



Research Article

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Quantitative evaluation of phosphorus dissolved in the water of Bounamoussa River (North Eastern Algeria)

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ABSTRACT

Phosphorus is an element responsible for the eutrophication of inland and marine aquatic environments. This global environmental phenomenon represents a current problem causing the decrease in the quality of aquatic environments. Within the frame of resolving this problem, we conducted analyzes of physicochemical parameters (T° , pH, EC, COD, PO_4^{3-} , Pt) on water taken from Oued Bounamoussa (northeastern Algeria) in an attempt to diagnose the eutrophication state of surface water of this watercourse. For this purpose, samples were taken on a seasonal basis during the periods of October 2013, January 2014, April 2014 and July 2014 from ten selected stations. The analysis results show that the temperature values are high in summer with an average of around $30^{\circ}C$ and low in winter to about $09^{\circ}C$. The pH varies between 6.14 and 8.14, with an electrical conductivity content ranging between $266 \mu s/cm$ and $4006 \mu s/cm$. An increase in the COD of up to $910 mg/l$ during July 2014 is witnessed. The eutrophication situation of the environment can be observed by the high values of orthophosphate and total phosphorus that exceed the standards of the surface water's quality. In general terms, water quality of Oued Bounamoussa that was affected by this phenomenon, is bad which causes an ecosystem disturbance.

Key words: physico-chemical analysis, Oued Bounamoussa, phosphorus, eutrophication.

INTRODUCTION

The renewable fresh water is a crucial resource for life. It deserves special attention, since it is highly altered and seriously threatened by human activities [01]. In Algeria, the exploitation of water resources is great. This is mainly due to the growing needs associated with the population growth, accelerated development of economic activities, including irrigated agriculture, industry and the lack of awareness of the population about environmental protection. All these factors lead to an imbalance of the ecosystem and generate pollutants that can affect the physicochemical and biological quality of aquatic receptors [02].

The eutrophication of lakes and reservoirs is amongst the most widespread water pollution parameters [3]. Eutrophication is a natural very slow process by which water bodies receives large amounts of nutrients including phosphorous, which stimulates the growth of algae and aquatic plants. However, human activities have accelerated, in many streams, the amount of phosphate components that reach them, which causes changes in the balance of these aquatic ecosystems. Through the increased use of chemical fertilizers in agriculture and the development of intensive farming, industrial effluents and domestic sewage also promote the phenomenon in urban and industrial areas [4].

This paper investigates the waters eutrophication of Wadi Bounamoussa, located to the north-east of Algeria in the wilaya of El-Tarf to contribute in the knowledge of the eutrophication influence on this ecosystem through a quantitative study of different forms of phosphorus dissolved in the streams.

EXPERIMENTAL SECTION

Presentation of the study sites

Sampling Stations

In this study, we have chosen ten water sampling stations located along Oued Bounamoussa based on some criteria mainly related to the field of the study area:

- The conditions must be favorable.
- Relationship with homes and farmland.
- Accessibility to the station.

The water samples were taken on October 2013, January 2014, April 2014 and July 2014.

Table 01: location of the studied stations at Oued Bounamoussa

Station	Lambert Contact		Region
	Latitude	Longitude	
S 01	N36° 36' 9,83''	E008° 24' 72''	Tofaha
S 02	N36° 39' 23,16''	E007° 57' 42,50''	Bouzitouna
S 03	N36°41' 11,82''	E007° 57' 36,12''	Skoufi
S 04	N36° 42' 30,92''	N36° 42' 30,92''	Nchayma ¹ (la ferme)
S 05	N36° 42' 44,31''	E007° 57' 29,93''	Nchaima ² (cimetière)
S 06	N36° 43' 35,13''	E007° 56' 39,63''	Pont de Zerizer
S 07	N36° 47' 37,96''	E007° 50' 12,27''	Bordj Semar
S 08	N36° 45' 25,12''	E007° 55' 23,69''	Ben-M'hidi
S 09	N36° 50' 28,10''	E007° 57' 19,58''	Griâte
S 10	N36° 50' 54,2''	E007° 56' 40,69''	Battah

Water samples were collected and filled into polyethylene bottles, previously rinsed with water from the station. They were then stored at 4 ° C during transportation to the laboratory and were analyzed within 24 hours.

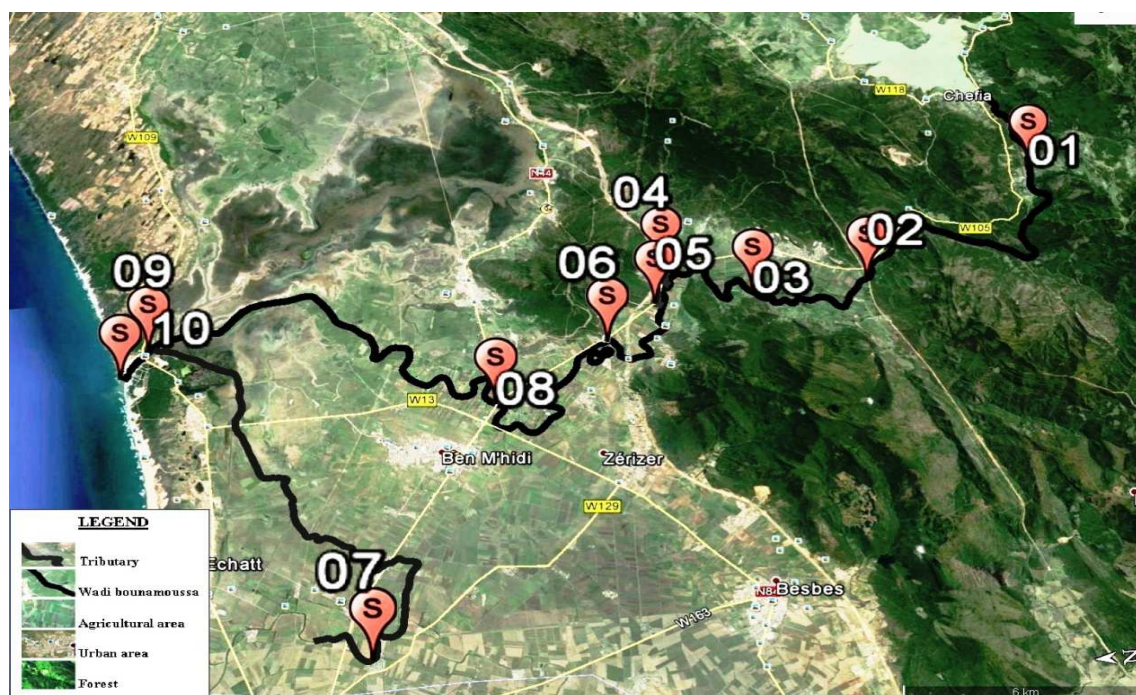


Figure 01 : Sampling stations [5].

Physicochemical Analysis Methods

Table 02: Parameters conducted in this study with their methods and measurement units:

Parametres	Mesures in situ	
	Analysis Methods	Measurement units
Temperature	A multiparameter (HANNA instruments HI 9828)	°C
pH	A multiparameter (HANNA instruments HI 9828)	
Electrical conductivity	A multiparameter (HANNA instruments HI 9828)	µs/cm
Measurements carried out in the laboratory		
COD	AFNOR Method(T90-101) [6]	mg/l
Orthophosphate	Spectrophotometric methods [07]	mg PO ₄ ⁻³ /l
Total phosphorus	Spectrophotometric methods [08]	mg PO ₄ ⁻³ /l

Materials and methods

Overview of Study area

El-Tarf province is located in the extreme north-east of Algeria, between latitude of 36° 75'00" and longitude of 08° 16'66". Crossed by the highway El Kala - Annaba (Figure 1), the province Covers an area of approximately 2891 km2. It is limited on the north by the Mediterranean Sea, on the South and South-West by Souk-Ahras and Guelma respectively, on the West by Annaba and on the East by the Algerian-Tunisian borders. In the agricultural sector, this region includes ten small agro-industrial units. Its Mediterranean climate makes it one of the wettest regions of Algeria. The average annual rainfall from south to north is highly variable from 450 to 1000 mm. [9] Located in the plain of Bounamoussa; a major irrigation perimeter spanning 90% of El-Tarf province and covering the municipalities of Besbes, Beni Amar, Zerizer, Asfour, Ben M'hidi and Chebaita Mokhtar. It is limited on the North by coastal dunes, on the South by the mountains of Medjerda, on the East by the Mountains and to the West by the National Highway 16 (Annaba, Souk- Ahras). [10]

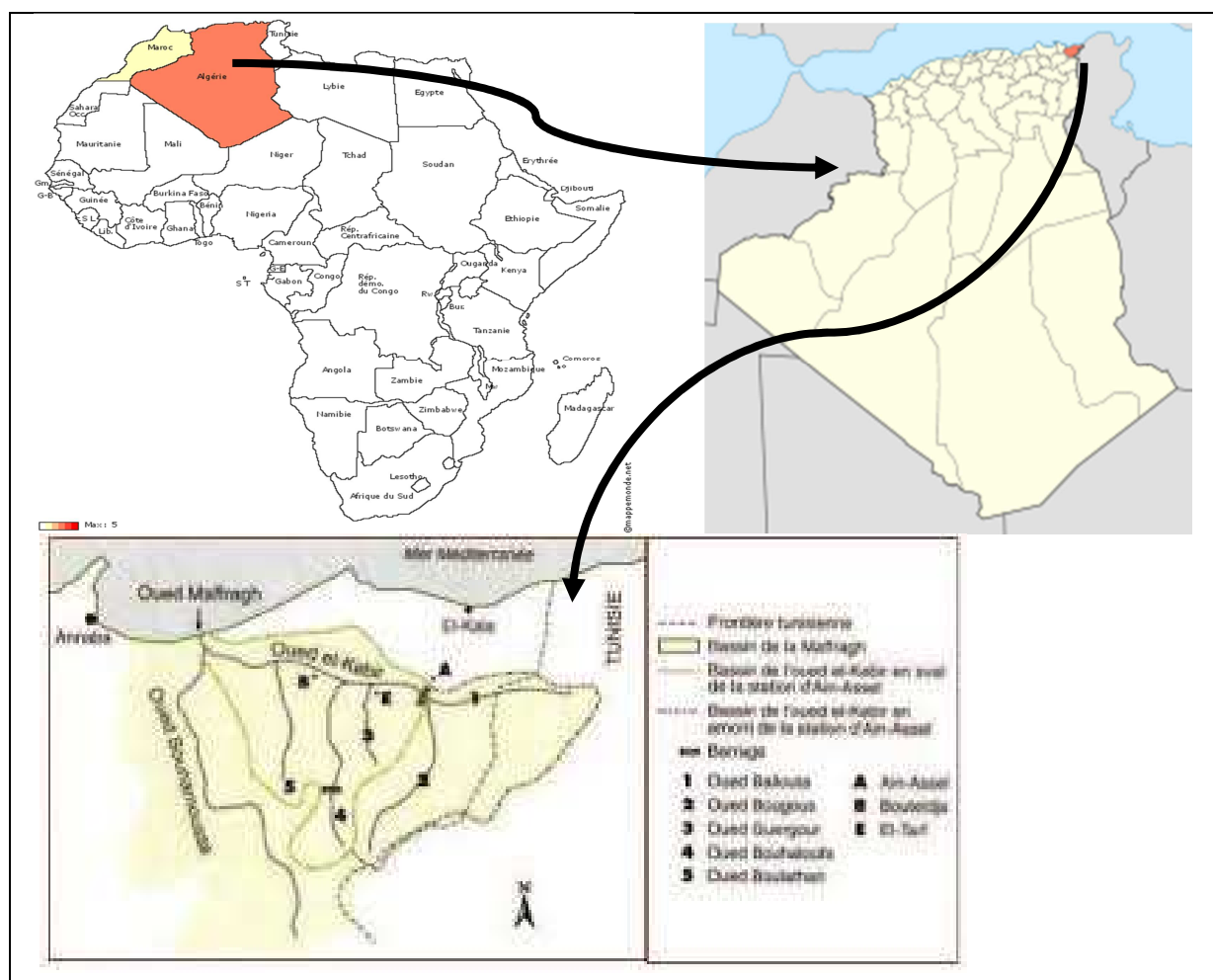


Figure 02: Geographical location of the watershed of Oued Bounamoussa

RESULTS AND DISCUSSION

The quality of river water was evaluated according to the physic-chemical parameters. It is determined by comparing our results across the quality grid of the National Agency for Water Resources (N.A.W.R) doors that are on the table.

Table 03: Quality class of surface water (N.A.W.R)

Parameter	Units	Excellent	Good	Fair	Poor	Excessive pollution
The temperature of the water	°C	< 20	20 à 22	22 à 25	25 à 30	30
pH	-	6.5 à 8.5	-	6 à 6.5 ou 8.5 à 9	5.5 à 6 ou 9 à 9.5	< 5.5 ou > 9.5
The electrical conductivity	µS/cm	< 400	400 à 750	750 à 1500	1500 à 3000	3000
DCO	mg/l	≤20	20 à 50	50 à 100	100 à 150	150
Orthophosphate	mg/l	< 0.2	0.2 à 0.5	0.5 à 1	1 à 5	5
Phosphore total	mg PO ₄ ³ /l	0,05	0,2	0,5	1	≤1

La temperature (T°C)

The water temperature is an environmental factor that causes significant ecological repercussions. [11] It acts on the density, the viscosity, the solubility of water gases, the separation of dissolved salts, as well as the chemical and biochemical reactions, the development and growth of organisms living in water and particularly the microorganisms [12].

The recorded temperatures of the study area (Figure 03) range between 09° C (S03) and 13° C (S09 and S10) during January 2014 and between 27 ° C (S03 and S04) and 30° C (S01) during July 2015. These variations in temperature follow those of the region's climate.

Temperatures measured in Oued Bounamoussa water belong to the good class with an average of 21° C.

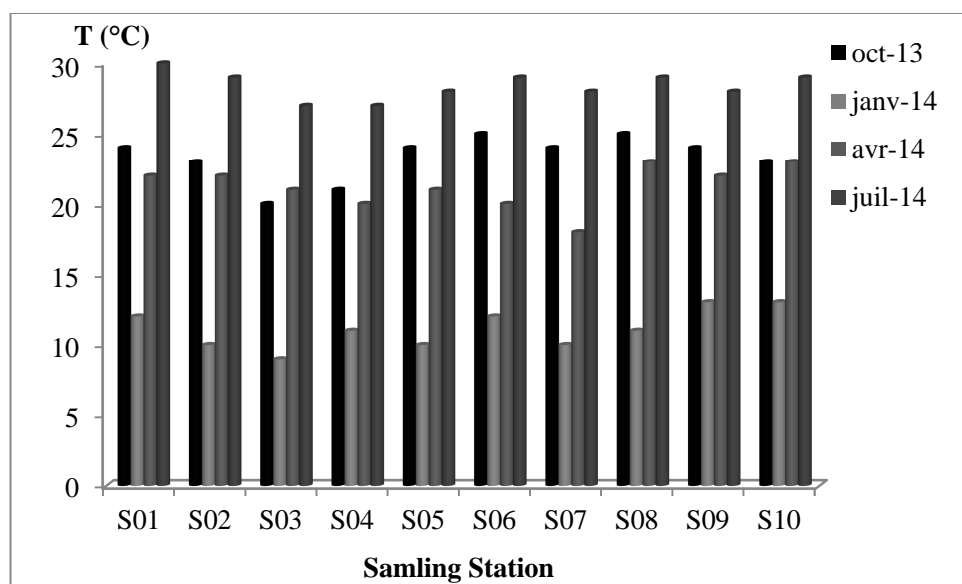


Figure 03: Spatio-temporal variation of temperature

Potential of Hydrogen (pH)

The pH of water measures the concentration of the protons H⁺ in. It summarizes the stability of the balance between different forms of carbonic acid and is linked to the buffer system developed by carbonates and bicarbonates [13]. The pH of water depends on the carbon balance and the photosynthetic activity of the ecosystems. The discharge of domestic and industrial waste water can influence the pH of the environment despite its buffer capacity [14].

The analysis of pH results shows a small variation, with an average of 7.36, a minimum of 6.44 at the station (S04) on October 2013 and a maximum of 8.14 at station (S02) on January 2015 (Figure 04).

The observed values show that pH is slightly neutral to alkaline in all stations of Oued Bounamoussa, in the rainy season more than in the dry period, which may be due to the rainwater. [1] The acidity of pH on October can be explained by the abundance of CO₂ dissolved in the water during the low water period [15] [16]. This small variation is due to the buffering effect of bicarbonate ions.

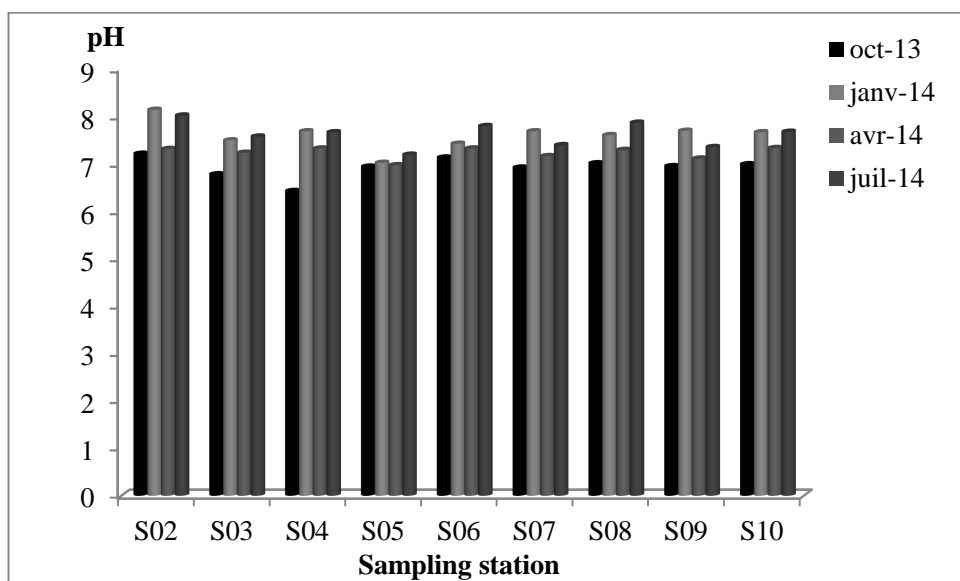


Figure 04: Satio-temporal variation of pH values

The Electrical Conductivity (EC)

The conductivity of the surface water of the study area (Figure 05) has significant values that vary as follows:

- A Maximum of 4006 μ s/cm at the station (S10) and a minimum of 436 μ s/cm at the station (S02) during the month of July 2014.
- A maximum of 1453 μ s/cm at the station (S10) and a minimum of 265 μ s/cm at the station (S02) on January 2014.

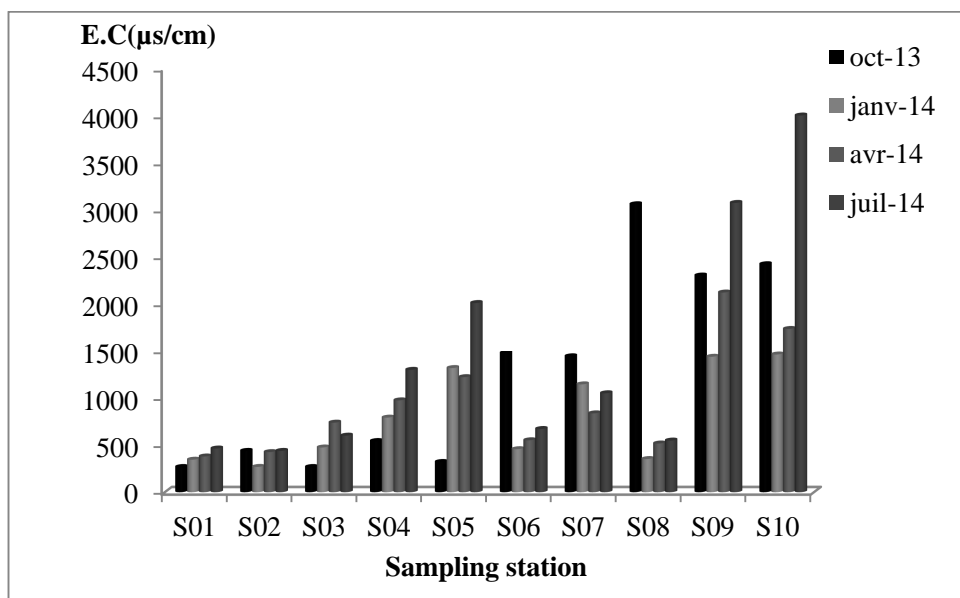


Figure 05: Spatio-temporal variation of the values of electrical conductivity

The increase in conductivity in the warm period may be due to the low flow of the Oued which results in increased levels of minerals and to strong atmospheric evaporation [17]. The highest value was recorded at the station S10 which is influenced by the proximity of the marine environment. Moreover, the minimum values are marked in January at all stations, which is probably related to the water dilution by rainfall [18].

In our study case, the values exceed the standard of the surface water quality (N.A.W.R) 1500 $\mu\text{s}/\text{cm}$, indicating excessive mineralization attributed to wastewater from neighboring towns which allows the classification Oued Bounamoussa in the poor class.

Chemical Oxygen Demand

Chemical oxygen demand (COD) represents the amount of oxygen consumed by the chemically oxidizable materials contained in water. It allows assessing the concentration of organic or inorganic materials, dissolved or suspended in water, through the amount of oxygen required for the total chemical oxidation [19].

COD contents recorded at the studied waters range between 50 mg/l (S07) and 910 mg/l (S02) in October and between 45 mg/l (S01) and 135 mg/l (S03) in January (Figure 08). The values recorded at October and July exceeds the standards of the N.A.W.R set at 100 mg/l.

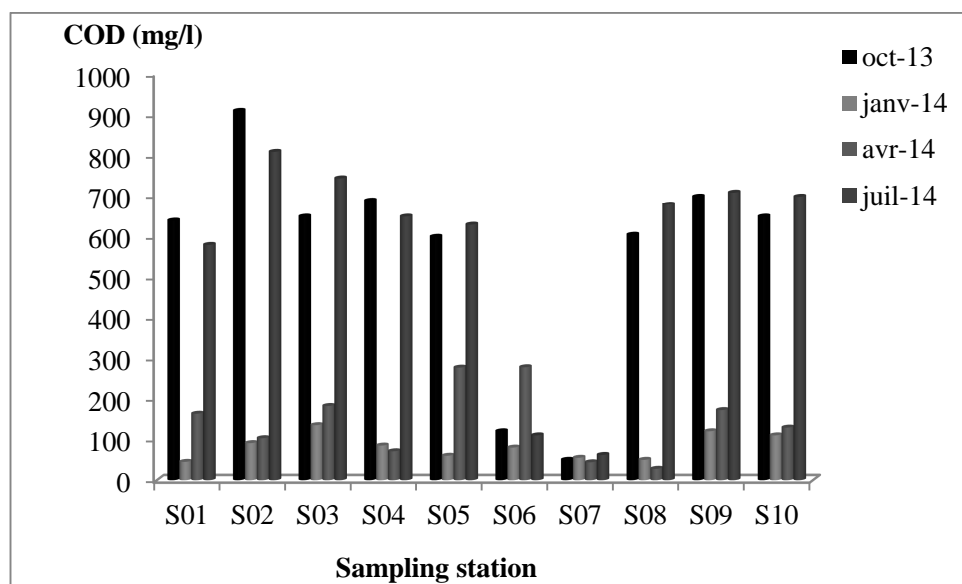


Figure 06 : Spatio-Temporal variation in chemical oxygen demand

Orthophosphate (PO_4^{-3})

The orthophosphate is a biogenic element vital to the growth of algae. The higher levels of this element in surface waters can cause eutrophication [01]. The results analysis (Figure 06) shows that concentration of orthophosphate in OuedBounamoussa surface water varies between 0.10 mg/l (S05) and 0.49 mg/l (S06) in January 2014 and between 0.18 mg/l (S02) and 2.29 mg/l (S05) in July 2014.

Orthophosphate that follow a spatial variation relatively marked by a rising trend in hot weather can be explained by the discharge of domestic waste water and by leaching of the farmlands fertilized with phosphate nourishments. The levels of orthophosphate we obtained are high and indicate a poor water quality according to the (N.A.W.R) standard. These high levels of this element cause the eutrophication that lead to ecosystem disturbance by the appearance of algae as Cyanophyceae with a rate of (44.03%), Euglenophycées (41.61%), Diatomophyceae (10.96%) and Chlorophyceae (3.38%) [20].

Total Phosphorus (TP)

In this study, seasonal evolution of the total phosphorus showed higher concentrations during July than during October, January and April. The recorded contents (Figure 07) range between 2,81mg $\text{PO}_4^{-3}/\text{l}$ (S05) and 1,30 mg $\text{PO}_4^{-3}/\text{l}$ (S06) and between 1,70 mg $\text{PO}_4^{-3}/\text{l}$ (S07) and 0,64 mg $\text{PO}_4^{-3}/\text{l}$ (S10) respectively during July and October. These high values are due, on the one hand, to the industrial wastes including those containing detergents, and on the other hand, to the phosphate fertilizers. The total phosphorus content ranges from almost similarly to orthophosphate, which indicates a self-purifying effect in this hydrosystem.

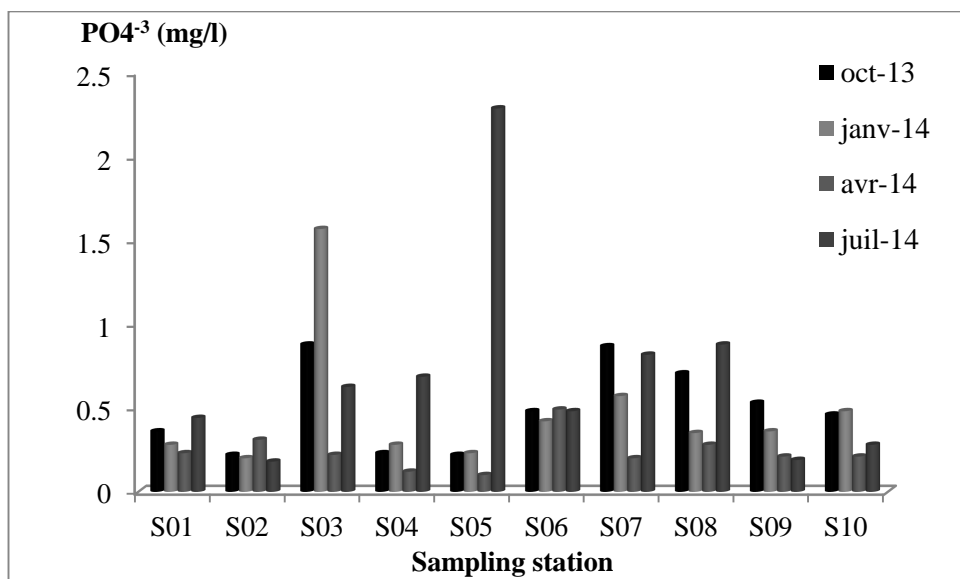


Figure 07: Spatio-temporal variation of orthophosphate values

Thus, Total phosphates measured in the water of Oued Bounamoussa belong to the class of excessive pollution with an average of $1,71 \text{ mg PO}_4^{-3} / \text{l}$.

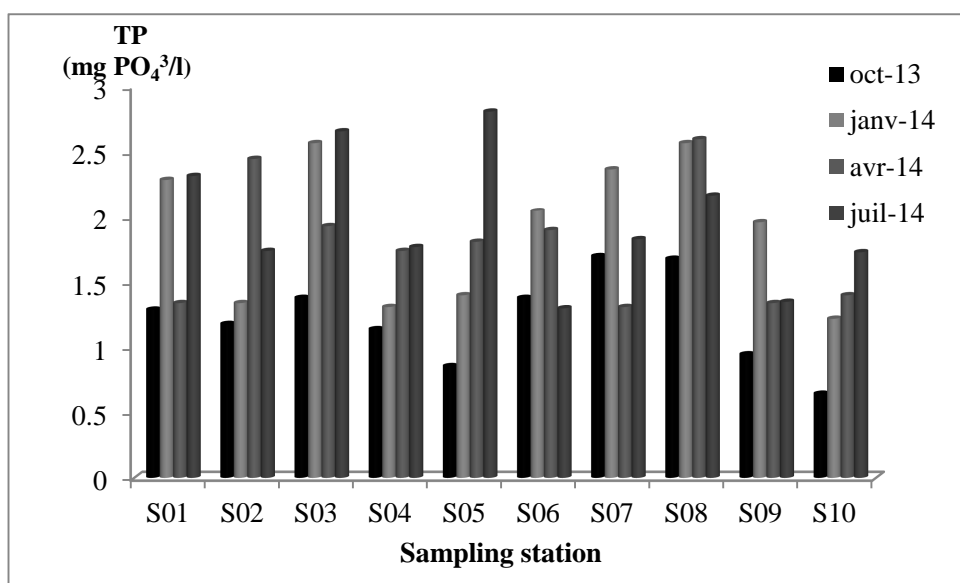


Figure 08: Spatio-temporal variation of total phosphorus values

CONCLUSION

In the light of the results obtained in the physicochemical parameters measured at the surface water of Oued Bounamoussa, a degradation of water quality is noticed and most tests revealed levels that exceed the of the international quality standards of surface water. It is worth mentioning that the contents discharged in phosphorus materials characterize a favorable situation for eutrophication.

This phenomenon promotes the proliferation of pollution-resistant organisms such as Chlorophyceae, Cyanophyceae and Diatomophyceae that represent the algal population.

The agricultural and industrial activities as well as the urban areas are the main sources of the phosphorus. Therefore, the preservation of water resources becomes imperative facing the deterioration of these aquatic ecosystems and requires the establishment of treatment plants. Measures should also be taken to control and treat effluents.

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