

Article

The use of Organic Pollution Index method to assess the impact of WWTP discharges on lake water quality: A case study

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Abstract : In wet area, the problem arises in a more serious way in front of the wastewater rejections in the lakes, case of the lake Mellah in North Algerian. It is from this point of view that this work is registered, bearing on the determination of the capacity of elimination of the micropollutants in the purification plant. Also to evaluate the impact of water of rejection the purification plant on water of the lake Mellah. A prospection of the site from a physicochemical point of view at summer undertaken in order to evaluate the water quality of lake Mellah. The statistical and graphic data processing by the organic pollution index method highlighted a very strong organic contamination at the right of the rejection of the station which tends to be dissipated in the lake. This phenomenon plays a central role in the balance of the biological hydro assessment of the ecosystem.

Keywords: Lake Mellah; Wastewater; Quality; Organic pollution

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1. Introduction

The water surface was always confederated like the universal receptacle of all the form of pollution [1]. Algeria vis-a-vis problems of water supply which are accentuated by the explosion demographic, industrial development and agricultural as well as the dryness, the purification of waste water does not constitute a priority, of this fact several existing stations are very badly managed and not very effective [2].

The lake Mellah located near the town of El Kala and having a surface of 860ha [3] (Fig. 1) and is presented in the form of a coastal lagoon, communicating with the sea by a channel (long 900 m). This depression which communicates with the sea became currently a discharge system in which are poured, domestic effluents of the neighbouring localities [4]. The population is principally used in agriculture, especially animal husbandry. There are not serious threats which influence the ecosystems of the lake Mellah but tendency appraise by urbanization and extension of agrarian plots, which are owed to the increase of the population and its livestock and will not be without effects on the quality of waters which feed the plan of water of Mellah [5].

The town of Gantra El Hamra one of the villages are evacuated their rejections in a network of cleansing of the unit type in which the waste water and the rain water and they undergo a preliminary treatment by a purification plant located at the West of the agglomeration near CW N°109. This station they undergo several data processing runs: Outfall of storm, mechanized fine cleaning, desanding pool-deoiler, mining area of ventilation, lamellate decantation and the thickening of muds. It treats the whole of waste water of the city Gantra El Hamra and of the connected communes is poured their rejections towards the lake. The population of this city believes continuously and is evaluated with 1100 inhabitants in 2010 [6].

The objective of this study is to determine the residual pollution of a treatment plant by analyzing the total parameters for estimating the organic pollution of wastewater. The knowledge of a polluting load determines the quality of the effluent starting from analyzes carried out on samplings representative.

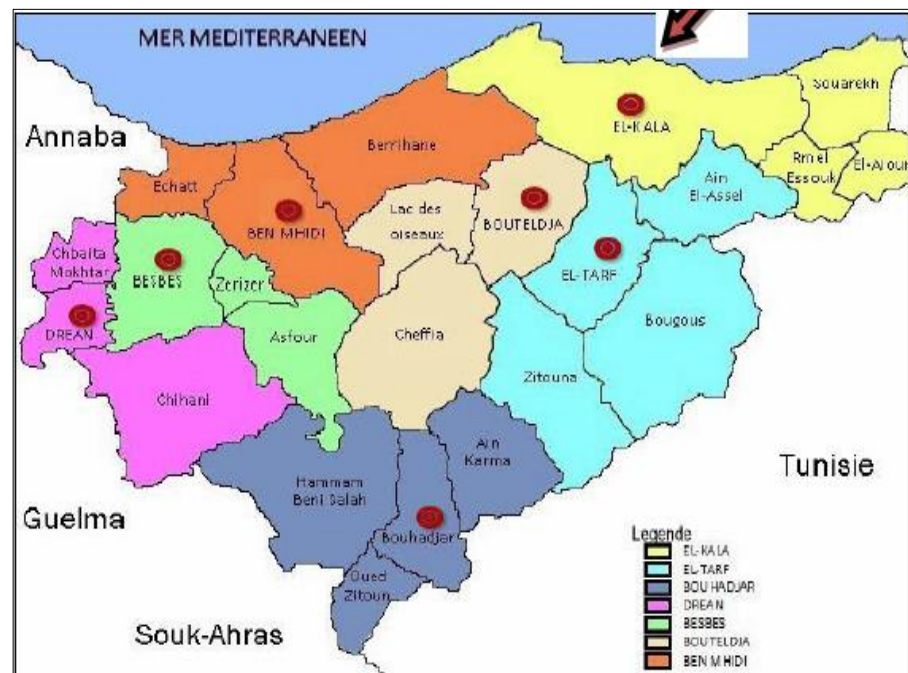


Figure 1. Geographical location of the study area

2. Materials and Methods

Thirty-six samples were carried out with the current of the year 2010 and were carried out with the upstream and the downstream of the purification plant like on the level of the lake Mellah on two sites (the site 1 and the site 2 (Fig. 2).

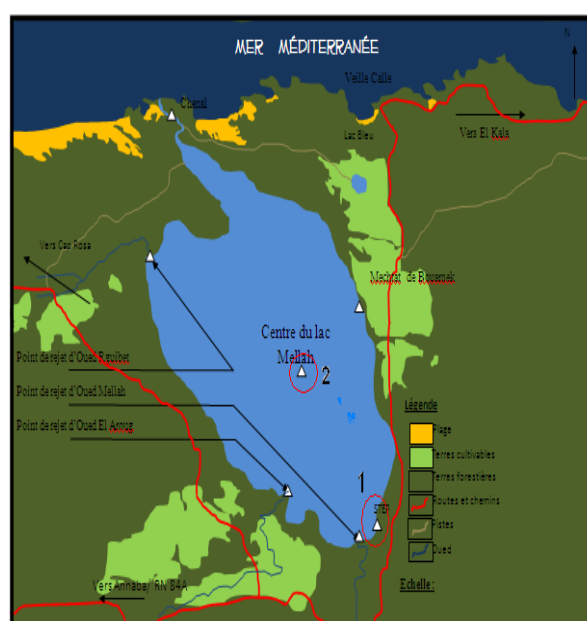


Figure 2. Chart of localization of the zone of study and the sites of taking away

A monthly follow-up over one one-year period (from January in December 2010), on the level of purification plant (upstream and downstream) and on the level of the southern bank of the lake Mellah (Site1), close to the discharge system of the marshy zone in which the purification plant throws and centers lake Mellah (Site 2). The measured parameters are : Temperature, pH, dissolved Oxygen and salinity (in situ with a multi parameter (Consort 535 and oxymetry and PH-meter) and Radiometers analytical (Pionner 20 and Pionner 30) Suspended matter, COD, BOD₅, NO₂, NO₃, orthophosphate, and chlorophyl (at the laboratory with spectrophotometer and BOD measures).

Table 1. Roast quality (OIP)

N° Class	BOD ₅ (mg/l)	NH ₄ (mg/l)	NO ₂ (mg/l)	PO ₄ (µg/l)
5	> 2	< 0.1	5	15
4	2 - 5	0.1 - 0.9	6 - 10	16 - 75
3	5.1 - 10	0.91 - 2.4	11 - 50	76 - 250
2	10.1 - 15	2.5 - 6	51 - 150	251 - 900
1	> 15	> 6	> 150	> 900

OIP= average of the numbers of the classes of the 04 parameters:

OIP = 5,0 – 4,6 : null organic pollution.

OIP = 4,5 – 4,0 : weak organic pollution

OIP = 3,9 – 3,0 : moderate organic pollution.

OIP = 2,9 – 2,0 : strong organic pollution

OIP = 1,9 – 1,0 : very strong organic pollution.

3. Results

3.1. Descriptive statistics

The physicochemical characteristics of rough and purified waste water purification plant of town of El Gantra El Hamra are gathered in table 2:

Table 2. Results of total parameters of the pollution of rough and purified waste water (January-December .2010)

Nature of water	Raw water				Purified water			
Parameters	Min	Max	Mean	Stan. Dev.	Min	Max	Mean	Stan. Dev.
Vol. in m ³	95.82	285.67	174.96	62.96	-	-	-	-
pH	6.87	7.65	7.13	0.25	6.46	7.45	6.84	0.35
T	15.05	27.71	19.08	4.03	14.49	28.93	20.57	5.42
O ₂	3.40	4.30	3.87	0.28	-	-	-	-
Sus. matter mg/l	134.14	478.71	260.47	91.72	18.10	40.76	27.14	6.02
BOD ₅ mg/l	104.00	322.67	210.84	60.98	7.55	30.0	20.51	7.57
COD mg/l	199.95	548.82	361.87	105.42	20.0	72.45	41.84	16.47
NO ₂ mgN/l	0.03	0.37	0.085	0.09	0.01	0,254	0.09	0.07
NO ₃ mgN/l	3.20	9.00	6.10	2.07	3.70	16.25	8.53	4.41
COD/BOD ₅	1.33	2.29	1.77	0.29	0.94	3.21	2.15	0.64

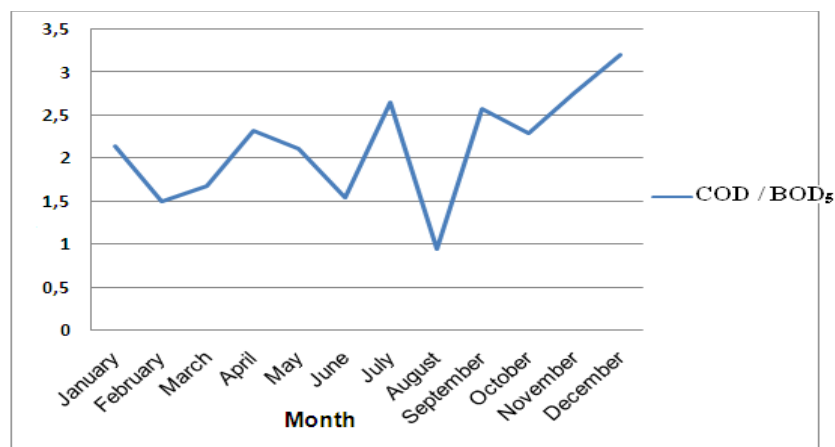


Figure 3. Temporal evolution off carry forward/ratio COD/BOD₅ for purified toilets

The COD/BOD₅ ratio gives a first estimate of the biodeterioration of the organic matter of a given effluent; one generally agrees on the following limits:

- COD / BOD₅ < 2 : the effluent is easily biodegradable;
- 2 < COD / BOD₅ < 3 : the effluent is biodegradable with selected stocks;
- COD / BOD₅ > 3: the effluent is not biodegradable;

Figure 3 and table 2, show an evolution in the time of COD/BOD₅ ratio. It is noted that the biodeterioration is important in December and November to the downstream of purification plant. In addition, the report/ratio is about 2.76 and 3.21, it is that the effluent is with difficulty degradable, that there exists a fraction of the organic matter which is very with difficulty, even no biodegradable. This result could be allotted to the rejections of an industry of textile connected to this collector and effluents of breeding (involving the development of micro-algae at the purification plant, what is called eutrophication); nitrates coming from manures, the liquid manure and the manure; pesticides [7].

During the day, thanks to photosynthesis, these algae release from great quantities of oxygen in water at the point to create conditions of supersaturating of water, but when the light disappears, all these algae will breathe, consume all oxygen which they produced in the course of the day and will put seriously to lack some oxygen.

3.2 Performance evaluation of the Wastewater treatment plant (El Gantra El Hamra)

The analysis of the samples finished, it is appropriate to have the results in such way that they are easily exploitable to determine the residual pollution of the purification plant of El Gantra El Hamra. It is also presented, in what follows, the interpretation of the results obtained for each analyzed parameter.

3.2.1 The temperature

The temperature of water in entrée and the exit of purification plant increase. This increase is due at the same time to their surface of contact with the air which decreases too [8].

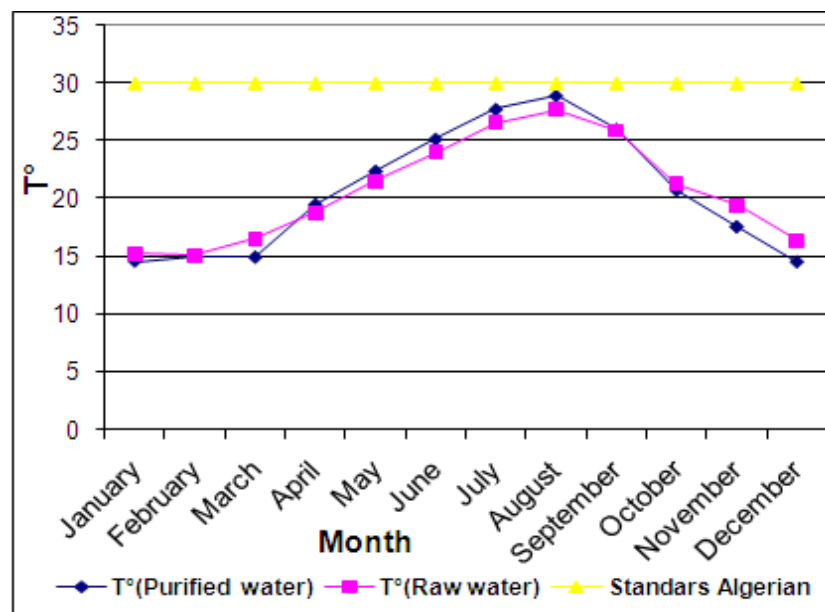


Figure 4. Temperature of water of the purification plant (upstream and downstream of the purification plant)

The shape of the curve shows that the temperature is particularly high in the summer of; this is explained by the waters which are directly influenced by the air temperature [8]. The temperature of water in entered and left largely respects the standard set at 30°C [9] (Figure 4).

3.2.2. Hydrogen potential (pH)

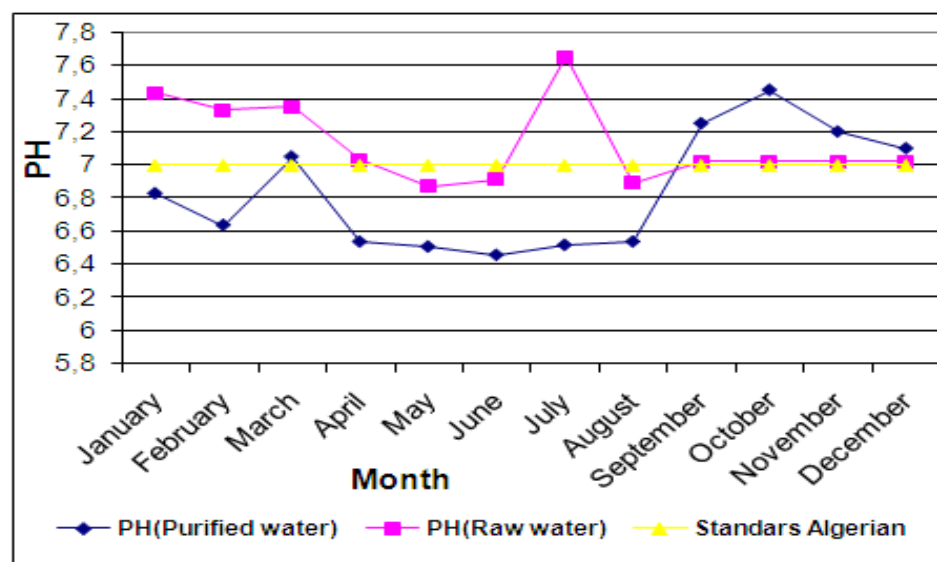


Figure 5. Hydrogen potential (pH) of water of the purification plant (upstream and downstream of the purification plant)

The pH is considered as one of the most important parameters of water quality. It should be closely monitored during the sampling period [10]. pH of water at exit east of between 6,5 and 7,5. Respecting the standard of rejection delimited between 6,5 and 8,5 (Figure 5), these values coincide, according to GAUJOUS [11], with the normal pH of sea water and fresh water in calm zones.

3.2.3. Suspended matter (Sm)

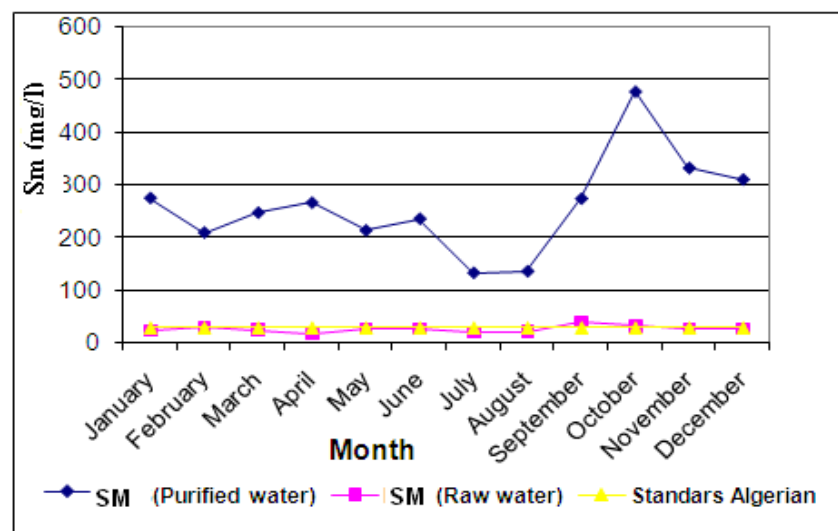


Figure 6. Content of Suspended matter of water of the purification plant (upstream and downstream of the purification plant)

The temperature of water in entrée and the exit of purification plant increase. This increase is due at the same time to their surface of contact with the air which decreases too [8].

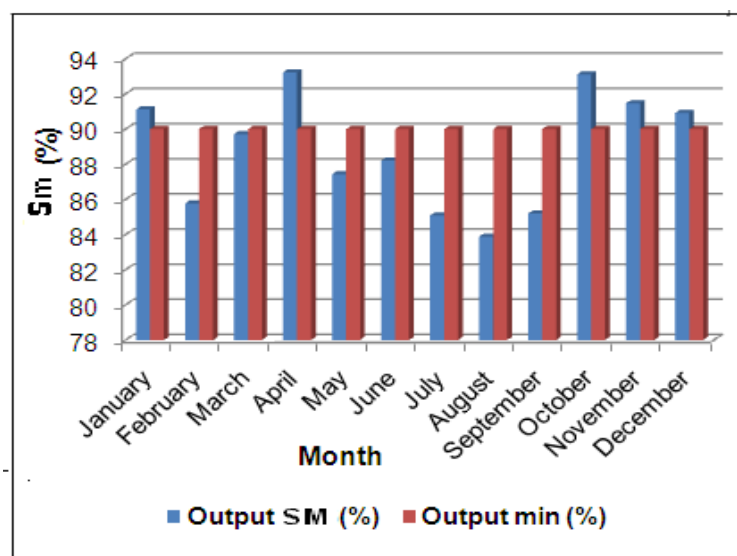


Figure 7. Output in Suspended matter of water of the purification plant

The concentrations as of Suspended matter in the majority of the samples do not exceed the standard at the entry and the exit of the station but with ego of September and October they are exceeded the delimited standard of rejection 30 (Figure 6). Indeed, with a content of 275.21 mg/l at the entry against only 40.76 mg/l on the level of the exit, the output of purification for this parameter reaches 85.19%, as well as the average output after the purification (Suspended matter) reached 88.76% which is lower than the standard of output 90% (Figure 7).

3.2.4. Biochemical Oxygen Demand for 5 days (BOD5)

It is represented by the amount of oxygen required for microorganisms to degrade organic matter in water. In a way similar to the Figure 8, the Figure 9 illustrates in terms

of BOD₅, the importance of residual pollution. After purification, the reduction of the biodegradable matters is of 322.67 mg/l with 13.07 mg/l is lower than the standard of rejection set at 120 mg/l and what represents an output in BOD₅ of 95,95%. The output of elimination of the BOD₅ is in means of 88.95% is higher than the standard 70% in the treated effluent.

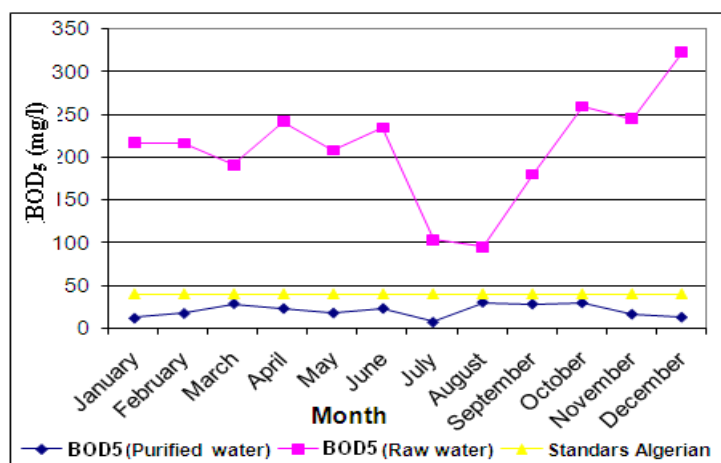


Figure 8. Content of BOD₅ of water of the purification plant (upstream and downstream of the purification plant)

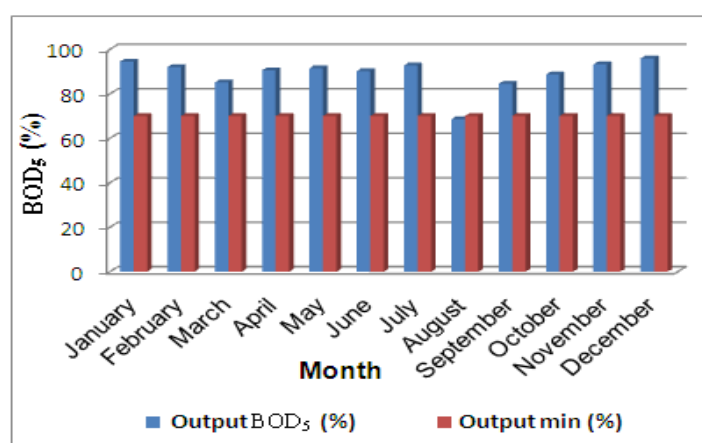


Figure 9. Output in BOD₅ of water of the purification plant

3.2.5. Chemical Oxygen Demand (COD)

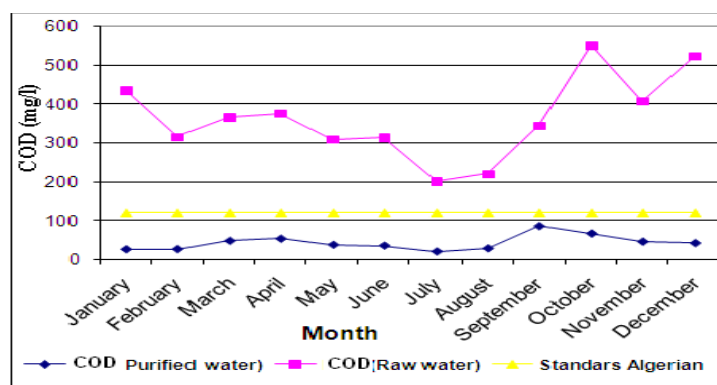


Figure 10. Content of Chemical Oxygen Demand of water of the purification plant (upstream and downstream of the purification plant)

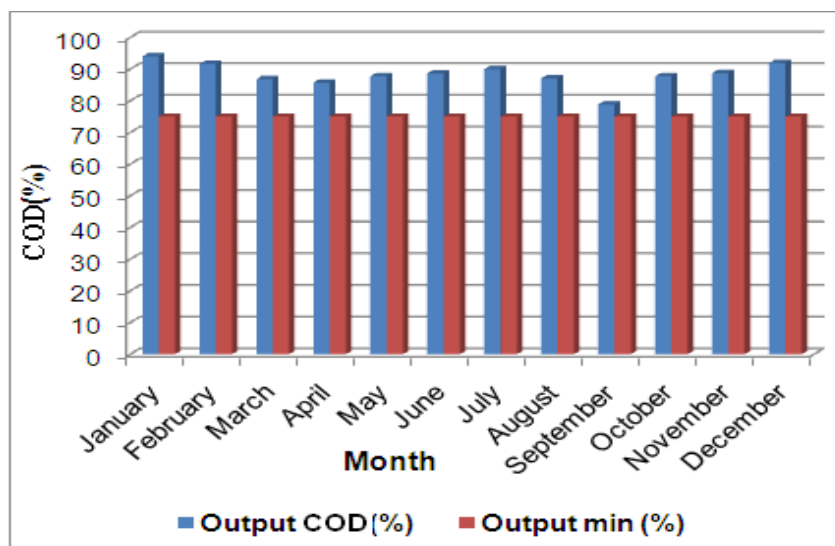


Figure 11. Output in Chemical Oxygen Demand of water of the purification plant

On the figure, one can clearly see the variation which shows the low content of Chemical Oxygen Demand of water at exit with that of the entrée like with the standard of rejection, limited with 120mg/l (Figure 10). The average output in Chemical Oxygen Demand is of 88.25%. This testifies to the very effective treatment of purification with respect to the oxydable matters and like with the standard of output (75%) (Figure 11).

3.2.6. Nitrite NO_2

We can, also, note through the Figure 12, the importance of present of nitrite appreciably growing until very exceeding the standard of rejection (0.1mg/l), in water entered and water of exit with a concentration of 0.120 mg/l with 0.123 mg/l with ego of October and 0.03 mg/l with 0.25 mg/l with ego of November. This result could be allotted to the rejections of the effluents of breedings. What is explained the insufficiency of ventilation in the mining area of ventilation [12].

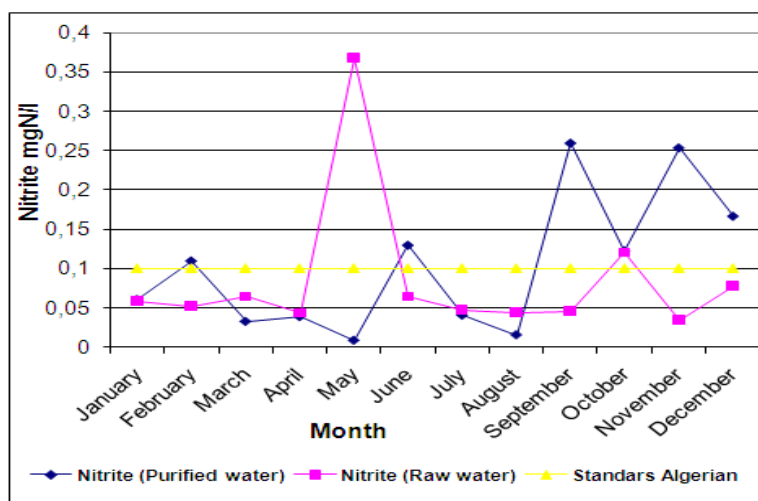


Figure 12. Content of NO_2 of water of the purification plant (upstream and downstream of the purification plant)

3.2.7. Nitrate NO_3

The nitrates are much less dangerous than nitrites. The concentrations of nitrates in the majority of the samples do not exceed the standard of the hydraulic public domain (50 mg/l). Indeed, with a content of 4.27 mg/l at the entry against only 4.75 mg/l on the level of the exit in May (Figure 13).

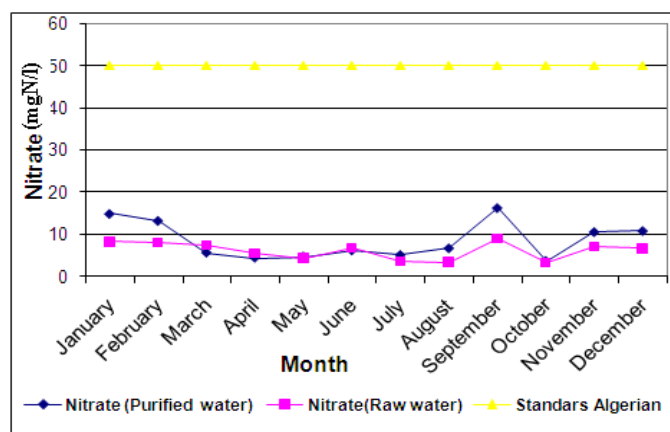


Figure 13. Content NO_3 of water of the purification plant (upstream and downstream of the purification plant)

3.3. Evaluation of water quality of the station and lake Mellah

According to the method of the OIP, table 3.et the graphs represent the computed values of the index of organic pollution to the current of year 2004 [13] and 2010 at the various points of sampling.

Table 3. Organic contamination class of the In/Out-flow of the station and the lake mellah (2004-2010).

Month	Entre to the station	Exit of the station	Site 1 in 2010	Site 2 in 2010	Site 1 in 2004	Site 2 in 2004	Site 3 in 2004
Jan	P. V. strong	P. strong	P. moderate	P. weak	P. weak	P. weak	P. weak
Feb	P. V. strong	P. V. strong	P. weak	P. weak	P. weak	P. weak	P. weak
Mar	P. V. strong	P. strong	P. moderate	P. weak	P. weak	P. null	P. weak
Apr	P. strong	P. strong	P. moderate	P. weak	P. weak	P. weak	P. weak
May	P. V. strong	P. V. strong	P. weak	P. weak	P. weak	P. weak	P. null
Jun	P. V. strong	P. V. strong	P. weak	P. weak	P. weak	P. weak	P. weak
July	P. strong	P. strong	P. weak	P. weak	P. weak	P. weak	P. weak
Aug	P. strong	P. strong	P. weak	P. faible	P. null	P. weak	P. weak
Sept	P. strong	P. V. strong	P. strong	P. moderate	P. moderate	P. weak	P. moderate
Oct	P. V. strong	P. V. strong	P. V. strong	P. modérée	P. weak	P. weak	P. weak
Nov	P. strong	P. V. strong	P. strong	P. V. strong	P. moderate	P. moderate	P. moderate
Dec	P. V. strong	P. V. strong	P. moderate	P. moderate	P. weak	P. weak	P. weak

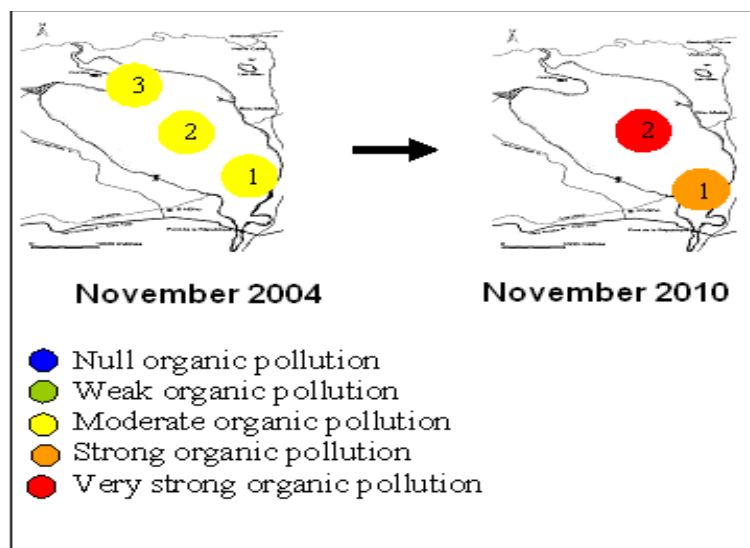


Figure 14. Chart of evolution of the water pollution of the lake Mellah between 2004 and 2010

Results represented in the Figures 14 & 15 show a very strong pollution at the period of low waters as with time pollution increases (2004 to 2010), which gives a bad water quality through practically the two sites (1et 2 in 2010) as a rejection servants or an effluent of breeding. This explained by the fact that the rejections poured increases by the population growth and sustainable development and that in period dries polluted water cannot move towards the sea because of the concentration of pollution on the level of the place of rejection, one also notices that dissolved oxygen is very weak in these two stations of sampling what generates without delay a eutrophication of the aquatic environment which is the lake Mellah [14,15].

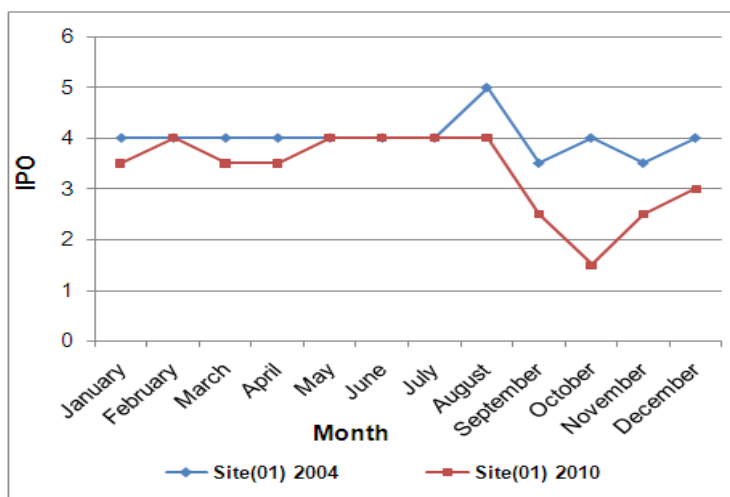


Figure 15. Temporal Evolution of OPI in water of the lake Mellah, with the right of site 1 (2004 – 2010)

For the period of high waters, the contribution of water by the rain and the streaming dilute these concentrations on the level of two stations; this dilution makes thus water quality average and supports the biological breakdown.

5. Conclusions

The quality and the quantity of urban waste water depend primarily on the quantity of consumed water (equipment day laborer per capita). We tried through this work to determine the residual pollution of a purification plant by the analysis of the total parameters of estimate of the organic pollution of waste water. The statistical and graphic data processing highlighted an output moderated at the purification plant and weak treatment which the presence of the microalgae generates (importance of present of NO₂). As well as the comparison of the various results obtained in waste water of the purification plant of the city with those raised in surface water of the lake Mellah, watch a direct impact of rejection of waste water purified on the water quality of the lagoon. At the end of this evaluation of degree of pollution in water of the lake, it results an evolution increasing from the degradation of water quality directly related to the socio-economic development of the town of El Gantra El Hamra i.e. impoverishment from the lake in products halieutics which constitute the independent sources of feeding for the lake and bordering populations.

Whereas to cure and determine the problem of pollution and its impact, the purification plants and of treatment should recover all waste water and to purify them to make them usable in the fields of agriculture, or it is necessary to minimize the presence of nitrogen in the rejection by a purification plant must be equipped with a system of denitrification of the water purified before their rejection in a specific mining area of anoxia.

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