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Research Article

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Physico-chemical characterization of effluent from the effluent treatment plant using activated sludge from Saida city (Algeria) and evaluation of the pollution degree

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ABSTRACT

Algeria water resources are facing quantity and quality issues. These resources are limited because of the climate (arid and semi-arid) and suffer a deterioration in their quality by the various pollutants releases. Pollution is a serious problem for the environment because of the emissions discharged into rivers; the untreated domestic wastewater is the main source of organic water pollution. To fill the water deficit, many farmers have had recourse to irrigation water discharges from waste water treatment plants. A follow-up 12 months hazard indicators (temperature, pH, electrical conductivity, BOD5, COD, SM, ammonium, nitrite, nitrate, orthophosphate) was conducted to determine the physical-chemical water quality of the station purification of polluted water at the entrance and exit to get an idea about the spatiotemporal evolution of the elements. The analytical monitoring showed a close correlation between the temperature and pH. The values of pollution parameters SM, BOD5, COD, NH_4^+ to NO_3^- output uncross believes in the output show a treatment. The results of the Principal Components Analysis (PCA) revealed a close relationship between pollution parameters BOD5 at the outlet (S), SM (S), COD (S) and NH_4^+ (S), NO_3^-(S). Regarding orthophosphtes, no change was observed and this shows the purification inefficiency. Monitoring of the spatiotemporal evolution of the organic pollution index "OPI" to reveal the nature of the pollutant water discharges from the STEP.

Keywords: physico-chemical, effluent treatment plant, polluted water, activated sludge, ACP, IPO

INTRODUCTION

Algeria is among the 17 poorest African countries in terms of water potential, ie below the theoretical scarcity threshold set by the World Bank in 1000 m^3 per capita per year. If in 1962 the theoretical availability of water per capita per year was 1500 m^3, it was only 720 m^3 in 1990, 600m^3 in 2011, it will be only 430 m^3 in 2020 [1] . In 2025, Algeria will record a water deficit of 1 billion m3 [2]. This situation encourages actions to optimize the use of water in all its forms. Given the scarcity in conventional water, so there is the possibility of reusing the huge amounts of waste water discharged into the environment or the sea. Currently, the purpose of treating a billion cubic meters of wastewater for the irrigation of 100,000 hectares. For now, the volume of water treated is 560 000 cubic meters, 65% of its water resources are devoted to agriculture [3]. The potential for the reuse of treated wastewater for agriculture will change significantly by about 17 million m3 in 2011 to 200 million m^3 in 2014, and the number of participating stations will be 25 treatment plants 2014 [3]. The national sanitation network accounts for 27,000 linear kilometers to 102 stations, including 52 in step 50 and in lagoons [4] .The total volume of wastewater discharged annually is assessed almost 600 million m3, of which 550 for single cities in the north. This figure would increase to almost 1.15 billion m^3 in 2020 [5].

EXPERIMENTAL SECTION

Environment study

Saida is located in the northwest of Algeria (Figure 1) in a valley at the foot of two massifs of the Tell Atlas, the mountains of north Dhaya, south steppe plateaus at an altitude 869 m, longitude 0 ° 09'06 "east and latitude 34° 49'49" north. It is characterized by a semi-arid climate, dry and hot in summer, cold and damp in winter. The monthly average temperature is 8°C in winter and 27 ° C in summer. The average annual rainfall is around 340 mm. The conventional water resources are mainly underground. The surface water resources are non-existent. The availability of water is about 230 m^3/ capita a year, a ratio of 47% of the national average. The sewerage system isunitaryadapted to the topography.

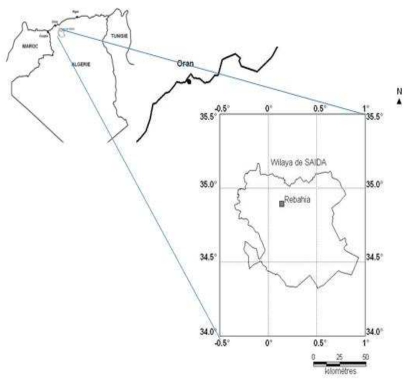


Figure 1: Location of the study area

Study area

Station presentation

The study site chosen, the STEP (Polluted Water Treatment Station) of the city of Saida (Figure 2) designed by the Spanish company (SACOM sector DIESA Algeria) on behalf of the NAO (National Office for Algerian sanitation) is located on an area of 11.47 ha, operational since January 1, 2010 with a capacity of 150. 000Eq / Hab, the proposed treatment system is the activated sludge biological treatment at low load. The station was designed to handle 30,000 m^3 / day of wastewater by biological means of the city of 169,858 inhabitants (2011 estimate) deals only 15,000 m^3 / day (April 2014). Currently, sewage from certain areas of the city are not connected to the general sewer system. It is located in the industrial area of Rebahia the northwestern area of the city near the river Sidon that constitutes the receiving environment of treated water. The STEP project had several points: the protection of the spa water, the water table and captive Dam Ouisert, the ability to reuse the treated water for irrigation, use of sludge from purification in agriculture, environmental protection, and finally the improvement of living conditions of the population. Raw sewage at the entrance to the STEP must have the following physicochemical characteristics: raw waste water (input)charge/day (BOD_5 =9 000 Kg/d SM =12000kg/d) concentration/ day BOD_5=300 mg/d SM = 400mg/d, DCO=500 mg/d).

Treated wastewater (Output): BOD_5 =30 mg/l, SM = 30 mg/l, COD=120 mg/l NH_4^+= 5 mg/l.PH =6,5 – 8,5.

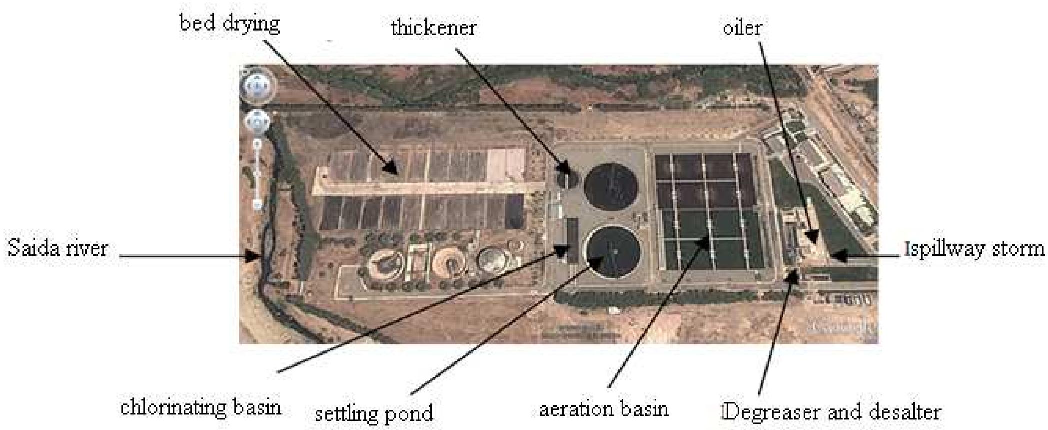


Figure 2:Aerial view of the entire STEP

Process for treating the scrubbing station

The operation of the STEP (Figure 2) is based on 3grands treatments. The first treatment consists of: the storm overflow for removing bulky, heavy, greasy elements ... .Who would be embarrassing for the biological treatment, screening, mandatory phase to eliminate using a coarse grid 80 mm large size materials (wood, rags, plastic bottles, dead animals ....) can cause blockages, grit removal operation for retainingthe particles of at least 200µmas the sands and other minerals avoiding their deposits in the channels and pumps thereby protecting the apparatus against abrasion. Degreasing or deoiling to remove floating materials, generally fat, lower density than water, with the flotation principle particles by blowing air circulated in the bottom of the channels generating the formation of "skimmings "Secondary treatment in two phases, an extended aeration by eliminating microorganisms dissolved organic pollution or colloidal non-settling. Basin into two parts: the first, in which air is blown sufficiently to maintain the conditions for development microorganisms which will consume the carbonaceous pollution and nitrified, the second anoxic portion in which microorganisms realize the elimination of nitrogenous pollution with denitrification. The organic pollution (COD, BOD_5) is degraded by aeration. We must therefore maintain a dissolved oxygen to get good results in COD, BOD_5. The second phase, a clarification by concentration of excess sludge to distract the aeration tanks, centrifugation causing accelerated settling of particles a solid liquid mixture. Before the spill in OuedRebahia, treated wastewater is routed to the terminal basin to meet the discharge standards, tertiary treatment, chlorination using chlorine to destroy microorganisms, neutralization, operation which consists of the Disposal strong alkalis or strong acids, settling, deposition of particulate suspensions. The used biological treatment is the activated sludge process (dispersed bacterial culture). The sludge collected at the end of treatment experience, thickening, drying before being reused as fertilizer in agriculture.

Methods of analysis and sampling

The samples were taken over a 12-month period November 2012 to October 2013 at the entrance and exit of the final settling tank to monitor the performance (efficiency) purifying the STEP. The studied parameters, temperature, pH, electrical conductivity (EC), BOD_5, COD, suspended solids, ammonium, nitrite, nitrate, orthophosphate. The temperature, pH, electric conductivity and were determined by a pH meter Hach model. The number of samples per month varies between settings: 21 for temperature, pH, EC, between 9-12 for the SM, BOD5, COD, and 3-4 for nitrogen and orthophosphate anions. In total 2213 samples were performed and analyzed. For Suspended Materials(SM), the filtration is performed through a porous membrane of 0.45 microns, then drying at 105 ° C for 2 hours. BOD_5 was determined by the manometric method based on the principle Warburg (AFNOR, T90-103-1).
The chemical oxygen demand (COD) was analyzed by spectrophotometer by the reactor by digestion method at 105°C for 2 hours. Nitrate ions, ammonium, orthophosphate, iron and chromium are analyzed by colorimetric methods using a spectrophotometer. For the nitrate ions we use salicylate, Nessler reagent for ammonium ions. For the determination of orthophosphate, molybdate is used as reagent.

Data processing

In order to establish a relationship between the different physico-chemical parameters and to further evaluate the relationship between them, a statistical processing by the principal component analysis (PCA) was applied to all parameters.

To estimate the overall organic pollution in the stations of study and visualize the spatiotemporal evolution of this pollution, we made use of a composite index: the Organic Pollution Index (OPI).

Statistical analysis of data (CPA)

Statistical analysis of data was performed by the CPA [6] [7], descriptive method, which aims to present, as a graph, the maximum of information in a data table and applies only quantitative variables. It is purely algebraic and geometric hypothesis does not presuppose any laws on data processed. It consists in looking for a prioritization of the information contained dan a data table and this by calculating the maximum elongation axes of a scatter along several axes. This method allows to highlight the interrelationship between variables and possible similarities between individuals or groups of individuals with similar characteristics on a given axis [8]. PCR was performed using Statistica software (version 6). A raw data matrix having 10 physicochemical variables was used. The variables selected for this statistical study are: the temperature (T), the potential hydrogen (pH), nitrogen compounds (NH_4^+, NO_2, NO_3), phosphorus compounds (orthophosphate (PO_4^{3-}), Suspended Materials (SM), the Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), electrical conductivity (EC).

Organic Pollution Index «OPI»

There are several methods to assess the degree of organic pollution Lisec Index [9][10], and the index of organic pollution IPO [11]. It is this index that was applied in this study. This index has been used in Algeria and elsewhere by several authors giving good results[12]. It allows to assess the degree of water pollution from physico-chemical parameters (Table 1), orthophosphate (PO_4), ammonia (NH_4), nitrite (NO_3) and biochemical oxygen demand during

5 days (BOD5). The IPO index represents the average number of classes for each parameter and the values of this index are divided into five classes (Table 2) representing pollution levels ranging from less polluted (class 5) in more polluted (class 1) corresponding to the accepted colors (blue is no pollution, very strong red pollution).

Table 1: Class limits of organic pollution index (OPI)

Parameters	BOD_5 mg/l	NH_4^+ mg/l	NO_2^- µg/l	$PO_4^=$ µg/l
Classes				
5	< 2	< 0,1	5	15
4	2-5	0,1-0,9	6-10	16-75
3	5,1-10	1-2,4	11-50	76-250
2	10,1-15	2,5-6	51-150	251-900
1	> 15	> 6	> 150	> 900

OPI = Average class numbers of 4 parameters.

Tableau 2: OPI Classes, pollution degrees

Classes average	Organic pollution level
5,0-4,6	Null
4,5-4,0	Low
3,9-3,0	Moderate
2,9-2,0	High
1,9-1,0	Very high

RESULTS AND DISCUSSION

Physico-chemical water quality
The temperature

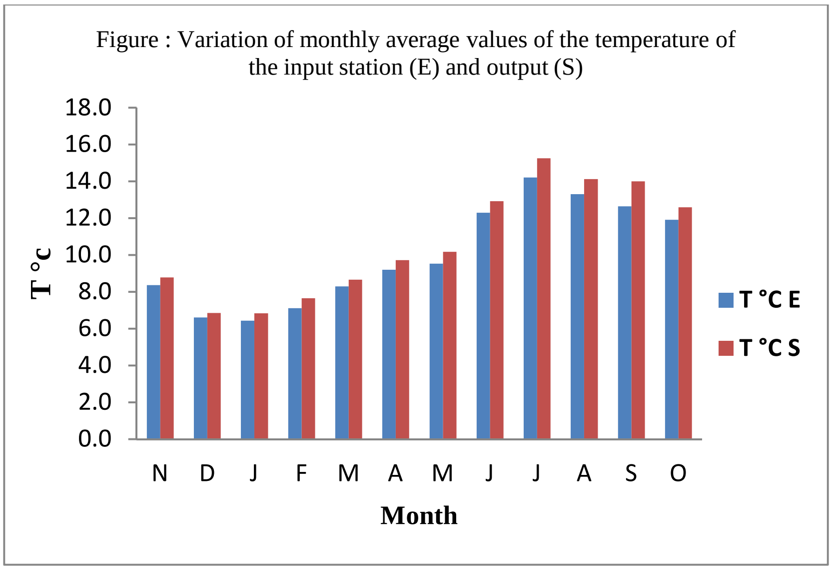


Figure 3: Evolution of the mean monthly temperature at the input (E) and the output (S) of the STEP

The temperature of the water is an important factor in the aquatic environment influencing the physico-chemical and biological reactions[13]. This is a key factor in biological activity with ecological repercussions [14]. Depending therefrom, are psychrophilic microorganisms, mesophilic or thermophilic[15]. The average monthly values of the temperature at the inlet varied between 6,4 and 14,2 ° C (Figure 3), at the exit, they are between 6.8 and 15.3°C below 30°C value authorized standard [16]and those found in Morocco or Mauritania [17][18][19][20].

The pH

The pH of natural waters are between 6 and 8.5 [13]. This is an important element for the interpretation of corrosion in the pipes of the treatment facilities is also a very important parameter that influences the biological activity of microflora of water. The vast majority of microorganisms grows at pH between 4.5 to 8.0 and the optimum range between 5.5 and 7.5 [21][22]. Most organisms can not tolerate a pH higher than 9.5 or less than 4. It is generally recommended a pH between 6.5 and 7.5 for wastewater treatment plants [23], for low pH promotes the growth of filamentous fungi and other organisms that cause floating sludge [24], while the nitrifying bacteria require pH between 7.4 and 9 for Nitrosomonas, 8.5 9.1.The Nitrobacter bacteria Acinetobacterdephosphatate grow well in acidic pH.

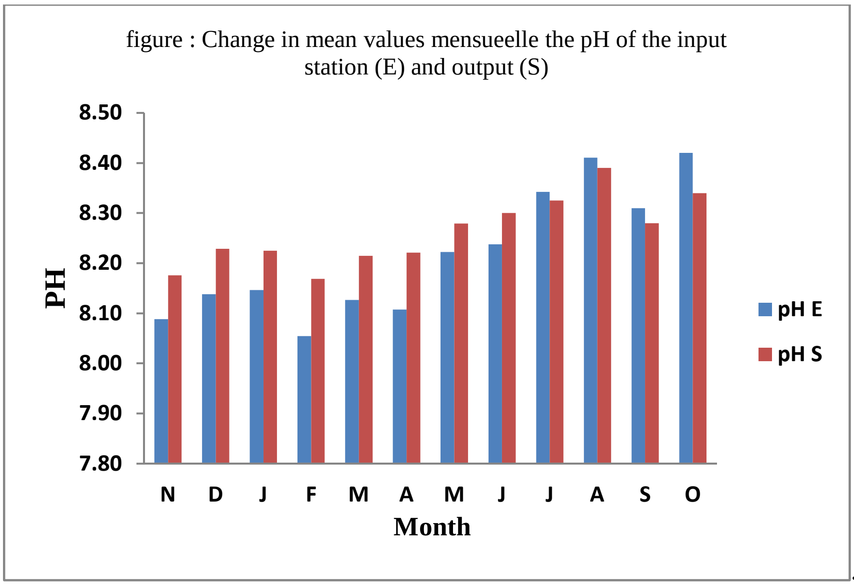


Figure 4: Evolution of the monthly average of the pH to the input (E) and the output (S) of the STEP

Monthly mean pH values recorded at the entrance of the effluent (4) are basic and vary between 8.05 and 8.42 and 8.17 to 8.39 at the output, which corresponds to Algerian standards (6.5-8.5) of wastewater discharged into the environment [25]but are still higher than those found in Yemen and Morocco [26][18]. The pH in winter and spring out of the step are higher than at the entrance when we were the opposite.

The electrical conductivity(EC)

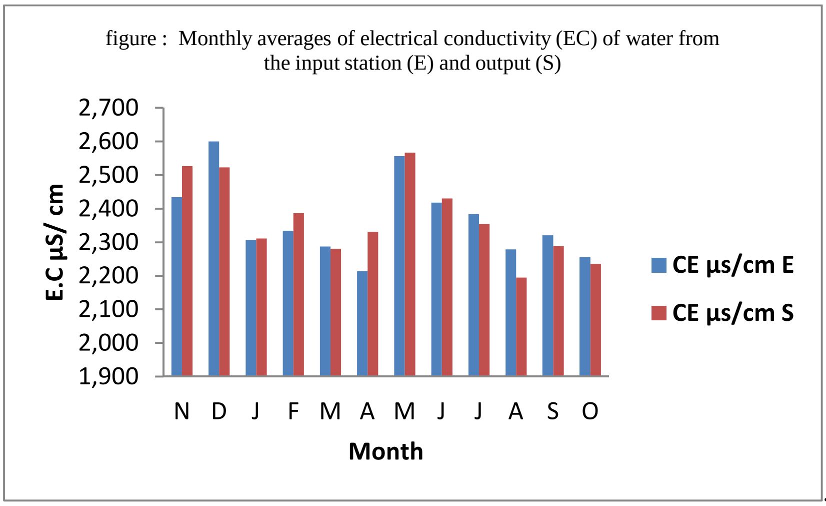


Figure 5: Evolution of the monthly average of the electrical conductivity (EC) to the input (E) and the output (S) of the STEP

The electrical conductivity reflects the overall degree of mineralization, it also serves to determine the amount of salt dissolved in water [27][28]. It depends on the temperature, it is greater when the temperature rises. The effluent at the input (Figure 5) shows the monthly average values in electrical conductivity between 2214 and 2600 microseconds / cm at the exit they are between 2195 and 2567 below the maximum laid down by the Algerian standard 3000 microseconds / cm [25]and rproche to those found in Yemen [26] but lower than those found in Morocco [18]. The values obtained despite low by the standards remain high and this due to the salinity of ADE waters of the region (Algeria Des Eaux).

The Suspended Materials(SM)

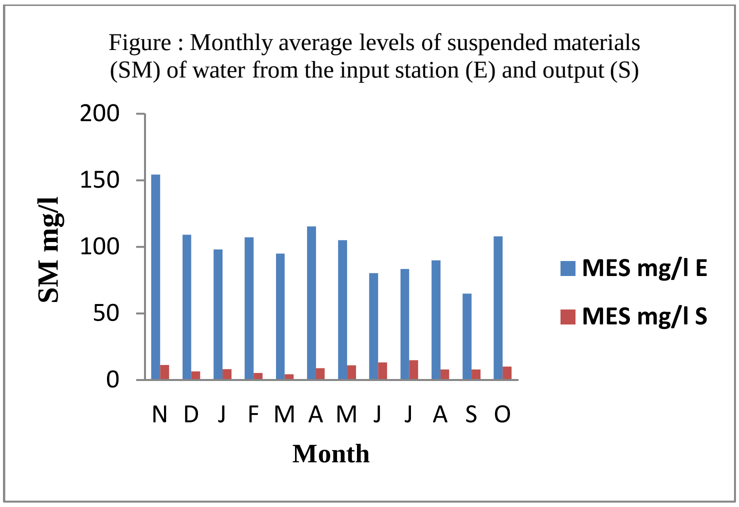


Figure 6: Evolution of the monthly average of Suspended Materials(SM) to the input (E) and the output (S) of the STEP

Suspended Materials (SM) are all inorganic and organic particles in the wastewater. Suspended solids represent the total settleable solids settleable and not whether organic or inorganic. In rivers such materials promote the reduction of brightness and lower organic production due to the decline in dissolved oxygen concentration subsequent to reduced photosynthesis phenomena. The high levels of suspended solids can be regarded as a form of pollution. Such an increase may also cause a warming of the water, which will have the effect of reducing the quality of habitat for coldwater organisms[29]. Average monthly TSS at the entrance of step (6) despite high (between 65-154 mg / l) remains well below those recorded in Morocco and Yemen [19][17][18][26]. The strong values of MES at the entrance of the step in the month August October and November due to the storms of late summer and autumn rains. At the exit, they vary between 4 and 15 mg / l although the lower discharge standard in the receiving environment of 30 mg / l made by WHO (2001) and the Algerian Ministry of Agriculture [25]as well as those raised in Morocco and Yemen [30][26].

Biochemical oxygen demand(BOD5)

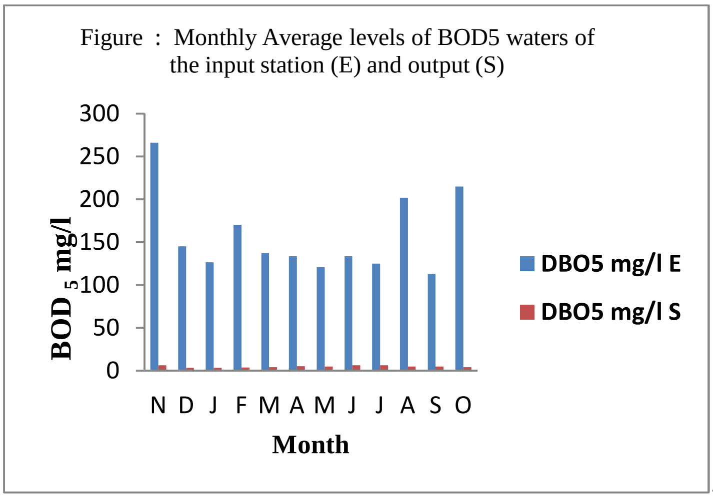


Figure 7: Evolution Monthly average BOD_5 on input (E) and output (S) of the STEP

BOD_5 (biochemical oxygen demand) defined as the dissolved content of oxygen consumed by microorganisms during an incubation period in the dark at 20°C for 5 days to decompose the organic material, dissolved or suspended contained in one liter of water. It therefore allows the evaluation of biodegradable organic matter. BOD5 natural water is less than 2mg/l. The water receiving domestic waste have concentrations above 10 mg/l [13]. The monthly mean values of BOD_5 (fig.7) of the untreated effluent varies between 121 and 266 mg / l registering high values in the months from August to October-November during heavy rains aligning with strong SM, while BOD_5 of the treated effluent varies between 3 and 7mg/l although inferior to the discharge standard in the receiving environment of 30 mg /l granted by the Algerian Ministry of Agriculture [25]and those allowed in Morocco 100mg/l and Yemen 150mg/l [30][26].

The chemical oxygen demand (COD)

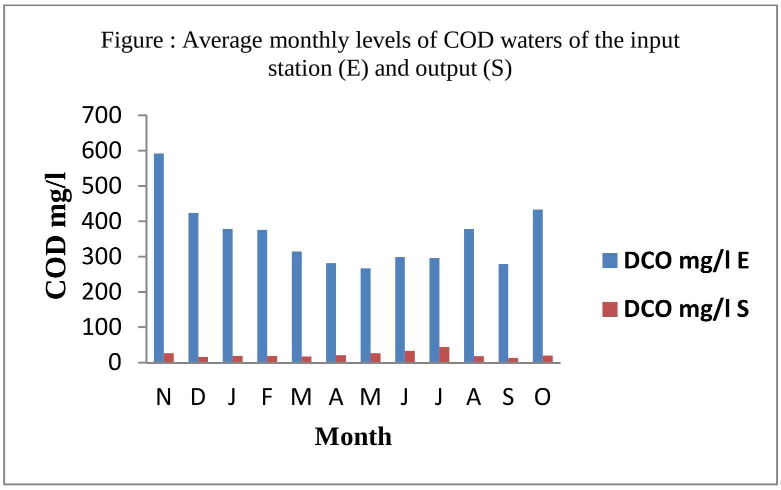


Figure 8 : Evolution of the monthly average of the COD at the entry and exit of the STEP

The chemical oxygen demand (COD) represents the oxygen consumption for the non-biological oxidation of all organic matter in the effluent, whether or not biodegradable. It allows to assess the concentration of organic materials or inorganic, dissolved or suspended in water, through the amount of oxygen required for the total chemical oxidation [31] .The COD is divided into different compartment: soluble COD, particulate, degradable, non-degradable. The results of the COD [32]is written then: COD input = output + COD COD of sludge + Oxygen consumed.

The monthly average values of COD (Figure 8) of the effluent untreated vary between 267 and 593 mg / l, they uncross in winter-spring and summer-autumn growing in the high values of the untreated effluent in August - October-November following those of TSS and BOD 5. There is a significant correlation between COD and BOD 5 (Figure 9). The COD of the treated effluent is between 13 and 26mg / l lower the rejection Algerian standard of 90 mg/l [25]and those allowed by Morocco and Yemen of 500 mg/l [30][26]. Furthermore the annual average ratio COD/BOD5 is average (2.32), which allows us to deduce that the charge organic matter wastewaters are biodegradable with selected strains [33].

Figure 9show anR^2= 0, 7733 (y= 1,7492x + 84, 6212)

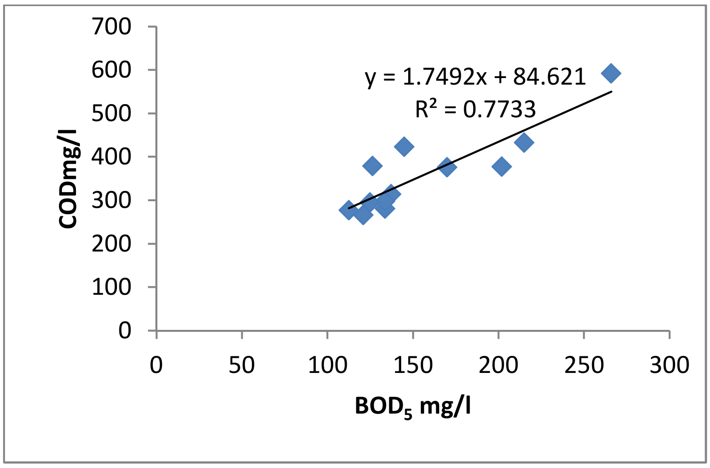


Figure 9: Correlation established between BOD_5 and COD of wastewater step

Nitrogen compounds

Ammonium (NH_4^+)

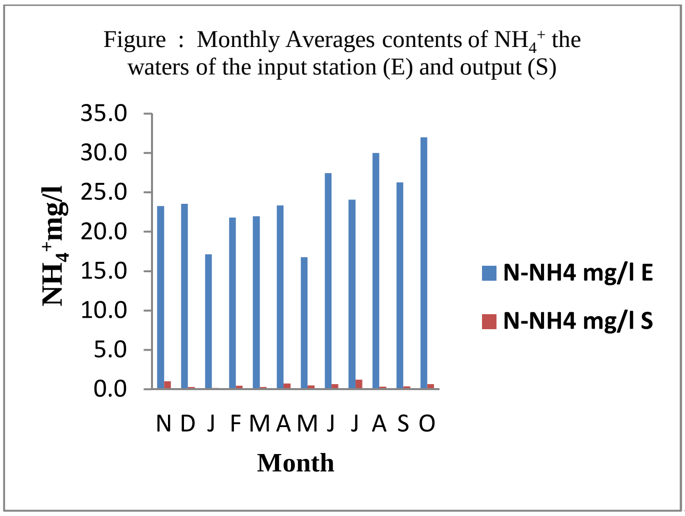


Figure 10: Evolution of monthly averages of ammonium (NH_4^+) to the input and output of the Step

The Nitrites (NO_2^-)

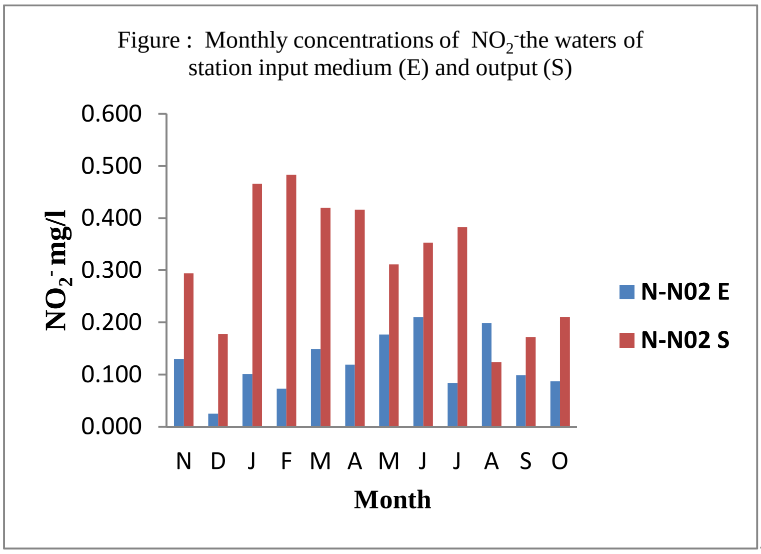


Figure 11: Evolution average monthly nitrite (NO2) at the input (E) and the output (S) of the STEP

Nitrates (NO_3^-)

The nitrogen present in the waste water can be ammonia or an organic nature. Organic nitrogen is mainly a component of proteins, polypeptides, amino acids and urea. The ratio between the organic and ammonia forms depends on the channel length of the network because it is the beginning that the transformation of organic nitrogen NH_4-N. In the effluent treatment plant, ammonification continues until the nitrogen to the inlet of the basin of the activated sludge exists mainly in the form of NH4-N. The mineral nitrogen including ammonium (NH4), nitrite (NO2-) and nitrates (NO3-) constitutes the major part of the total nitrogen. The mechanism of the biological nitrogen removal is carried out in two stages, which are chronologically nitrification and denitrification.

Nitrification is the biological oxidation of ammonia nitrogen to nitrate. This transformation is performed in two steps: nitration, followed by nitration. It is carried out in the presence of oxygen by autotrophic bacteria which use ammonium nitrogen (NH_4^+) and carbonates (HCO_3^-) as an energy source. The nitration is the oxidation of ammonia nitrogen to nitrous nitrogen (NO_2^-) by autotrophic bacteria of the genus Nitrosomonas, Nitrosococcus or Nitrospira. To convert 1mg of NH_4^+ in NO_3^- must 4,57mg of O2.La chemical transformation of ammoniacal nitrogen is expressed by the equation:

$$2NH_4^+ + 3O_2 \longrightarrow 2NO_2^- + 2H_2O + 4H^+ \quad (1)$$

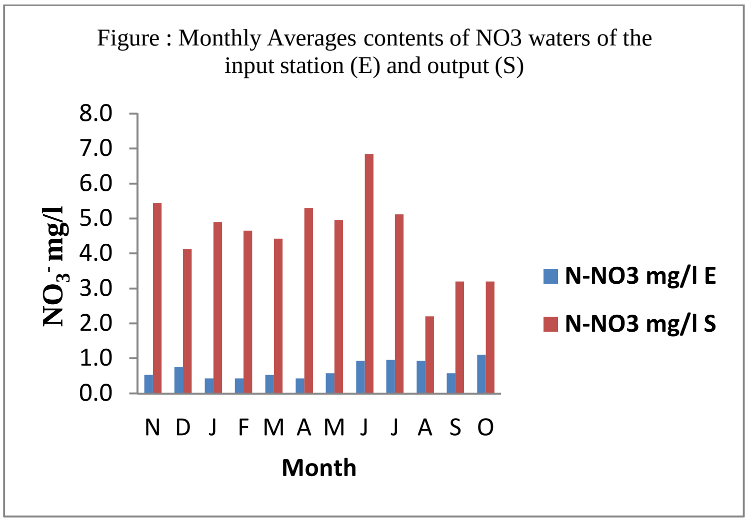


Figure 12: Evolution of the monthly average nitrate (NO_3) to the input (E) and outlet (S) of the STEP

The nitration takes place in the presence of bacteria of the genus Nitrobacteroxidise nitrite (NO2-) formed during the nitration step of nitrates (NO3-). The transformation of 1 mg NO3- to N2 brings 2.86 mg O2. The chemical reactionis:

$$2NO_2^- + O_2 \longrightarrow 2NO_3^- \quad (2)$$

The microorganisms responsible for nitrification (Nitrosomonas and Nitrobacter) are very fragile. They need constant temperatures (never below 12 ° C), a C / N / P favorable, and sufficient oxygen supply.

Denitrification is a reduction of nitrate to nitrogen gas (N2) by heterotrophic bacteria of the genus Pseudomonas in the absence of dissolved oxygen with the presence of nitrates [34]. The chemical reaction is:

$$NO_3^- + 6H^+ + 5e \longrightarrow 1/2N_2 + 3H_2O \quad (3)$$

Sources of organic matter are diverse (methanol, glucose, ethanol). For good denitrification requires a carbon pollution BOD5 / minimal NO3-> 2.

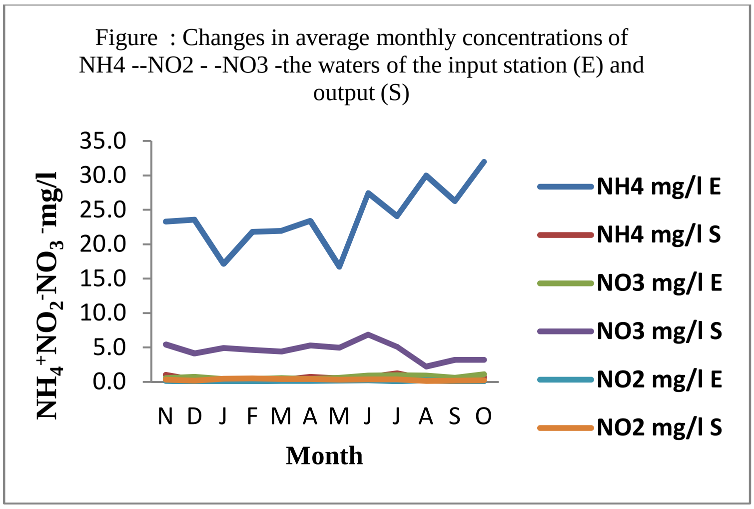


Figure 13: Evolution of the average monthly nutrients into and out of step

The annual levels of ammonium (NH_4^+) registered with the inlet of the effluent (Figure 10) vary between 16.8 and 30mg/l whereas the output vary between 6.8 and 15.3 mg/l. The fraction of nitrogen released by the nitrosation reaction of ammonium combined with oxygen from the cleaning is added to the fraction nitrite (NO2-) and nitrate (NO_3^-) in the effluent output (Figure 11 and 12) confirm the equation 1 and 2. Figure 13 are represented where the variation of nutrient input and output effluent shows high values of ammonium (NH_4^+) to the entry and higher values nitrates (NO_3^-) in the output between 2.2 and 6.9mg/l.

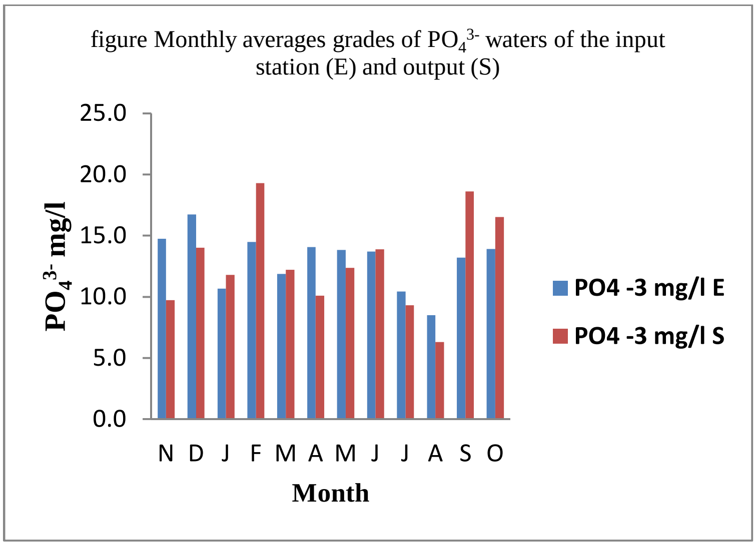


Figure 14: Evolution of the monthly average of phosphate (PO_4^{3-}) to the input (E) and outlet (S) of the STEP

The origin of phosphorus wastewater is multiple[35]. It comes from the human metabolism (urine and feces), household detergent added to the washing water (washing and dishwasher mainly), waste (not detergents) collected with the kitchen waters (dishwashing, liquid food wastes) and wash water (laundry, floors, ...), industrial waste, agricultural waste or of natural origin are retained in the soil and are not found in wastewater. The forms of phosphorus from waste water is soluble or particulate consists essentially of inorganic phosphorus (mainly polyphosphates) and orthophosphates which part comes from the first of the hydrolysis; organic phosphorus: phospho-lipids, esters, polynucleotides, ATP, ADP,...

Domestic sewage have phosphorus contents of usually between 10 and 25mg/L. Phosphate excreted in the urine represented approximately 25 to 50% of household waste, the phosphorus is present mainly in the form of inorganic phosphates [36]. The share of human waste represents only 30-50% of total P, the rest from cleaning products [31]. Indeed, many detergents contain phosphates. The sodium tripolyphosphate content (STPP) of certain detergents may exceed 50%. In Mediterranean countries where water is harder, the consumption of detergents is greater [37]. Phosphate removal of wastewater requires expensive and rarely used treatments. The primary, secondary and tertiary treatments have extraction yields of P respectively 20, 40 and 85%. Such as nitrogen, phosphorus element is a pollutant in the environment at higher contents than 0.5 mg / l [31]. The phosphorus discharges in aquatic ecosystems are one of the most serious environmental problems because they help to accelerate eutrophication of these areas, in particular in enclosed or semi-enclosed areas such as lagoons, estuaries ... [28]; [38].

The effluent at the inlet of the step are characterized by monthly average levels of orthophosphate (PO43-) oscillating between 8.5mg/l and 16.7mg/l (Figure 14), while the levels to vary the output between 6.3 and 19,3.Ces levels are relatively close to the acceptable limit of 10 mg / l of a direct discharge into the receiving environment [39], but remains well below those encountered in Mauritania and Yemen [26]. The phosphorus removal depends on several factors include the nature of the reagent employed, the molar ratio, pH of the sludge, and the concentration of phosphorus in the effluent at the entrance of the station.

STATISTICAL ANALYSIS OF DATA

In order to establish a relationship between physicochemical parameters and to better assess the purification station by activated sludge waste water of the city, an ACP statistical analysis (PCA) was applied at the set of parameters for one year. For the data processing by the principal component analysis, we used 10 variables: temperature, pH, electrical conductivity, BOD_5, COD, suspended solids, ammonium, nitrite, nitrate, orthophosphate and as individuals 12 samples taken from November 2012 to October 2013. A monthly deduction is the monthly average of the values of each parameter. Values are calculated as input to the step represented by "E" and the output of the step by "S".

Correlation between the different parameters studied

The study of linear correlations between the studied parameters provides information on the strength of associations between them. The correlation matrix of 10 parameters measured during the study period is shown in the table below.

In the interpretation of the correlation matrix, we held that the parameters $r > 0.75$. The analysis between the physico-chemical parameters studied shows that there is a good correlation between the temperature and the pH ($0.83 < r < 1$). The suspended solids (SS) and chemical oxygen demand (COD) is correlated with the input ($r > 0.76$). At the exit, the suspended material shows (MES) correlates well with the biological oxygen demand (BOD 5) and COD ($0.76 < r < 0.86$). The ammonium (NH_4^+) to the output is correlated with SM-COD-BOD 5 ($0.79 < r < 0.80$). Nitrate (NO_3) to entry are well correlated with the input and output pH ($0.82 < r < 0.83$), they are also well correlated with ammonium (NH_4^+) to the inlet ($r = 0.75$). The electrical conductivity (EC) is not correlated with any other parameter. Finally conclude we can say that the parameters of the SM pollution, COD, BOD_5, NH_4^+has an affinity between them.

Table 3: Correlation matrix of physicochemical parameters studied at the effluent treatment plant

	MES (E)	MES (S)	DBO5 (E)	DBO5 (S)	DCO (E)	DCO (S)	PH (E)	PH (S)	CE (E)	CE (S)	T (E)	T (S)	NH4 (E)	NH4 (S)	NO3 (E)	NO3 (S)	NO2 (E)	NO2 (S)	PO4 (E)	PO4 (S)
MES(E)	1.00																			
MES(S)	-0.02	1.00																		
DBO5(E)	0.70	0.01	1.00																	
DBO5(S)	0.00	0.76	0.17	1.00																
DCO(E)	0.76	-0.06	0.88	-0.05	1.00															
DCO(S)	-0.03	0.86	-0.06	0.68	-0.13	1.00														
PH(E)	-0.52	0.37	0.04	0.25	-0.20	0.19	1.00													
PH(S)	-0.55	0.38	-0.04	0.27	-0.29	0.23	0.96	1.00												
CE(E)	0.17	0.24	-0.10	-0.04	0.14	0.22	-0.20	-0.15	1.00											
CE(S)	0.47	0.29	0.00	0.10	0.20	0.28	-0.51	-0.47	0.87	1.00										
T(E)	-0.55	0.57	-0.03	0.66	-0.34	0.44	0.85	0.84	-0.24	-0.41	1.00									
T(S)	-0.56	0.56	-0.05	0.65	-0.35	0.43	0.85	0.83	-0.24	-0.41	**1.00**	1.00								
NH4(E)	-0.21	0.12	0.41	0.28	0.16	-0.03	0.67	0.62	-0.36	-0.52	0.65	0.64	1.00							
NH4(S)	0.29	0.79	0.30	0.80	0.17	0.80	0.14	0.09	0.02	0.22	0.45	0.44	0.20	1.00						
NO3(E)	-0.32	0.48	0.18	0.27	0.02	0.40	0.83	0.82	0.05	-0.25	0.72	0.70	0.75	0.32	1.00					
NO3(S)	0.22	0.48	-0.21	0.37	-0.09	0.59	-0.53	-0.45	0.28	0.58	-0.22	-0.24	-0.43	0.41	-0.23	1.00				
NO2(E)	-0.15	0.25	0.04	0.47	-0.25	0.20	0.22	0.37	-0.12	-0.08	0.38	0.36	0.10	0.00	0.11	0.18	1.00			
NO2(S)	0.13	-0.03	-0.30	-0.07	-0.21	0.28	-0.62	-0.59	-0.22	0.10	-0.44	-0.43	-0.61	0.10	-0.55	0.65	-0.04	1.00		
PO4(E)	0.45	-0.08	0.10	-0.18	0.26	-0.18	-0.50	-0.56	0.49	0.66	-0.48	-0.47	-0.10	0.04	-0.19	0.32	-0.43	-0.02	1.00	
PO4(S)	-0.23	-0.30	-0.20	-0.40	-0.11	-0.35	-0.14	-0.28	0.04	0.05	-0.19	-0.16	0.04	-0.29	-0.10	-0.04	-0.43	0.06	0.54	1.00

Correlation between variables and factors

The projection of the factorial plane F1 and F2 represents 56.96% of the information. The axis F1 has a variance of 35.66%, variable pH and temperature "input" and "output" are highly correlated with it. The axis F2 has a variance equal to 21.30%, the variables BOD_5, SM, COD and NH_4^+ in "exit" correlate well with him.

Table 4: Correlations between variables and the main roads

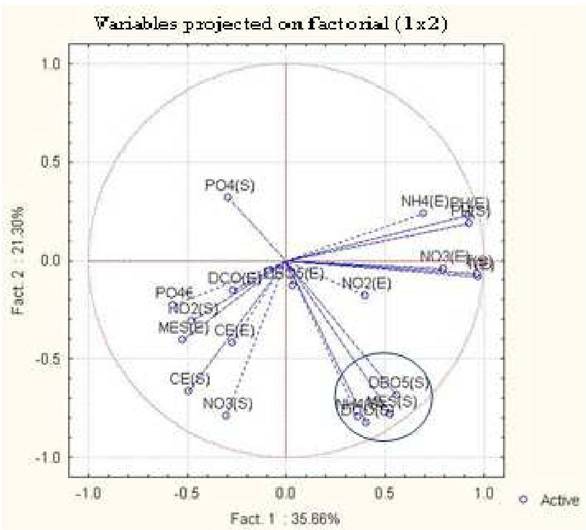
	F1	F2	F3
MES(E)	-0.523631	-0.401366	0.640059
MES(S)	0.526244	-0.781071	-0.054005
DBO5(E)	0.030526	-0.126751	0.901391
DBO5(S)	0.558962	-0.684626	-0.000820
DCO(E)	-0.268848	-0.150615	0.879311
DCO(S)	0.403087	-0.822776	-0.208428
PH(E)	0.918302	0.228270	0.108852
PH(S)	0.923473	0.188121	0.009618
CE(E)	-0.273047	-0.420233	0.104833
CE(S)	-0.495180	-0.662573	0.082578
T(E)	0.971772	-0.081783	-0.068073
T(S)	0.963070	-0.065830	-0.082811
NH4(E)	0.695700	0.237319	0.481614
NH4(S)	0.364454	-0.793970	0.187643
NO3(E)	0.796732	-0.043569	0.286314
NO3(S)	-0.303994	-0.791063	-0.354784
NO2(E)	0.397530	-0.175747	-0.218383
NO2(S)	-0.480371	-0.306821	-0.553709
PO4(E)	-0.571381	-0.225915	0.306852
PO4(S)	-0.292388	0.317537	-0.069270

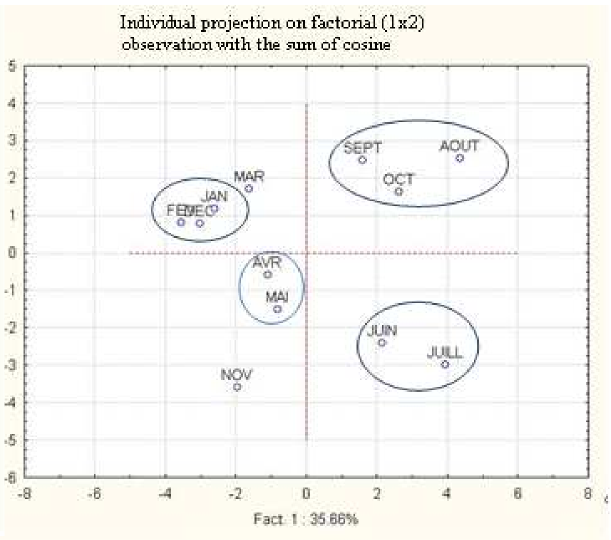
Table 5: Variables projection Quality (cos²)

	With Factor1	With Factor2	With Factor3
MES(E)	0.274190	0.435285	0.844959
MES(S)	0.276933	0.887005	0.889922
DBO5(E)	0.000932	0.016998	0.829504
DBO5(S)	0.312439	0.781152	0.781153
DCO(E)	0.072279	0.094964	0.868152
DCO(S)	0.162479	0.839440	0.882882
PH(E)	0.843279	0.895386	0.907235
PH(S)	0.852802	0.888191	0.888284
CE(E)	0.074555	0.251151	0.262141
CE(S)	0.245203	0.684205	0.691024
T(E)	0.944341	0.951030	0.955664
T(S)	0.927503	0.931837	0.938694
NH4(E)	0.483998	0.540319	0.772271
NH4(S)	0.132827	0.763215	0.798425
NO3(E)	0.634782	0.636680	0.718656
NO3(S)	0.092412	0.718194	0.844065
NO2(E)	0.158030	0.188917	0.236608
NO2(S)	0.230756	0.324896	0.631490
PO4(E)	0.326477	0.377514	0.471672
PO4(S)	0.085491	0.186321	0.191119

The table above indicates the projection quality of the plan on variables (F1 x F2). Only well-designed variables can be interpreted. So the projection quality of variables SM(S), BOD_5 (S), COD (S), NH_4^+ (S) and NO_3 (S) on the plan is good (> 0.70) and we can say that they are similar.

Figure 14 Variables projection on term 1 & 2Figure 15Individuals projection





It is apparent from the projection of the variables on the plane F1 and F2 (Figure 14) and the projection of individuals (Figure 15) that the pH (E) and PH (S) and T (E) and T (S)are similar. The shaft 1 is T °C and pH: individuals who are on the right have high value of T° and PH and those on the left have small values of T °C and pH. So the months July and August have strong values and least December, January and February are the lowest values. We can say that the pH varies according to the temperature and thus of the season. The BOD_5 parameters (S), SM(S), COD (S) and NH4 (S), NO3 (S) are well correlated with the axis 2. Individuals November and July were relatively higher values.

Evaluation of the chemical quality of water by the Organic Pollution Index (OPI)

The average monthly evolution of the pollution degree IPO Index calculated by the effluent (Table 6) shows a very heavy pollution and high at the entrance to the exit of the station. The effluents at the entrance of the resort have a very high level of pollution (IPO between 1 and 1.5 with an average of 1.21) with a coefficient of variance of 13.22%, while the exit IPO index remains at a high level of pollution (IPO between 2 and 2.75 with an average annual 2.42) with a coefficient of variance 9,10%. It is therefore important to note that despite the sewage treatment applied to the residual pollution load of water remains very high. It is noteworthy that the treated effluent is discharged into the river that may cause a problem to the environment (agriculture, aquatic life, groundwater ...). It should be noted that the region is famous for its very good numeral water and hydrotherapy.

Table 6: Organic Pollution Index "OPI"

Month	OPI Input	OPIOutput
N	1,25	2
D	1,5	2,5
J	1,25	2,5
F	1,25	2,5
M	1,25	2,5
A	1,25	2,5
M	1	2,5
J	1	2,25
J	1,25	2
A	1	2,75
S	1,25	2,5
O	1,25	2,5
Average	1,21	2,42
Maximum	1,5	2,75
Minium	1	2
Standard deviation	0,160	0,22
coefficient of variation (%)	13,22	9,10

CONCLUSION

This study allowed us to make a diagnosis of the state of pollution in the city of Saida. This assessment includes an evaluation of the physico-chemical quality of effluent from the treatment plant wastewater at the entrance and exit of the treatment plant. The results of physicochemical analyzes showed that qualitatively the waters are characterized by:

- A similar change in the temperature and pH at the inlet and at the outlet of the step, with temperatures and higher pH values in summer and winter;
- The values of the temperatures of the effluent at the inlet of the step are higher relative to the outlet and after the change of the seasons; they are lower in periods of cool (November-December-January-February-March-April-May) and highest in warm (June-July-August-September);
- The values of the effluent pH at the entrance of the step are less than compared to the output in cool period (November-December-January-February-March-April-May), and conversely when the temperature increases (June-July-August-September);
- No change is obtained by purification on electric conductivity;
- The values of pollution parameters SM, BOD_5, COD, Nitrate (NO_3) are lower at the outlet of the step that has the input;
- Treatment of orthophosphate ($PO_4^{=}$) is not effective and remains unchanged or even values are higher at the exit.

The implementation of the ACP on sewage treatment outcomes briefed us on the existence of a close relationship between the temperature and pH on the axis F1. The BOD_5 parameters (S), SM (S), COD (S), NH_4^+ (S) and NO_3(S) are well correlated with the axis F2. This axis can be likened to an axis reflecting the degree of pollution and eutrophication through the discharge of nitrates. The parameter orthophosphate ($PO_4^{=}$) that does not vary much during the year this little boost eutrophication of rivers. The index "OPI" highlighted a picture of the pollution evolution at the effluent treatment plant for a year or soft and have noted that this index ranks the effluent of step at the entrance to a level very strong pollution and leaving a high level indicating a depuration problem. In conclusion, it seems useful to reported that despite maximal treatment, the environment is threatened in our opinion because it takes effect a reduction of nitrate (NO_3) orthophosphate ($PO_4^{=}$) before discharge into the receiving environment.

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