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Correlation study between Nitrate, Nitrite, Chloride and Sulfate in Natural Waters of Bouregreg River (Rabat, Morocco)

Nabih Zerki, Karima Achelhi, Rahma Bchitou and Ahmed Bouhaouss

Nanostructures Laboratory, Process Engineering and Environment, Department of Chemistry, Faculty of Sciences, University Mohammed V-Agdal, Rabat, Morocco

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ABSTRACT

The objective of this study is to verify the current level concentrations of the nitrate, nitrite, chloride and sulfate anions, and measured some physico chemical parameters (temperature, pH and conductivity) of natural waters in several sites upstream and downstream of Bouregreg river , by analytical analysis for the characterization of these species and water parameters studied, and then applying a statistical processing from the principal component analysis (PCA) of the results found using SPSS software to determine the different correlations and have interpreted the data of each of the elements studied.

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INTRODUCTION

Many studies have shown that most of the chemical species that are discharged into the aquatic environment is found always more or less associated with bottom sediments [1,2,3], and under the influence of changes in physical-chemical properties of the medium, these species may again ironing in the aqueous phase [4,5].In Moroccan estuaries, several authors have shown such contaminations [6,7,8,9] which are due to domestic and industrial discharges installed along the Moroccan coast.Indeed, the physical and chemical characteristics of the water such as pH, temperature and conductivity, are among the principal factors that govern the exchange of chemical elements in ecosystems [10,11].The determination of these characteristics allows the understanding of mechanisms that govern the distribution of elements in water, especially those related to sedimentary particles watershed and are likely to be transported to the treatment station[12,13].

In this context the Bouregreg principal river through the city of Rabat and opening onto the Atlantic Ocean has been experiencing a significant deterioration probably due to important human activities in the area characterized by a permanent pollution due to domestic and industrial wastewater discharged directly into the estuary without treatment.

MATERIALS AND METHODS

Sites and samples:

The samples were collected during the month of May 2012 in two groups of sites. A group upstream and the other downstream (Fig. 1).The distance between the sites is averaged 500 meter, and time is approximately 20 minutes.The upstream sites are located in vicinity of the Sidi Mohamed Ben Abdellah dam.They are characterized by stagnant waters where the maritime influence is very low.Moreover, the downstream sites are located at the mouth of a few kilometers from the ocean; this is a crossing zone between Rabat city and Salé city.All samples of water and sediments were collected on the surface at the edge of river.These samples represent the transition period between the cold and warm period.

We respected the following precautions:

-the sampling location is a calm area and regular sedimentation.
-The samples are taken on the surface layers (4-6 cm) in two to three points spaced a few meters.
-the sediments are preserved in plastic bags of food, and then stirred for homogenization.

Corresponding Author: Nabih Zerki, Nanostructures Laboratory, Process Engineering and Environment, Department of Chemistry, Faculty of Sciences, University Mohammed V-Agdal, Rabat, Morocco.

At each site, we collected 1 to 2 liters of water sample,we using plastic bottles previously rinsed with distilled water.Transportation and conservation of water takings for this study were made so as to be closest to the optimum conditions for water analysis.

Fig. 1: Location the sampling sites in the Bouregreg estuary.

Analysis:

To evaluate the physical and chemical properties of Bouregreg water, we determined for each sample a number of parameters such as temperature, pH, conductivity, total phosphorus, as well as chlorides, sulfates, nitrates and nitrites).

The temperature and pH of the samples were determined during sampling on the banks of the river.

In order to interpret analytical results and extrapolate the resulting and necessary information on the Bouregreg river pollution, we used a method of statistical multivariate analysis, which is the principal component analysis (PCA).This method allowed providing information on measures physicochemical parameters made during the period of this study and look for correlations between the different physicochemical parameters. Moreover, this method reduces the number of variables called principal components[9].This will result to the fact that the cloud of individuals projected on new major plans is the least distorted way to make the total inertia of the projected maximum cloud [14].A variable representation is thus obtained in the main planes of which the coordinates are the correlation values of the original variables with the main components [15,16],this was performed on 7 reduced centered variables which represent the concentrations of chlorides, sulfates, nitrates and nitrites in the water, the pH, conductivity and temperature.

RESULTS AND DISCUSSIONS

Experimental results:

After determining the concentrations of studied elements on the Bouregreg River, we reported in table 1 the various analyzes obtained.

The study of the spatial variation of the levels registered in water (Table 1 and Fig.5,6,7,8) shows that the classification of levels in the waters presents respectively in the following order: chloride>sulphate> nitrate> nitrite.

The spatial distribution of the contents analyzed in different sampling sites shows that the site downstream S7 has a high content of Cl and NO_3 in water ([Cl] = 589 mg / l, [NO_3] = 31.04 mg / l) (Fig.5 and Fig.7).

The variation of the NO_2 content does not present remarkable changes except for the downstream site S6 where the maximum level reached 0.523 mg / l (Fig.8). Moreover, we note that for the period of study the content of SO_4 is maximum at site downstream S7 ([SO_4] = 124 mg / l) (Fig.6).

The temperature varies between 18.6 ° C (site S8) and 20.4 ° C (site S1) with an average of 19.42 ° C. This average increases gradually as one moves downstream of the upstream sites, to the site as shown in Table 1 and Fig. 2.

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The study of the spatial evolution of pH at the Bouregreg River (Table 1 and Fig. 3) shows the existence of a very small spatial variation characterized by the presence of two zones, one upstream and other downstream.

Upstream zone is characterized by pH between 7.1 and 7.4.

Downstream zone is characterized by pH between 7.9 and 8.3.pH values at the mouth reflects the alkalizing effect of seawater.

Between these two areas, domestic waste and neutral or slightly basic characters give the river water intermediate pH values.

The conductivity increases from upstream (500 µS/cm) to downstream (4266 µS/cm) (Table 1 and Fig. 4). This is explained by both: remoteness of marine influences and dilution by freshwater inputs.

Table 1: Levels of chloride, sulfate, nitrate and nitrite in Bouregreg water and those of some physicochemical parameters.

	Tem (°C)	pH	Cond (µS/cm)	Cl(mg/L)	SO_4(mg/L)	NO_3(mg/L)	NO_2(mg/L)
S1	20,4	7,1	530	329	96	10,25	0,356
S2	20,1	7,3	500	333	88	12,46	0,404
S3	19,8	7,4	509	411	101	15,75	0,434
S4	20	7,2	520	402	91	13,12	0,332
S5	19	8,3	2074	498	118	20,75	0,489
S6	18,7	8,1	3967	524	110	29,66	0,523
S7	18,8	8,3	4120	570	124	30,23	0,512
S8	18,6	7,9	4266	589	123	31,04	0,511

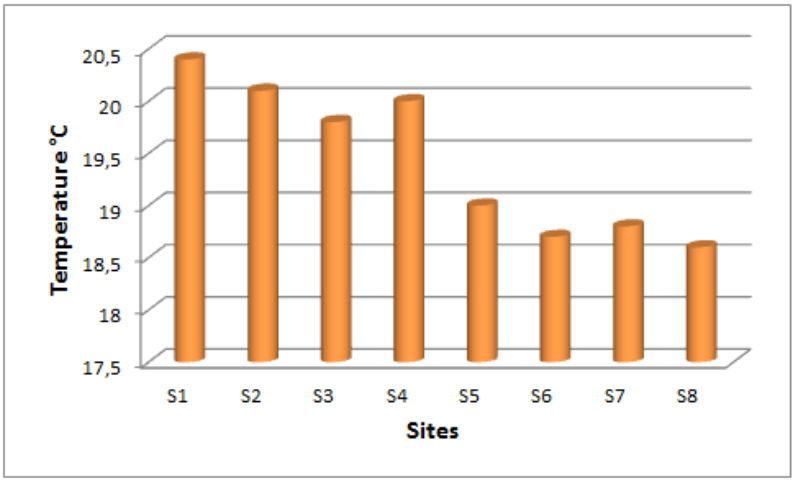

Fig. 2: Variation of temperature as a function of sampling sites.

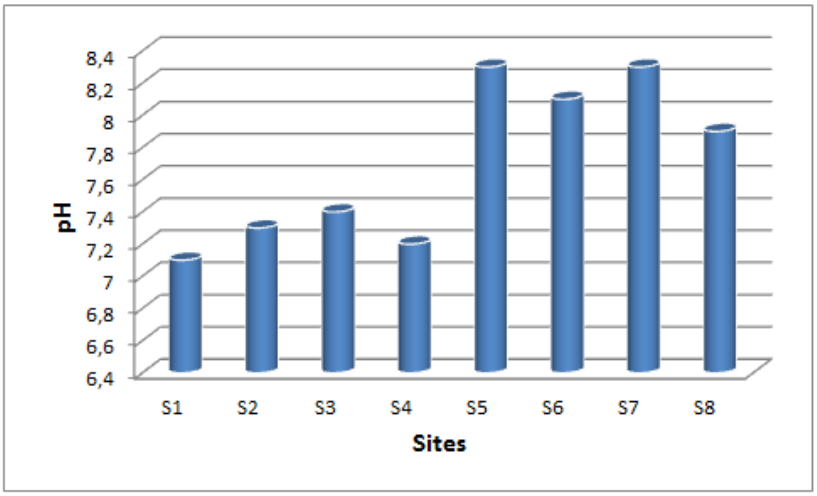

Fig. 3: Variation of pH as a function of sampling sites.

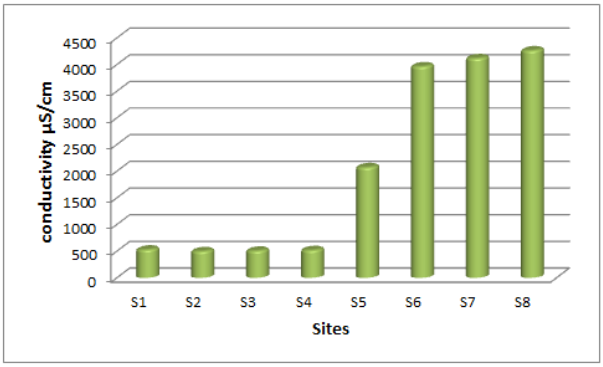

Fig. 4: Variation of conductivity as a function of sampling sites.

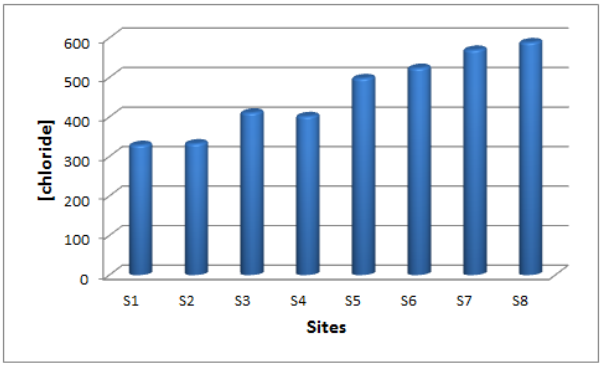

Fig. 5: Variation of chloridesas a function of sampling sites.

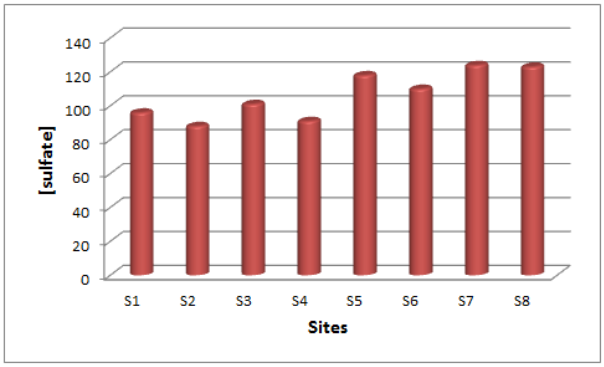

Fig. 6: variation of sulfatesas a function of sampling sites.

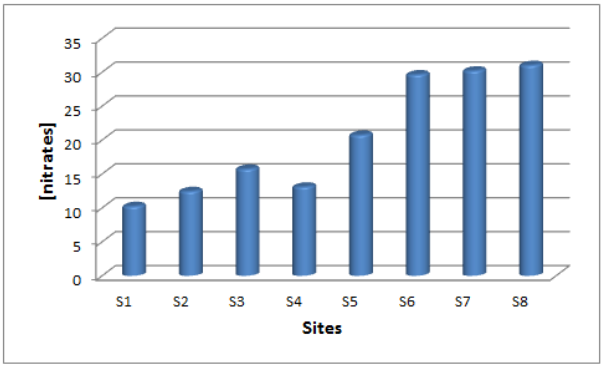

Fig. 7: Variation of nitratesas a function of sampling sites.

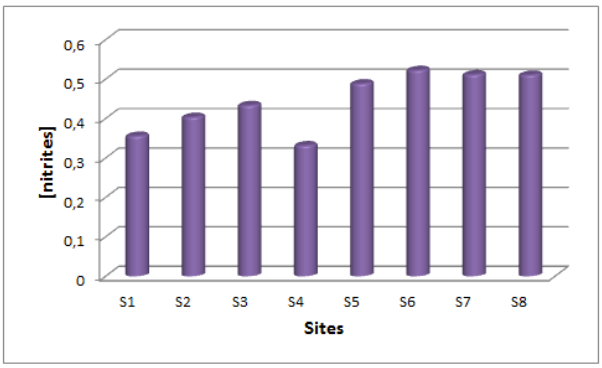

Fig. 8: Variation of nitritesas a function of sampling sites.

Correlations study:

Table 2 shows the correlation matrix between physicochemical parameters determined. From the results of this matrixwe can take the following conclusions:

-NO_2 is positively correlated with pH, the correlation coefficient is to 0.909.

-Cl is positively correlated significantly with NO_3, SO_4 and conductivity whose correlation coefficients are respectively: 0.965, 0.933 and 0.937.

-NO_3 is positively correlated with NO_2, the correlation coefficient isto 0.914.

Table 2: Correlation matrix between the physicochemical parameters studied.

	Tem	pH	Cond	Cl	SO_4	NO_3	NO_2
Tem	1,000						
pH	-0,917	1,000					
Cond	-0,942	0,829	1,000				
Cl	-0,972	0,868	0,937	1,000			
SO_4	-0,903	0,891	0,872	0,933	1,000		
NO_3	-0,970	0,849	0,985	0,965	0,881	1,000	
NO_2	-0,936	0,909	0,880	0,866	0,868	0,914	1,000

The principal component analysis:

According to the graphic projection of the principal component analysis we note:

For the studied parameters the total inertia of cloud axes is selected: Axis 1: 51%, Axis 2: 96%, and as shown in Fig.9 which shows the correlation of the circle, this figure shows two groups. The first group formed by: Cl, SO_4, NO_3, NO_2, Cond, pH, which correlates positively, and the second formed by temperature which correlates negatively.

For sampling sites, two axes have been selected, the respective contributions to the total inertia of the cloud are: Axis 1: 50%, Axis 2: 99%.And as illustrated in Fig.10, which represent the correlation of circle which shows two groups that form.The first group consisting of the sampling sites: S1, S2, S3, S4, and the second consisting of the sampling sites: S5, S6, S7, S8, these two groups of sites correlate significantly with them and positively with axis 1 and axis 2.

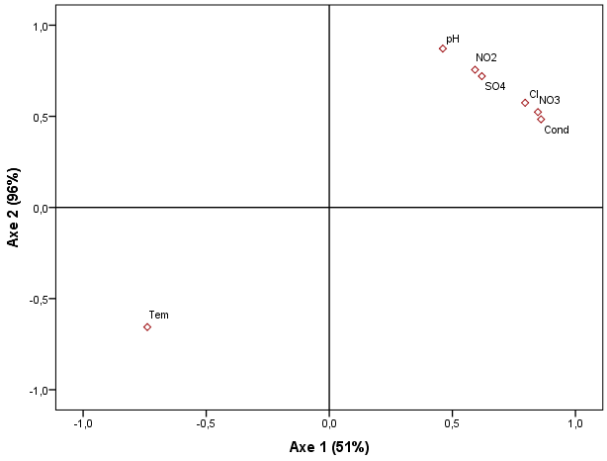

Fig. 9: Correlation Circle of principal component analysis.

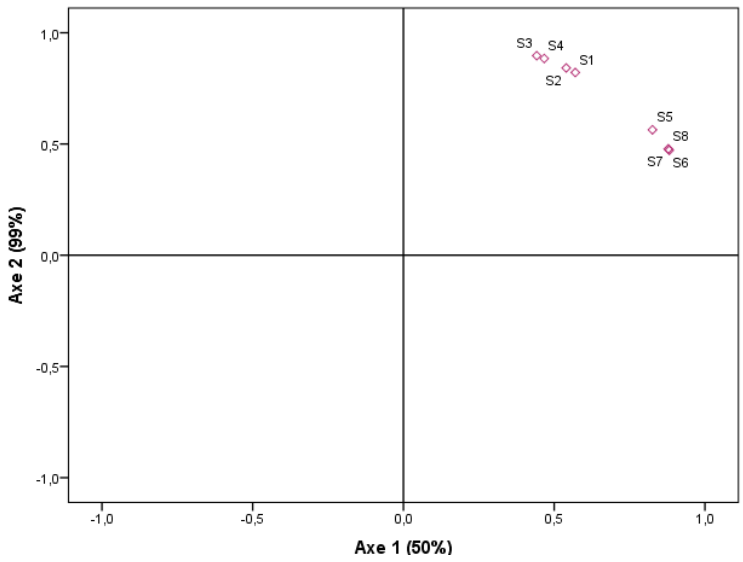

Fig. 10: Correlation Circle of principal component analysis.

Conclusion:

Determination of chloride, sulfate, nitrate and nitrite content of natural water in several sampling sites upstream and downstream of Bouregreg River allowed us to characterize these waters depending on the species studied along the river.

The principal component analysis of the collected analytical data shows, firstly that the behavior of analyzed species (Cl, SO_4, NO_3, NO_2) in natural water of Bouregreg river correlates significantly between them, and positively with the conductivity and pH, and a negative correlation with the temperature.Second time, the CPA shows two sampling sites of groups that are conspicuous and correlate significantly between them and positively with axis 1 and axis 2.

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