]. The optimum pH range for reproduction of most aquatic species is between 6 and 7.2, and that beyond pH 9, many species are subject to mortality.

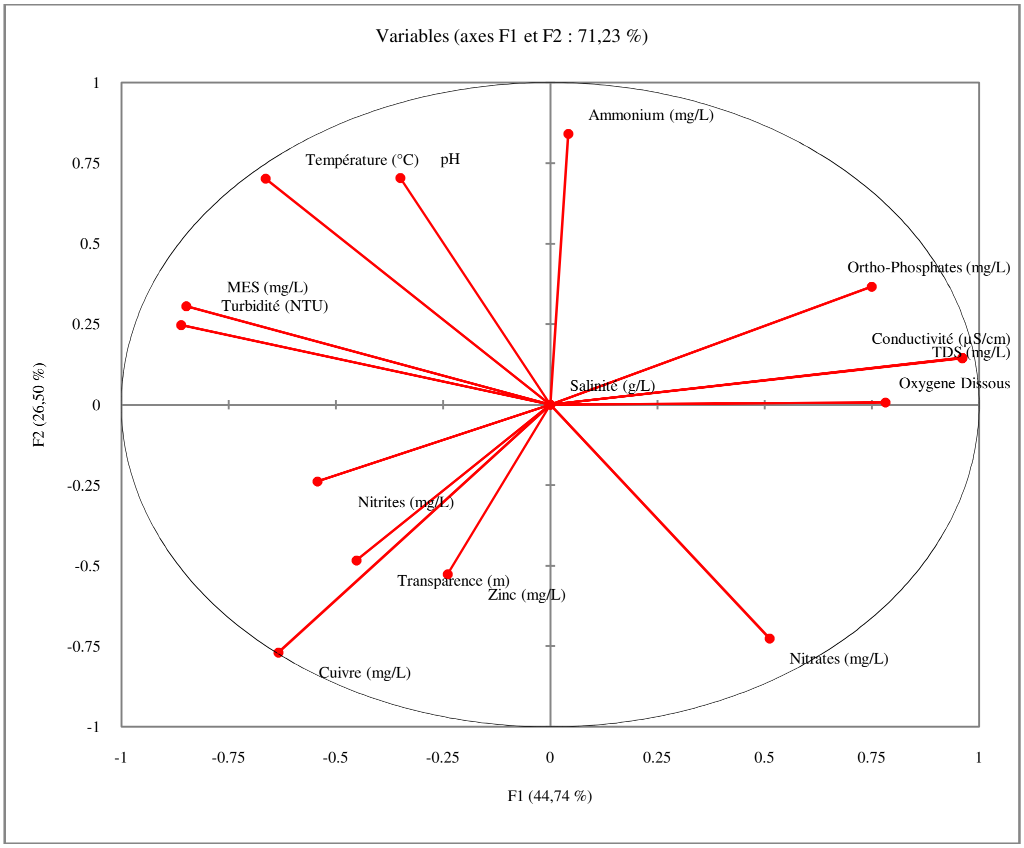


**Figure-13:** Circle of correlation of explanatory variables.

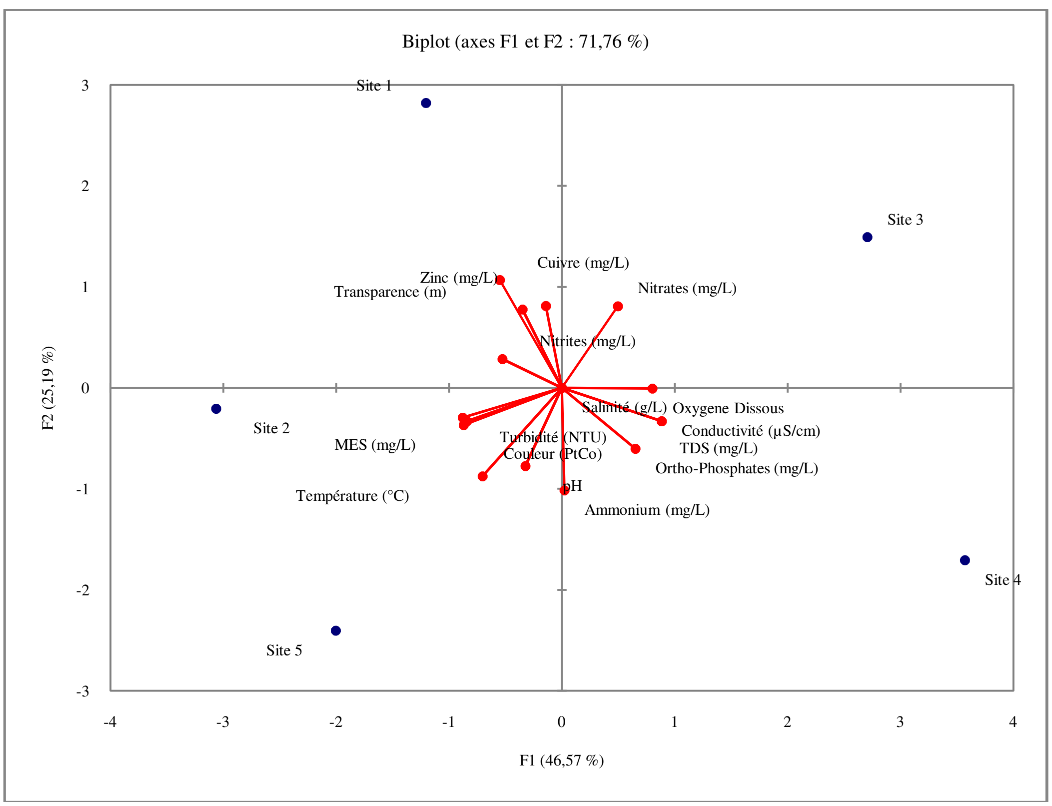


**Figure-14:** Distribution of sampling sites on the factor graph.

Dissolved oxygen levels range at all sampling stations from 7.2 to 8.6mg/L. These high concentrations of recorded dissolved oxygen are due to the low levels of organic matter present in the water. According to Lamizana-Diallo M. et al.[16], dissolved oxygen is at the crossroads of good numbers of phenomena; it is involved in the respiration of aquatic organisms, the oxidation and degradation of pollutants, the photosynthetic activity of flora and exchanges with the atmosphere. Studies have shown that reduced oxygen levels lead to abnormal physiological and behavioral effects in various organisms, particularly fish[18]. Water is classified as polluted if it has a dissolved oxygen content of less than 3mg/L[15]. From this we deduce that the river's water is not polluted. It is rather good quality considering the dissolved oxygen content.

The high values of color, turbidity and SS observed may be explained by the intensity of erosion effects that drains solids and colloids into the water[16]. Indeed, the abundance of SS in the water favors the reduction of the luminosity and lowers the biological production because of the fall of the dissolved oxygen following a reduction of the phenomena of photosynthesis[16]. According to the reading grid of the water column established by the French Institute for Marine Research[12], the river complex studied is turbid because its turbidity exceeds at 3 sites the threshold set at 40NTU and is not better at the two remaining sites. The high recorded turbidity can prevent the penetration of light and oxygenation of the square.

The conductivity of water is a measure of its ability to conduct electrical current. It is related to the presence of ions in water and increases with the concentration of dissolved ionic salts. The waters of the Mono River show electrical conductivity values fluctuating in the range 83.9-302µS/cm during the study period. The values of the electrical conductivity of the river's water are less than 1000µS/cm, so these waters are not very mineralized.

The biodegradable suspended solids (SS) contributes significantly to the modification of the water transparency and therefore to the oxygen demand which causes the decrease of the dissolved oxygen concentration in the aquatic environment[19]. Thus, the transparency of water depends on the amount of suspended solids (SS), which may consist of living microorganisms, organic and mineral debris[20]. The low values of transparency obtained at the different sites may be due to the strong current of water that perpetually erodes the river's edge.

Water column reading grid, the very high levels of nitrite ions, nitrates and phosphates indicate that the complex is eutrophic[12]. One of the consequences of eutrophication is the proliferation of aquatic plants. Indeed, this proliferation, especially that of the water hyacinth, is the origin of the formation of a screen on the surface of the water, prevents the oxygenation of the environment[21]. In addition, their decomposition induces an increase in the amount of organic matter in the medium, the degradation of which favors the asphyxiation of fish species. The study carried out here shows that only the nitrate values exceed the threshold value. Indeed, some authors have found that the evolution of nitrates is closely dependent on rainfall[22,23]. Labroue et al.[24] also reported that nitrogen inputs are related to precipitation, surface or subsurface water, and biological fixation by prokaryotic microorganisms. As for the nitrites which come from the reduction of the nitrates, they are relatively weak on all the sites of sampling.

The high nitrite content compared to the norm of 0.06 mg/L is a hindrance to the development of aquatic fauna because of its toxicity[25,26], which is not the case at the level of the Mono River. Their low presence indicates that the waters of the river are well oxygenated. They are maintained only in low oxygenated environments because they are unstable; they tend to oxidize to nitrates[27]. Phosphorus levels in water greater than 0.5 mg/L constitute a pollution index[28]. At the majority of the sites sampled, the phosphorus does not exceed the acceptable threshold. Phosphorus discharges into aquatic ecosystems constitute one of the most serious environmental problems, as they contribute to accelerating the eutrophication of these environments.

The state of eutrophication being mostly good at the different sites shows that the ecosystem of the river was not really damaged by human activities. It also shows that there is not a very strong activity of human around the river which can pollute it in a considerable way. At site 4, the state of eutrophication is average. This is due to the high pollution found there. It has been noted there, a place of rejection of waste by humans.

Principal Component Analysis is probably more enlightening us about the different correlations that exist between the parameters analyzed. Indeed, the parameters such as the conductivity, the color, the SS and the TDS are correlated in a very clear way. An increase of the electrical conductivity for example is caused by the increase of the ions present in this water whereas these ions come from the organic and solid materials which constitute the SS, the TDS and which induce the color of the water.

## Conclusion

The quality of Mono river water is not good to protect the aquatic life. The small amount of fish often noted in the river's water can be justified by the high concentrations of trace metals such as the copper and zinc studied and the very turbid nature of the water which could reduce the content of dissolved oxygen in the water.

The trophic status of the river is not critical at present due to the low nutrient levels observed but could become so with the inappropriate exploitation of this complex by the local populations. These results show the emergency actions or policy to control the discharge of wastewater into the Mono River in order to limit damage to this aquatic ecosystem life.

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