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Seasonal and Qualitative Approach of the Oued Mellègue Basin (Algeria)

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ABSTRACT

Water holds a particularly important place in our lives; it is a precious resource called: blue gold. Unfortunately, pollutants and pollution in general are the main causes of the degradation of the quality of water resources in the world. In this intention we have focused our research on a qualitative study of surface waters of the Oued Mellègue watershed (North East of Algeria), which is a tributary of Oued Medjerda (Souk-Ahras), whose objective is to estimate the intensity as well as the origin of the pollution that has contaminated this water course However, the results obtained reveal that the waters of this wadi are totally polluted and deteriorated, and they have lost all their physical and chemical qualities. And they become contaminated to the point that they have become harmful for the public and for the fauna and flora that shelter. So the research of solutions to the pollution of water resources must be in full swing, because the future of water is intimately linked to that of humanity. It must therefore be preserved and protected rigorously and with great accuracy.

Keywords: Oued Mellègue, precious resource, blue gold, pollutants, physico-chemical qualities.

INTRODUCTION

Water is a vital resource for all living things; without it, there would be no life possible on Earth. The observation is simple, all living things need water to exist (Zeghaba and Laraba, 2018).

Seen from the sky, it may seem disproportionate to talk about water scarcity on a global scale. 1385 million km^3 of water cover three quarters of the earth's surface, including oceans, seas, lakes, rivers and groundwater. But it is salt water that dominates this volume and thus reduces the possibility that we have to take advantage of this vast expanse. Thus, of the 1,385 million km^3 of blue gold that the planet has, only 34 million (2.5%) is fresh water. Moreover, only an infinitesimal part of this already greatly reduced amount can be used directly for our needs: indeed, most of the renewable fresh water is concentrated in the planet's icebergs, and would therefore be unusable in its current state (Barah, 2005).

Population growth and agriculture are the most significant pressures on the water resource. Pollution, linked to a growing population, poses a threat to public health, wildlife, as well as to sources of income such as fishing and tourism (Chaouki et al., 2015).

Industry has a close, if not vital, relationship with water. Industrial activities exert pressure on the resource, both in terms of withdrawal and pollution (Mouissi and Alayat, 2016). These activities are responsible for half of the organic pollutant discharges (suspended solids, nitrogen and phosphorus products) and almost all of the toxic discharges (metals, hydrocarbons, acids, materials) and ecological imbalance by heating the waters (Kendouci et al., 2013).

The preservation of the aquatic environment has thus become one of the major concerns of many populations and one of the priorities of authorities and professionals throughout the world. The study of pollution and its effects on ecosystems is a recent discipline, whose development is consecutive to the increase of discharges and accidents related to the intensification of anthropic activities (Letard, 2003).

According to Baumont et al., 2004, wastewater includes domestic wastewater (black water and grey water), runoff and industrial effluents. This water is therefore unavoidable and causes damage when it is discharged into nature. This water can infiltrate into the soil, causing not only soil pollution but also groundwater contamination; or it can run off the soil and be discharged either into rivers or directly into the sea. It is to be considered in a general way that water pollution is an anthropic consequence apart from the natural phenomena (Amar, 2015).

Developing countries, like ours, are not immune to such a threat. Indeed, for the last two decades, the findings on the current state of the environment of the city of Souk Ahras, especially the Oued Mellègue, are alarming.

It is in this context that we made this research which consists in a qualitative study of the surface waters of the catchment area of Oued Mellègue which is a tributary of Oued Medjerda (Souk-Ahras), whose objective is to estimate the intensity of the pollution as well as to determine the origin of this last one of this water course.

MATERIALS AND METHODS

Oued Mellègue is a wadi of 130 kilometers flowing in the West of Tunisia. Its watershed is partly in Algeria, in the willaya of Souk Ahras (in the North-East of Algeria). It is a tributary of the Medjerda (Figure 1). Oued Mellègue flows over a length of about (149 km) from its source at djebel Tadinart in the South-West to the Algerian-Tunisian border in the North-East (Belloula, 2017). The climate of our study area (Oued Mellègue watershed) is characterized by a typically semi-arid continental climate (cold winter and hot summer).

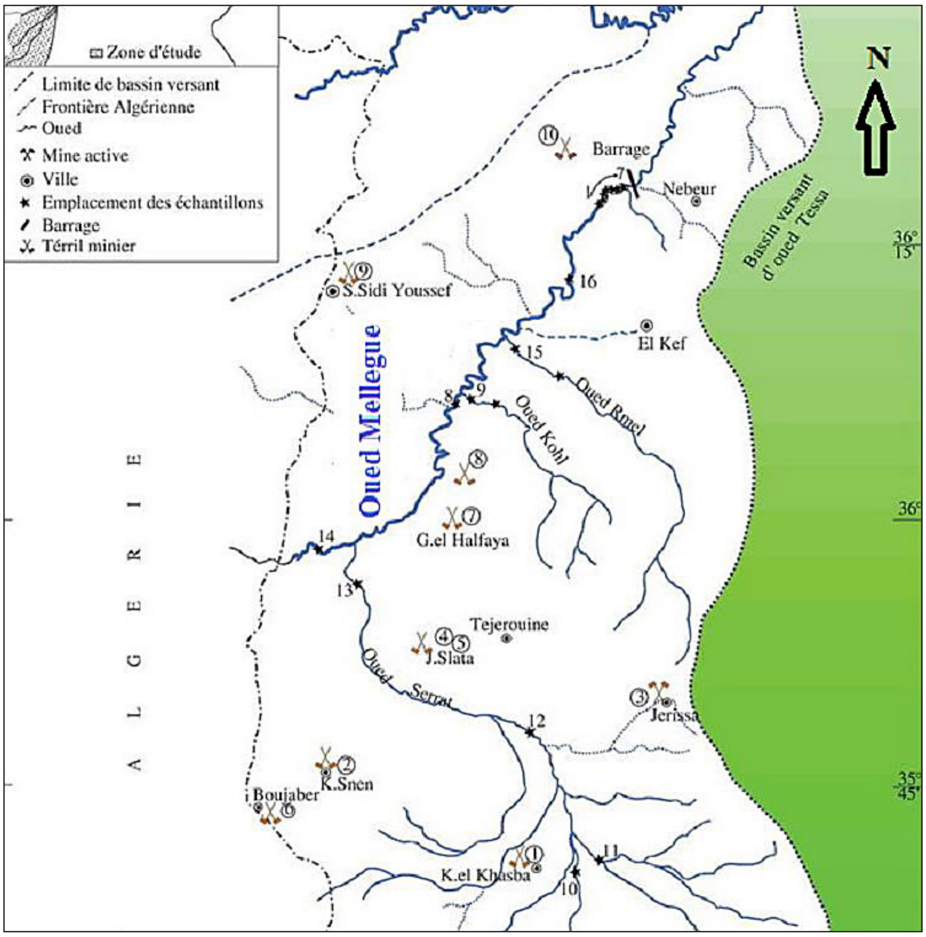

Figure 1. Presentation of the study area (Mlayah and al., 2013)

Protocol of sampling

The sampling of water was done on the surface waters of Oued Mellègue at a depth that varies between 15 to 20 cm. Where the sampling campaigns were made; from January 2022 to December 2022 (monthly sampling), and the latter is targeted to places where contamination (pollutant) is suspected (Mddepq, 2008). Then we followed the sampling standards filtration (0.45 µm filter), acidification (5 ml of HCl or HNO^-_3) and conservation (4 °C) (AFNOR, 1986).

In the laboratory we performed the following parameters (Table 1):
- pH,
- conductivity (EC),
- suspended matter (SS),
- chemical oxygen demand (COD),
- concentration of biodegradable organic matter (BOD^5),
- nitrates ($NO^-{}_3$), nitrites (NO^-_2), azote ammoniacal (NH^+_4),
- chloride concentration (Cl^-).

For statistical analysis

The obtained results were expressed as means ± standard deviation (SD) of the mean. The Differences were tested between the groups for statistical significance by one-way analysis of variance (ANOVA), followed by Tukey test for multiple comparisons (Minitab 18).

RESULTS AND DISCUSSIONS

Hydrogen potential (pH)

pH represents the degree of acidity or alkalinity of the aquatic environment. The pH of aquatic ecosystems is used as a proxy parameter to represent the complex relationships between water chemistry and biological effects (Bouakkaz, 2015). The pH values are between 7.8 and 9.5 (Figure 2), the waters of Oued Mellègue are alkaline especially in the dry season, they exceed the accepted standard between 6.5 and 8.5 (Khwaja et al., 2000, Singh et al., 2005).

Table 1. The water parameters measured

Parameters to be measured	Method of measurement
pH	pH-meter type PHYWE
Conductivity (EC)	Conductivity meter type W.T.W 1330 with measuring cell type LR 325/01 with thermal compensation
Suspended matter (SS)	Vacuum filtration
Chemical oxygen demand (COD)	Using a colorimetric analyzer
Concentration of biodegradable organic matter (BOD_5)	Biochemical oxygen demand for 5 days (BOD_5) (by Oxymetry)
Nitrates ($NO^-{}_3$), nitrites (NO^-_2), azote ammoniacal (NH^+_4)	Spectrophotometry
Chloride concentration (Cl^-)	Volumetry

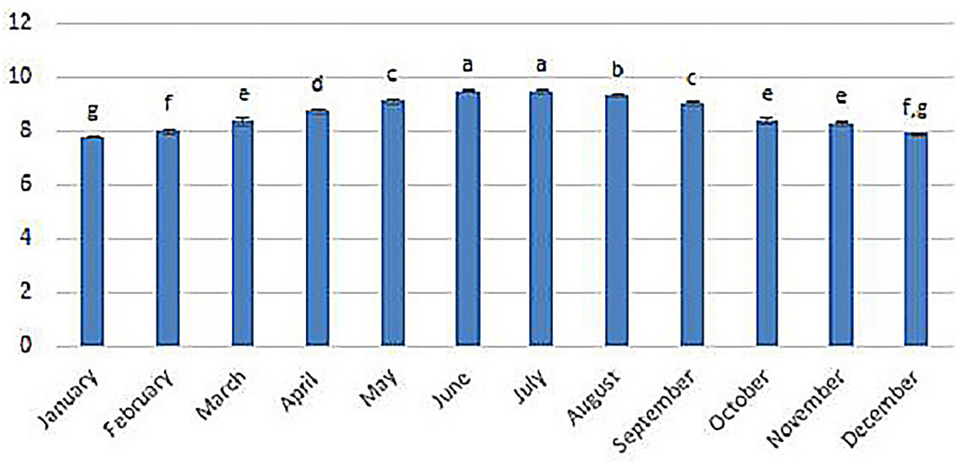

Figure 2. Potential hydrogen variation (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

Electrical conductivity (EC µs/cm)

The electrical conductivity in translates the capacity of an aqueous solution to conduct electric current; it determines the overall content of minerals present in a solution: A soft water will generally show a low conductivity, contrary water known as hard will show a high conductivity (Brémaude et al., 2006). The conductivity of this wadi is ranged between 2150 µs/cm to 3199 µs/cm (Figure 3). These concentrations are very high and far exceed the accepted discharge standard, evaluated at 2.5 ms/cm (Singh et al., 2005). These concentrations increase in the dry period and decrease in the wet period all along the wadi.

The matter in suspension (SS mg/l)

Suspended solids intervene in the composition of water by their ion exchange or absorption effects, as well as on trace chemical elements and micro-organisms. The concentrations of suspended solids are very important, varying between 500 mg/l and 4200 mg/l (Figure 4). They show a great variation between seasons along the Wadi. The elimination is very important but these concentrations remain high compared to the accepted standard of discharge, which is in the order of 50 mg/l (Singh et al., 2005). These high contents can prevent the penetration of solar rays, decrease the rate of dissolved oxygen and limit the development of the aquatic life; the asphyxia of fish, by clogging of the gills is often observed (Gaujous, 1995).

Chemical oxygen demand (COD mg/l)

COD is a measure of all (or almost all) the organic matter contained in natural or treated wastewater, whether or not it is biodegradable

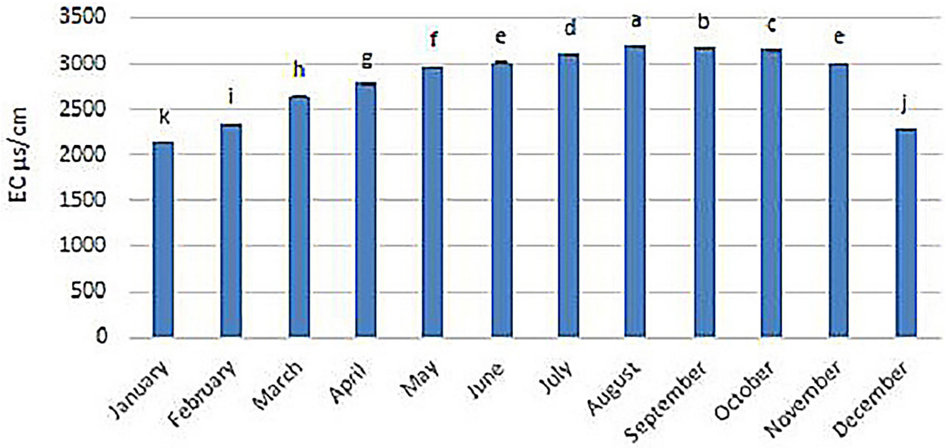

Figure 3. Conductivity variation (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

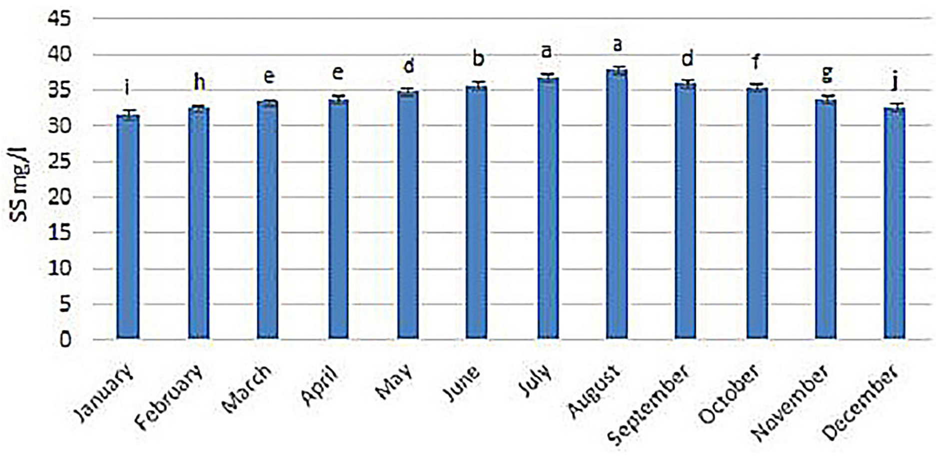

Figure 4. Suspended solid (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

(Boukermi and Hamdellou, 2018). According to the results obtained the rate of COD is very high throughout the year and they are between 32.09 mg/l and 38.22 mg/l (Figure 5), whose increase reaches its maximum in the dry period. According to the WHO surface water quality grid (COD 30 mg/L), the waters of Oued Mellègue are not of good quality. And this is related to the effect of diffuse pollution of organic matter.

Biochemical Oxygen Demand (BOD_5 mg/l)

The Biochemical Oxygen Demand (BOD_5) is the quantity of oxygen necessary for the degradation of the biodegradable organic matter of water by the development of micro-organisms, during 5 days at 20 °C, we speak then about the BOD_5. It is widely used to monitor urban effluents. It is expressed in mg O_2/l **(**Salghi, 2015). According to the results obtained, the levels of BOD_5 are high all along Oued Mellègue and exceed the WHO standard (40 mg/l) (Figure 6) especially in the dry period of the year; it ranges between 42.10 mg/l and 49.07 mg/l.

Nitrates (NO^-_3 mg/l)

The nitrate ion is the stable oxidized form of nitrogen in aqueous solution, it enters the nitrogen cycle as the main support of phytoplankton growth, it is then regenerated from organic forms by bacteria. The nitrate ion is produced by the oxidation of nitrite by bacteria called nitrobacter (Aminot and Chassepied, 1983). According to the results of Figure 7, the concentrations of nitrates vary between 44.02 mg/l and 48.10 mg/l, of which they exceed the WHO standard (44 mg/l), and they are very high in the dry period.

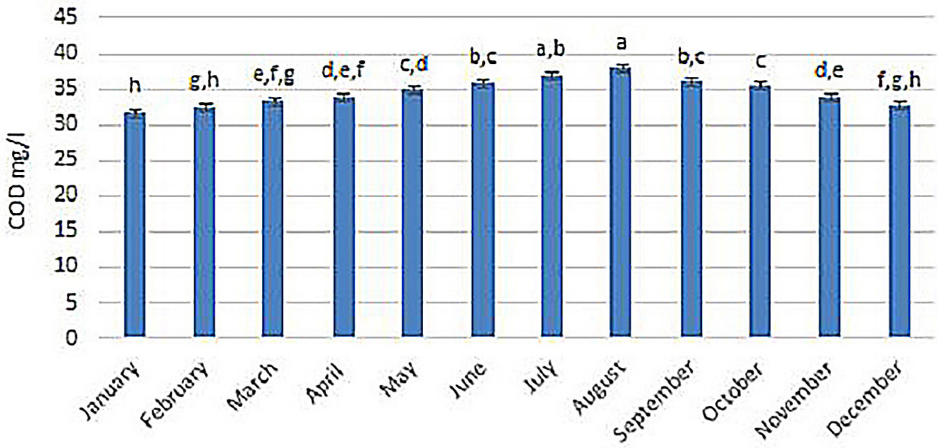

Figure 5. Chemical oxygen demand (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

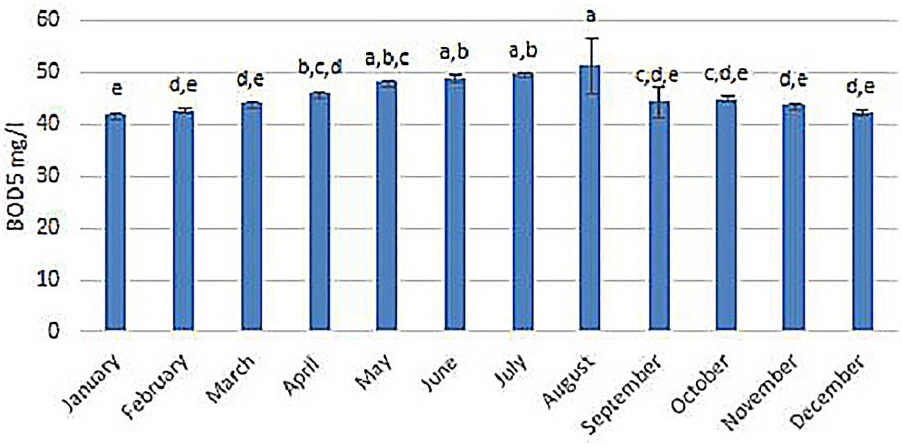

Figure 6. Biochemical Oxygen Demand (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

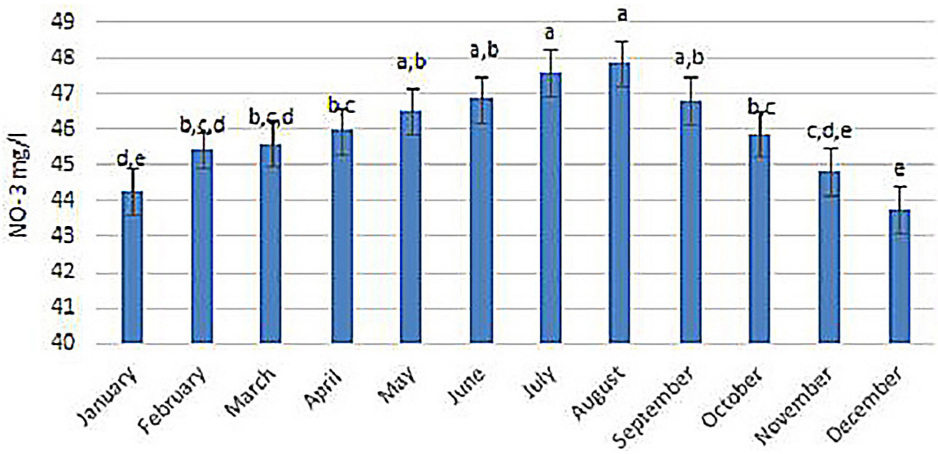

Figure 7. Nitrates (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

Nitrites (NO^-_2 mg/l)

In the nitrogen cycle, nitrites are considered to be intermediate ions between nitrates and ammoniacal nitrogen, which explains the low concentrations encountered in the aquatic environment which are of the order of a few micromoles per nitrous nitrogen (Aminot and Chassepied, 1983). According to the results of Figure 8, nitrite levels vary between 0.11 mg/l and 1.99 mg/l, and they exceed the WHO standard (0.1 mg/l), and they are very high especially in the dry period.

Ammonium (NH^+_4 mg/l)

Ammonium (NH^+_4) is the most toxic form of nitrogen. Its presence in water is linked to urban and industrial discharges or reducing nitrogenous forms (nitrates and nitrites) under reduced conditions (Debieche, 2002; Samai et al., 2022). According to Figure 9, the results show that ammonium levels vary between 0.19 mg/l and 0.35 mg/l, and all these levels are above the standard set by the WHO (0.1 mg/l).

Chlorides (Cl^- mg/l)

Water almost always contains chlorides but in highly variable proportions. The chloride content generally increases with the degree of mineralization of water (Tardathenry and Beaudry, 1984). The presence of chlorides in water is mainly related to the nature of the terrain crossed. Thus, it can be attributed to natural springs, wastewater or saline intrusions (Maiga, 2005). The accepted standard for fresh and natural water is 250 mg/l (Decree 11-125 Water Quality) (Samai, 2022).

The concentrations of chloride ions found in water of Oued Mellègue range from 75.33 mg/l to

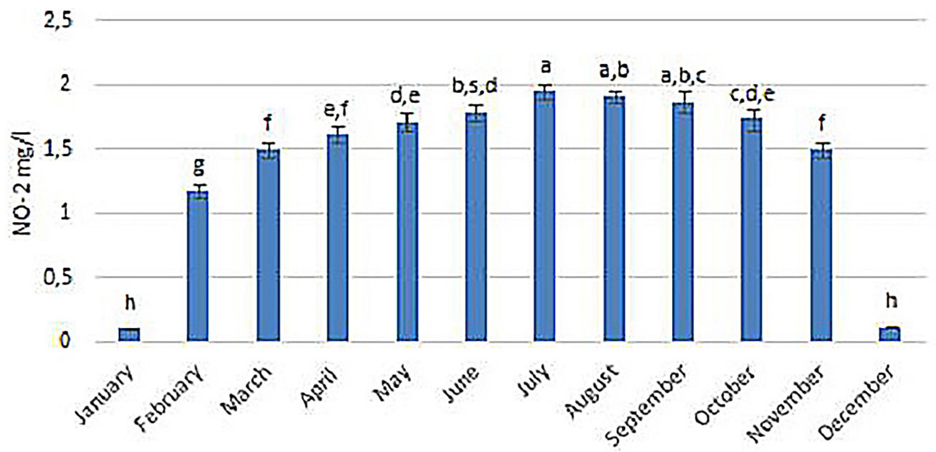

Figure 8. Nitrites (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

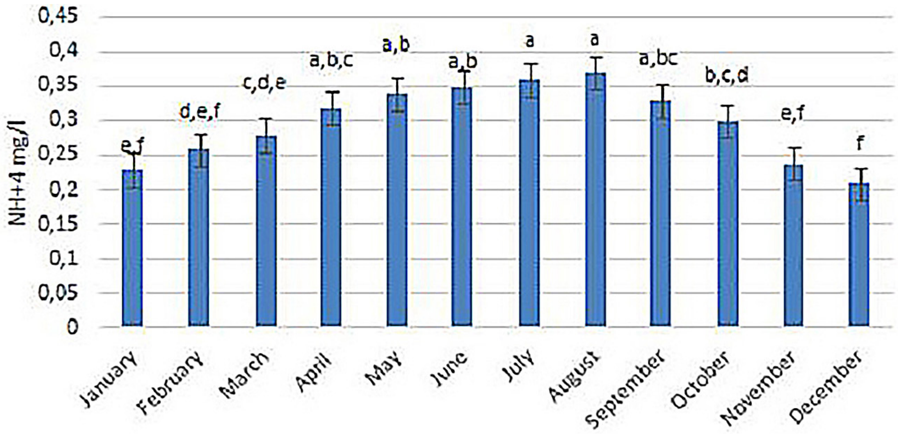

Figure 9. Ammonium (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

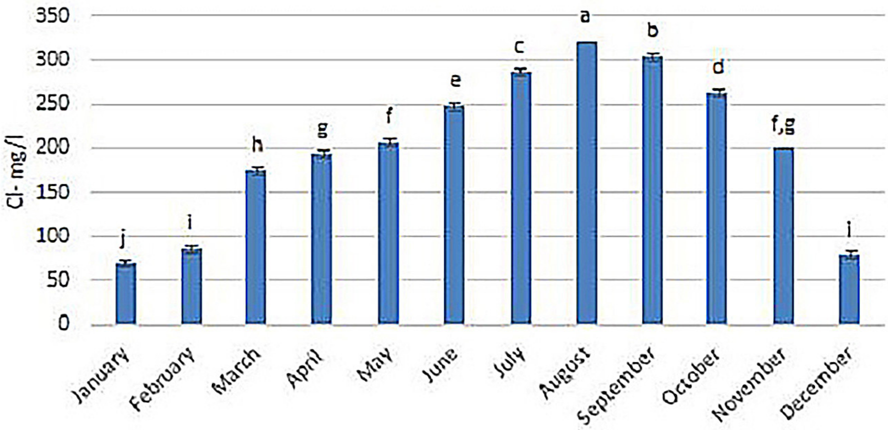

Figure 10. Chlorides (mean ± SD) for 12 months. Means that do not share the same letter are significantly different at $p < 0.05$

321.08 mg/l (Figure 10). This evolution is noticed especially downstream, it indicates the contribution of an anthropic contribution that can be of urban or industrial origin.

CONCLUSIONS

Essential to all life, water is a common good, a vital element for food, a living environment for many species and a resource for many economic activities. Globally overexploited and polluted by human activities, water has become a fragile asset over the decades. In a global context of scarcity, the quality and availability of water resources have become major issues, both in terms of public health and the environment, and even geopolitical stability in certain regions of the world.

The results of the physico-chemical parameters carried out on the surface waters of Oued Mellègue which is located in the North-East of Algeria, informed us that it is very polluted and that is observed at the level of the potential of hydrogen, the electric conductivity, the suspended matter, nitrates, nitrites, biochemical oxygen demand, ammonium and chlorides, which are all very high, especially in the dry season, from which this wadi becomes harmful on the health of the public and even on the whole ecosystem whether marine or terrestrial. For this situation it is recommended to place purification stations in several points of this river to avoid contamination and protect our nature.

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