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EVALUATION OF THE PHYSICOCHEMICAL QUALITY OF RAW AND TREATED WASTEWATER IN THE CITY N'GOUSSA AND THE POSSIBILITY OF THEIR REUSE IN IRRIGATION

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ABSTRACT

The reuse of treated wastewater in agriculture in Ouargla is encouraging but requires monitoring and further study to encourage the valorization of treated water in the entire agricultural sector of the basin of Ouargla.The objective of this study is to monitor the physico-chemical quality of raw and purified wastewater from the N 'GOUSSA WWTP in order to detect any anomalies that may exist in the WWTP and to be able to reuse the treated water for irrigation. . The physicochemical results obtained revealed that the raw wastewater entering the treatment plant exhibits fairly high organic and nitrogen pollution. Removal of MES and nitrogen compounds appears inefficient due to the massive proliferation of implanted filters.

Keywords: wastewater treatment; Reed plant filter; arid environment; physico-chemical parameters; Abatement rate

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1. INTRODUCTION

Water is a very limited natural resource in arid and semi-arid regions. In Algeria, existing water resources are threatened by pollution caused by urban and industrial water discharges into receiving environments. These discharges can contain many substances, in solid or dissolved form, as well as many pathogenic microorganisms, threatening the quality of the environment as a whole [1,2]. The reuse of treated wastewater for agricultural purposes is a widespread practice all over the world, particularly in developing countries [3]. However, the reuse of treated water is very recent in Ouargla, following the commissioning of the wastewater treatment plant [4], which annually discharges a volume of 12,266,117 m^3 of treated water to the outlet. The N'GOUSSA reed plant filter pilot station project (Ouargla wilaya) is part of the Algerian sanitation policy open to new treatment processes. The process is based on the principle of phyto-purification, the technique that is taking up space for the treatment of wastewater around the world. The purifying potentials of hydraulic systems with macrophyte plants were demonstrated in 1946 [5,6]. in various countries such as Italy, France, Russia, the United States and Senegal. The station is designed on an experimental basis to verify the feasibility and effectiveness of the mechanism in a Saharan region [7].

The objective of this study is to assess the physicochemical quality of the raw and purified wastewater from the N'goussa WWTP (town of Ouargla) in order to detect anomalies that may exist at the WWTP and be able to develop its purified water for irrigation.

2. PRESENTATION OF N'GOUSSA STUDY AREA

The commune of N'goussa located northwest of the wilaya of Ouargla at a distance of 20 km from the city of Ouargla. It covers an area of 2961 km^2, Number of inhabitant 17561 Eq / hab. N'goussa Municipality consists of three major groups of the population are: municipal headquarters N'goussa, Elboure, Afrane. For five secondary areas are: Alkhbna, Gharse Bougofala, Oglate Larbaa, Dbiche, Alkame

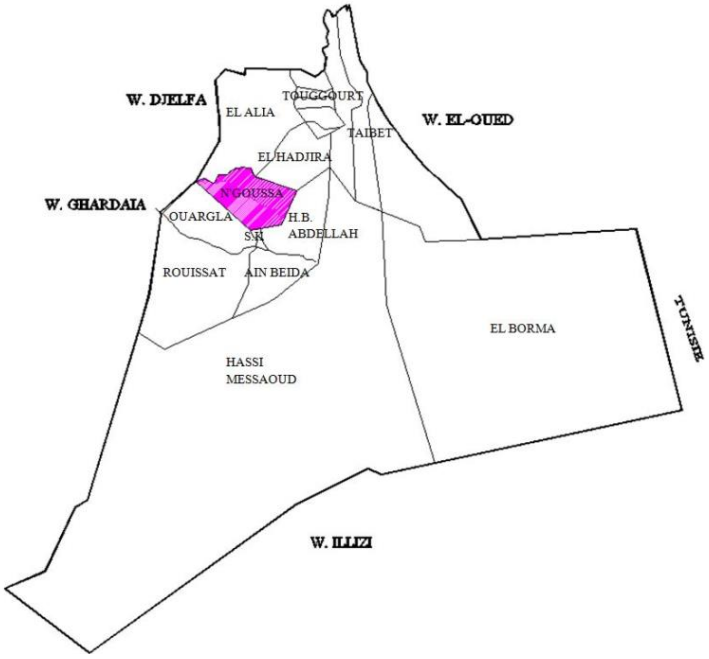


Fig.1. Geographical Location of N'GOUSSA

The commune of N'GOUSSA is one of the most important communes in the wilaya of Ouargla because of all its qualifications, whether urban, human, economic, even historical, or even its strategic location.

- Its presence on the axis of the link between Ouargla al-Hajira and Ghardaïa makes it a transit center of great importance.

The municipality of N'GOUSSA composed by four localities:

- Main town of N'GOUSSA (capital of the municipality).
- Secondary locality (FRANE- EL KOUM)
- EL BOUR secondary town
- Scattered localities (GHARS BOUGHOUFALA; AGALATT LARBAA; DEBICHE).

3. EXPERIMENTAL PROCEDURE

3.1. Presentation of the N'GOUSSA WWTP

The sewage treatment plant in the town N'GOUSSA called the vertical reed-planted filter treatment plant was commissioned in 2008. It was designed for a capacity of 11000 EH and covers an area of 2,2750 ha. It is based on a biological process of the biological treatment type

of wastewater by MACROPHYTES and includes the following works [8].

- Pumping station
- Distributor:
- Filter basins planted with reeds divided into 4 planted basins plantés.
-

Fig.2. Wastewater Treatment Plant N'GOUSSA

Fig.3. Pumping Station and Repeater

Fig.4. Reed Plant Filter

3.2. Principle of working

The treatment plant with filters planted with vertical flow reeds is made up of four parallel basins planted with reeds, each basin is divided into three equal parts operating alternately. Each basin is made up of three main inlets evenly distributed along the basin (one entry to each part), where each inlet of tubes fork intended for supply by tarpaulins. The treated water collects in front of the second basin for reuse in watering the trees of the station and the rest is thrown towards the Sebkha N'GOUSSA.

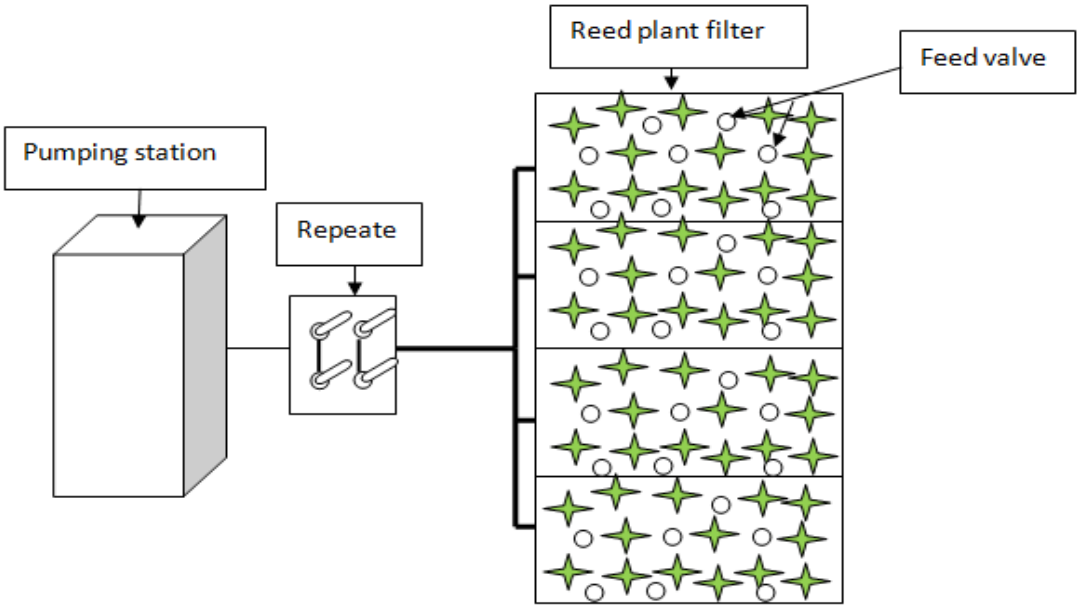


Fig.5. Synoptic Diagram N'GOUSSA Wastewater Treatment Plant

3.3. Physicochemical analysis of wastewater

Physicochemical analysis consists of determining pollution parameters such as COD, BOD_5, MES, NO_3^-, NO_2^- and dissolved O_2. These parameters were monitored for three years 2017; 2018 and 2019. between the different reed plant filter basins as well as between the entry and exit of the step. After taking and storing the samples according to the conditions required for wastewater, the analyzes were carried out according to the recommended protocols [9].

4. RESULTS AND DISCUSSION

Statistical analyzes of physico-chemical parameters for the comparison of means between the

concentrations of water parameters and between seasons were studied by ANOVA. Statistical analyzes were performed using Excel.

4.1. Temperature and pH

The temperature values of the different samples are very close. They oscillate between a minimum of 17,5 °C and a maximum of 29.4 °C at the inlet with an average of 11,9 ± 3.21°C C and between 17.05° C and 31,07° C for purified water with an average of 14,65± 2.75 ° C (Fig. 1). In Algeria, standards for discharges of wastewater admitted into the wild are around 30° C [10] .The pH values of raw wastewater are between 6.86 and 7.75with 7.05 ± 0.20 (Fig. 6) as the average value which is a characteristic of wastewater whose pH is more favorable for action of the roots in the aerosphere layer. These results are acceptable according to Algerian standards for discharges (6.5 - 8.5).

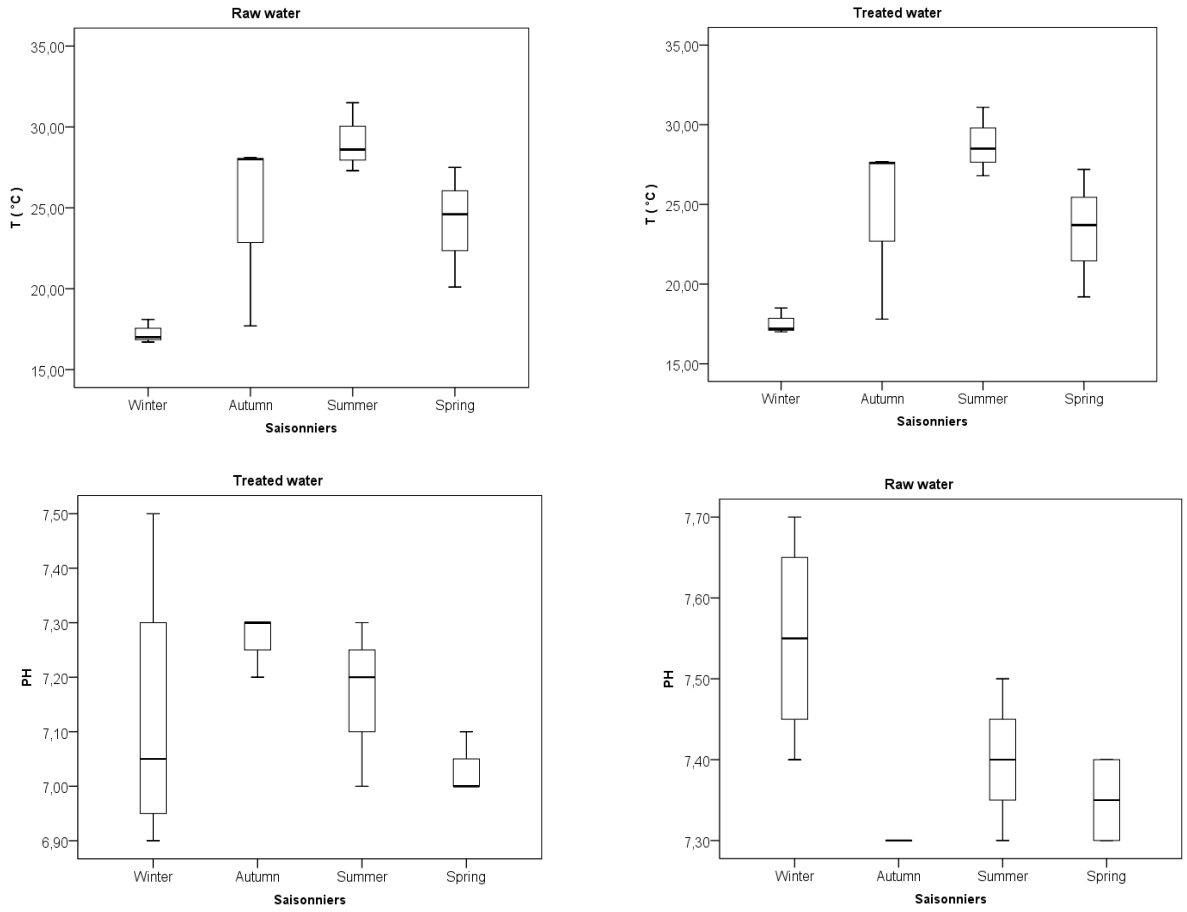


Fig.6. spatio-temporelle Variation of T and Ph

4.2. Physico-chemical parameters

4.2.1. Electrical conductivity (CE)

In raw wastewater, the maximum value is 10,38 ms / cm and the minimum value is around 5,36 mS / cm. In treated water, the maximum value of conductivity recorded is 7, 78 ms / cm and the minimum value is 6, 11 mS / cm (Fig. 7). Salinity is possibly the most important simple parameter, which determines the system of cultivation and management of land irrigated with wastewater [4].

The average values of electrical conductivity (CE) obtained (Fig.7) highlight the very significant mineralization of wastewater, with the highest value of 7,87 ms / cm upstream of the station. At the exit, we noticed that there was not a big difference. An exception was noticed in the summer period when the values at the exit. The stations increased compared to the entry, 8,04 ms / cm and 6,54 ms / cm were recorded in the waters of the station N 'GOUSSA.

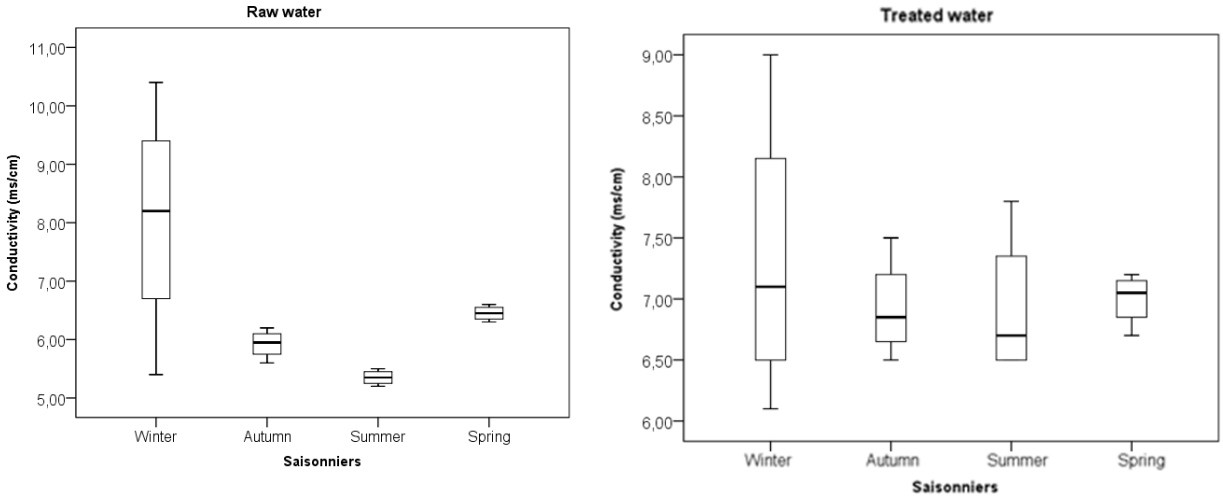


Fig.7. Spatio-temporelle Variation of CE

4.2.2. Suspended matter (MES)

The values recorded reveal a significant reduction in SS between raw and treated water (Fig. 8). They range from 228.00 mg / l to 50.50 mg / l with an average of 139.25 ± 89.25 mg / l for raw water. For purified water, the MES rate varies between 3.5 mg / l and 27 mg / l. These low values are due to the settling of settling materials. However, they remain below the WHO

rejection standard (30 mg /l) and that of the Algerian official journal limited to 35 mg/ l [10] According to [11], the presence of suspended matter in wastewater except in very special cases, does not constitute an obstacle to the reuse of these waters. On the contrary, it contributes to soil fertility.

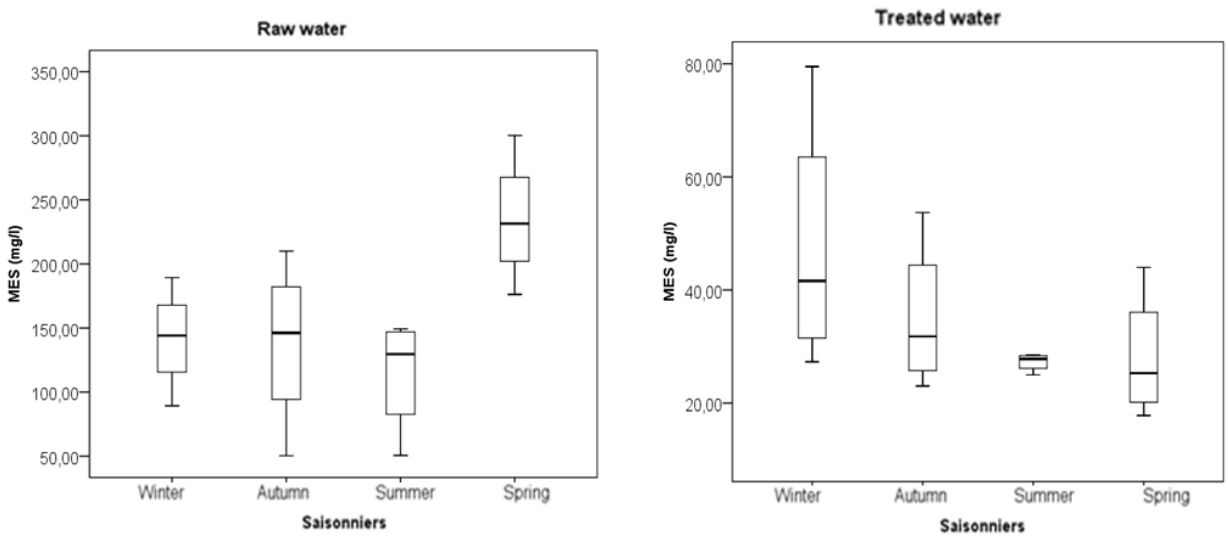


Fig.8. Spatio-temporelle Variation of MES

The effluents lose by filtration up to 90% of their suspended matter (MES) by passing through a mass of suitable aggregates (against only 50% by conventional settling). The MES (sludge) retained is dehydrated and composted on site thanks to the combined action of bacteria and plants. In this process, their volume decreases very sharply and the residue is transformed into potting soil which accumulates very slowly on the surface of the filters.

4.3. Organic pollution parameters (COD, BOD_5)

4.3.1. Chemical oxygen demand (COD)

The raw water COD values are variable. They range from 637.78 mg O_2/l to 207.87 mg O2 /l with an average of 422.825 ± 214.95 mg O_2 /l (Fig. 9). Concerning the treated effluent, the recorded values vary between 48.50 mg O_2/l and 101.40 mg O_2 / l. These values comply with Algerian rejection standards (120 mg O_2 / l), as well as those of the WHO (<90 mg O_2 / l).

Fig.9. Spatio-temporelle Variation of COD

4.3.2. Biological oxygen demand (BOD_5)

The average value of the pollutant load received by the station varies between 320.00 mgO_2 / l and 70.00 mg O_2 / l. The treated effluents are depleted and show BOD_5 contents which vary between 51.33 mg O_2 / l and 12.00 mg O_2 / 1 (Fig. 10) with an average of 5.89 ± 3.91 mg O_2 / l. BOD5 values are lower than Algerian rejection standards (40 mg O_2 / l) and those of WHO (<30 mg O_2 / l).

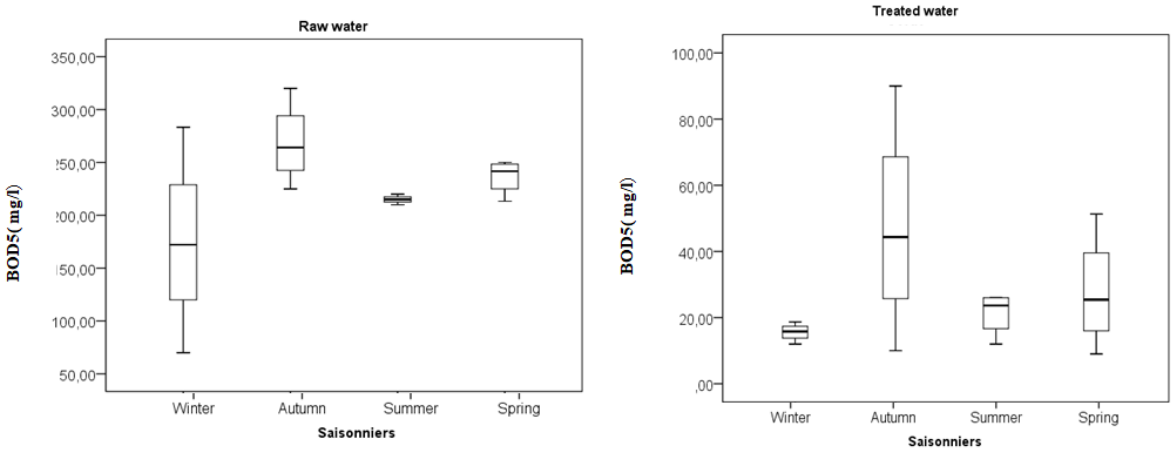


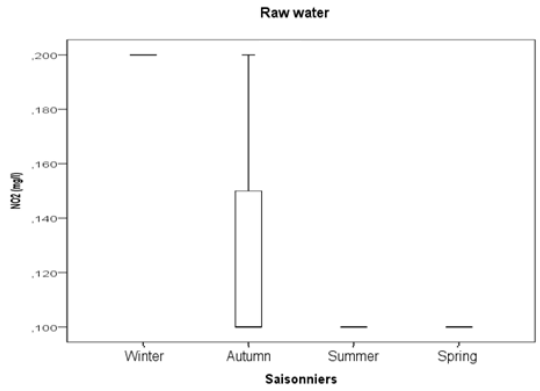
Fig. 10. Spatio-temporal variation of BOD5

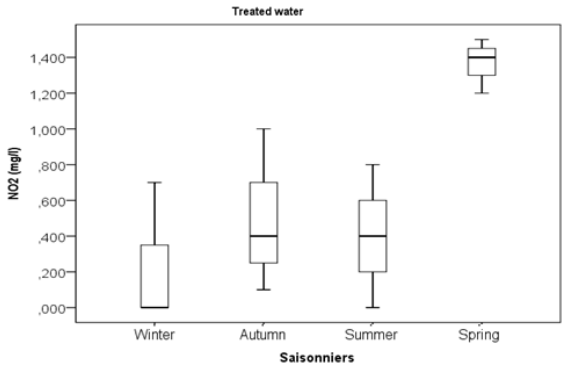
The relationship between COD and BOD_5 makes it possible to characterize the nature of the effluent. It averages 2.03. This value less than 3, gives the effluent good biodegradability [12] and confirms that the wastewater treated at the WWTP is of domestic origin [13] reported that

when the BOD_5 / COD ratio is $\geqslant$ 0.5, biological degradation begins immediately. When the BOD_5 / COD ratio is <0.5, there is a possibility that chemicals that have poor biodegradability delay the biological process. Based on these criteria, a threshold value of 0.5 was used to study the biodegradability of organic substances at the N'GOUSSA treatment plant. The BOD5 / COD ratio oscillates between 0.19 and 0.94 which indicates that pollutants are sometimes difficult to biodegrade

4.4. Nitrogenous matter

In this study, low nitrate contents are noted in the raw water. They vary between 0.168 mg / l and 4.038 mg / l. In treated water, these values range from 8.60 mg / l to 37.26 mg / l (Fig. 11). The level of nitrates has increased considerably in treated water compared to raw water but remains below WHO standards (50 mg / l). There is a reduction in the values of ammoniacal nitrogen (NH_4^+) in the treated water (Fig. 10). In fact, ammoniacal nitrogen is oxidized by nitrification to nitrite NO_2^- an intermediate state, and then the latter is rapidly oxidized to nitrate (NO_3^-). This transformation is carried out in the presence of oxygen by autotrophic nitrifying bacteria in two stages, the first being carried out by Nitrosomonas bacteria and the second by Nitrobacter bacteria [13].





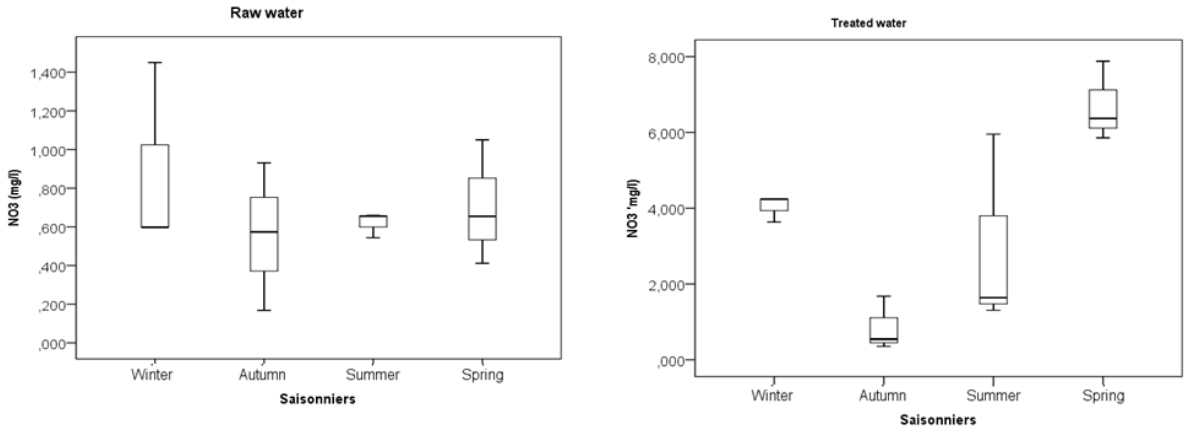


Fig.11. Spatio-temporal variation of NO_2 and NO_3

4.5. Correlation analysis

The multifactorial analysis (PCA) carried out allowed us to classify and process the information relating to the physico-chemical parameters and metallic trace elements in the wastewater N'GOUSSA city during the study period. The goal is to establish correlations between all of the variables selected. The PCA was performed on data centered and reduced compared to the means and standard deviations of these variables [7]. The eigenvalues of the PCA of the two components F1 and F2 and their contribution to the total inertia are shown in

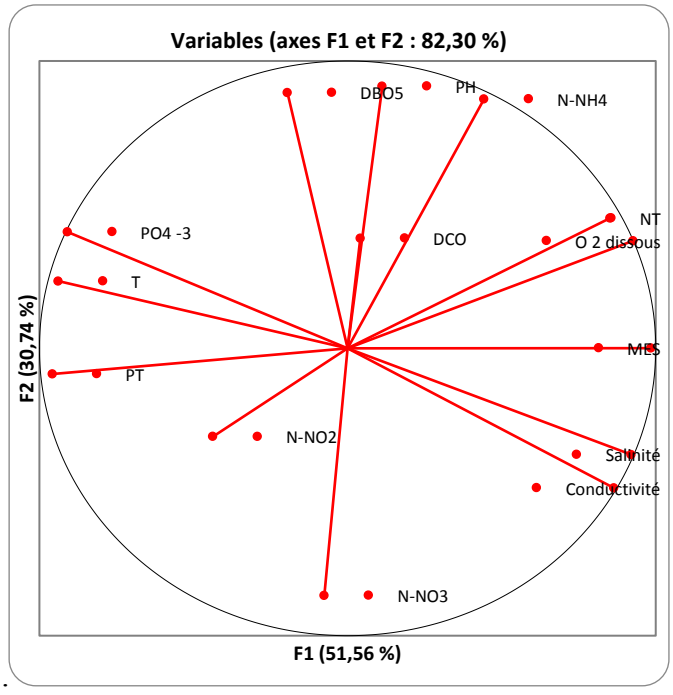


Fig.12. ACP physicochemical variables

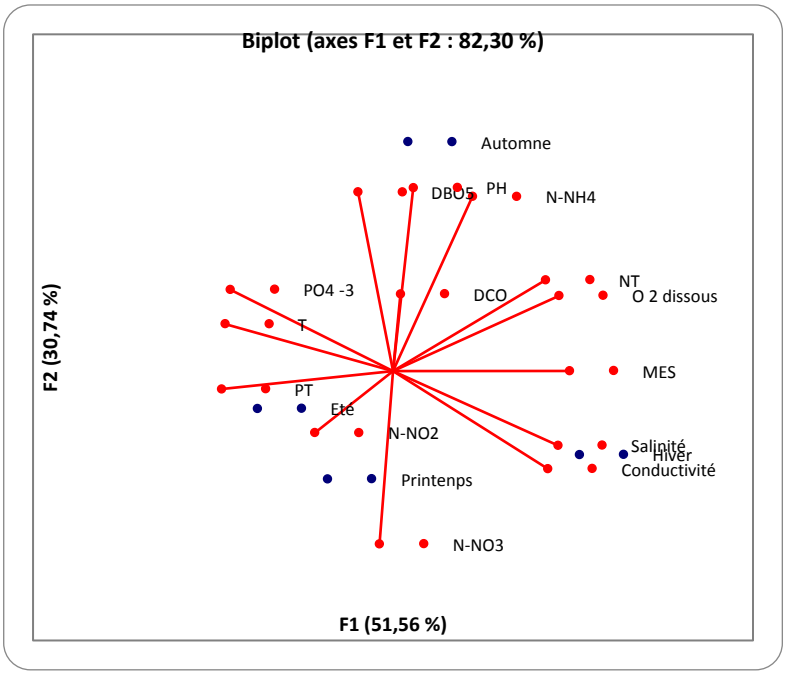


Fig.13. Biplot of physicochemical variables

2.5. Analysis of the space of variables in the factorial plan F1x F2

The correlation circle formed by the F1 and F2 axes (Fig. 13) giving 82.30% of the total information, according to the F1 axis summarizes 51.56% of the information and shows a positive correlation between the MES. COD, BOD5, pH, T, salinity, CE, and O2 they are mainly linked to the activity of biological pollution and organic particles in water. This could be explained by the process of photosynthesis [9].

The F2 axis summarizes 30.74% of the information and describes the variables related to mineralization (PT, P-PO4, conductivity, NO2, NO3, pH). It can be considered as a mineralization gradient.

5. CONCLUSION

The results described in this research work show that the treatment by reed plant filter studied could not reduce the salinity of the wastewater. This salinity is favored by evaporation, especially in the summer period. The results in the reduction of nitrogen pollution and presents significant yields of COD and BOD5, for phosphates, we have obtained a remarkable decrease

in the reed plant filter, but the Fig.s remain above the standards of discharges and d 'irrigation. The comparison of the organic contamination of the raw and treated effluent from the city N'GOUSSA with the reuse standards, shows that it remains within tolerable limits.

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