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Characterization of the performance of wastewater treatment in Sidi Merouane plant.

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ABSTRACT

Preservation of water resources is one of the major problems in our environment. The present study aims to evaluate the physicochemical quality of the treated water discharged from an urban waste water treatment plant located in Northeastern Algeria. Several parameters were analyzed over six months. The obtained results reveal that the treated water is characterized by neutral pH, high electrical conductivity and low organic matter content. Phosphorus concentrations do not exceed 2mg/L. Nitrogen is mainly ammoniacal. Heavy metals concentrations are lower than that allowed for agricultural valorization.

Keywords: water, physicochemical quality, activated sludge, Sidi Merouane wastewater treatment plant, Algeria

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INTRODUCTION

In urban areas, the increase in population generates large quantities of wastewater loaded in various pollutants which contribute strongly in the degradation of surface and ground water quality [1]. The reuse of treated water from wastewater treatment plants is an international practice [2]. It has become an environmental and economically viable option for agriculture and industry. Conventional treatment of urban waste water includes the use of primary treatment to remove solids, oil and grease; secondary biological treatment to remove organic matter and nutrients; and tertiary processing where disinfection is used. The primary treatment consists of simple decanting which can be enhanced by chemical additives. The secondary biological treatment allows the biodegradation of organic matter in wastewater through aerobic or anaerobic bacteria. Nitrogen and phosphorus removals are also performed in this treatment. Generally, in wastewater treatment plants, assessments of water quality is carried out to guarantee that the operational process acts in accordance with the legislative requirements for environmental protection and efficient use of water resources [3]. The objective of the present study is the evaluation of the physicochemical quality of treated waste water of Sidi-Merouane plant located in the northeastern Algeria.

MATERIAL AND METHODS

Study site

Sidi Merouane waste water treatment plant is located in northeastern Algeria in Mila (Figure 1). It is designed to treat wastewater coming from agglomerations of Mila, Grarem, Sidi Merouane, Sibari1, Sibari2, and Ras Elbir. The main steps of waste water treatment in the plant are illustrated in Figure 2. The treated effluent is intended for discharge into the dam of Beni Haroun.

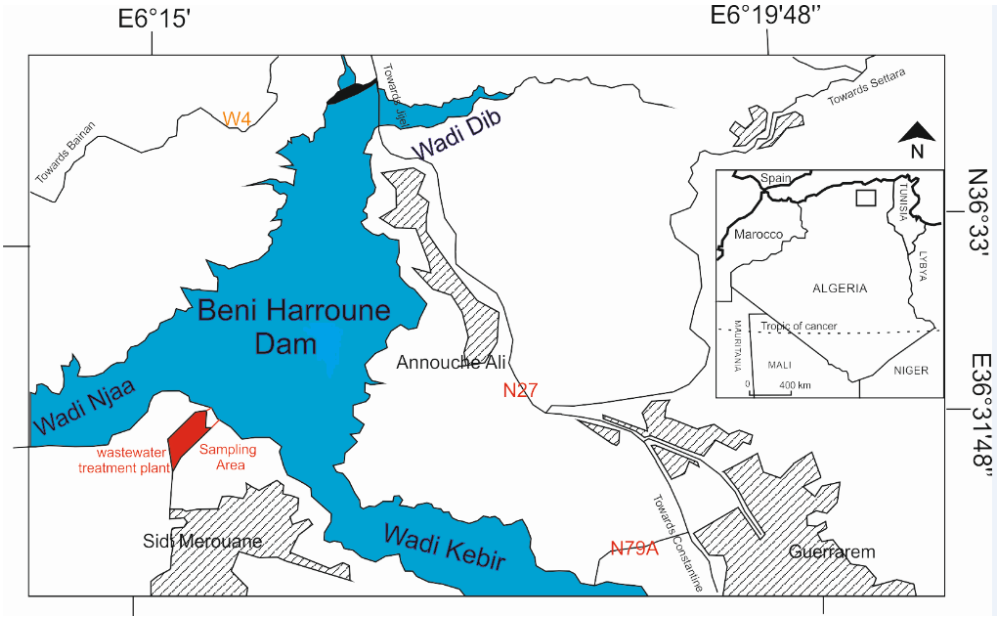

Figure 1: Localization of Sidi Merouane plant

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Figure 2: Wastewater treatment steps in Sidi Merouane plant

Water sampling and analysis

Water samples were collected once a month from February to June 2014 at the exit of the treatment plant. In order to get representative samples and to make possible their comparison, three samples were taken at three times in the day. Polyethylene bottles were used for water sampling. The samples were transported in cold and stored at 4°C in laboratory. The Table1 summarized the water parameters analyzed and the corresponding analytical methods used.

Table 1: Measured parameters and analytical methods used in water analyses

Parameter	Analytical method
pH	Potentiometric
Electrical Conductivity (µS/cm)	Conductimetric
Hardness (mg $CaCO_3$/L)	Complexometric
Bicarbonate (mg/L)	Acidimetric
DCO (mg/L)	Spectophotometric
Hardness- Calcium - Magnesium (mg/L)	Complexometric
Chloride (mg/L)	Precipitation (Mohr method)
Sulfate (mg/L)	Nephelometric (barium chloride)
Nitrate (mg/L)	Spectrophotometric (sodium salicylate)
Nitrite (mg/L)	Spectrophotometric (Zambelli reagent)
Ammonium (mg/L)	Spectrophotometric (blue indophenol)
Orthophosphate (mg/L)	Spectrophotometric (Ammonium molybdate)
Iron (mg/L)	Spectrophotometric (phenanthroline)
Manganese (mg/L)	Spectrophotometric (ammonium persulfate)
Aluminum (mg/L)	Spectrophotometric (aluminon)
Zinc (mg/L)	Spectrophotometric (ferrocyanide)
Chromium (mg/L)	Spectrophotometric (Diphenylcarbazide)

RESULTS AND DISCUSSION

The Sidi Merouane treated waters are characterized by basic pH (Table 2).The measured values vary between 7.81 and 8.11. They remain within the standards set by OMS [4]. The highest value is recorded in April. Generally, the pH variation is explained by the oxidation of organic matter and the reduction of nitrates. The values of electrical conductivity are height (Table 2). The highest mineralization recorded in June is in relation to the importance of evaporation and to the intense bacterial activity. The Sidi Merouane treated waters are very hard (Table 2). The measured hardness reaches 530 mg ($CaCO_3$)/L in March.

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Table 2: Evolution of pH, Electrical Conductivity and Hardness in treated water of Sidi Merouane plant

Sample	February	March	April	May	June
pH	7.81±0.01	7.92 ±0.15	8.11 ±0.07	7.94 ±0.02	7.97 ±0.02
E.C (µS/cm)	1483.33±12.5	1413.33 ±9.01	1525 ±17.32	1151± 8.73	1619.33±24.00
Hardness ($mgCaCO_3/L$)	501.33± 6.11	533.33±10.06	465.33±36.29	408 ± 72.99	506.67 ±16.65

Both calcium and magnesium concentrations show slight fluctuations during the sampling period (Figure 3). Calcium concentrations are more important.

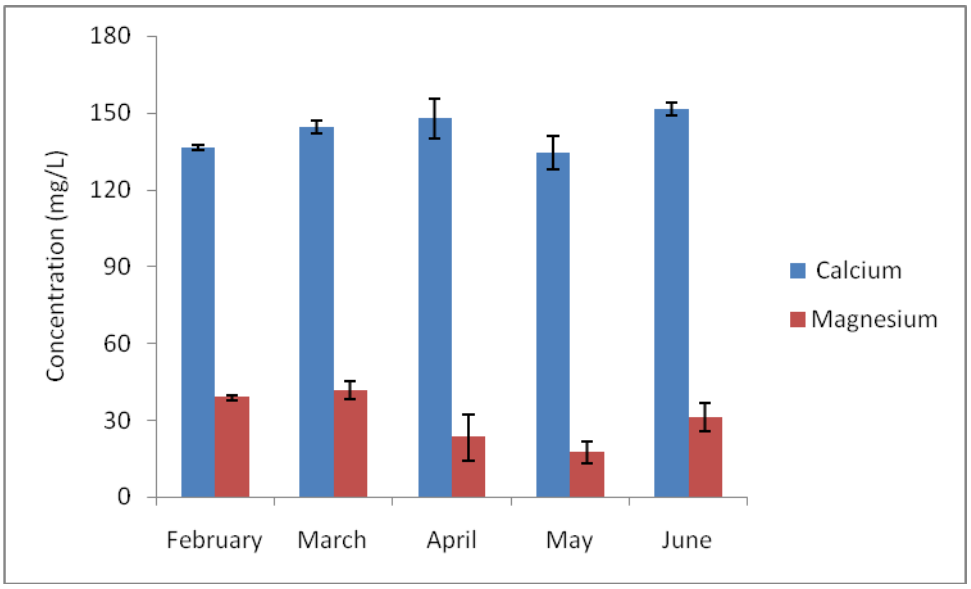

Figure 3: Evolution of Calcium and Magnesium in treated water of Sidi Merouane plant

Bicarbonate is the most important anion in Sidi Merouane treated waters (Figure 4). Its evolution seems to be identical to that of **hardness. Consequently, the hardness of the treated water is mainly temporary.** Both sulfate and chloride show fluctuations. The low concentrations of the two ions in March can be attributed to organic incorporation and/or to their content in raw water.

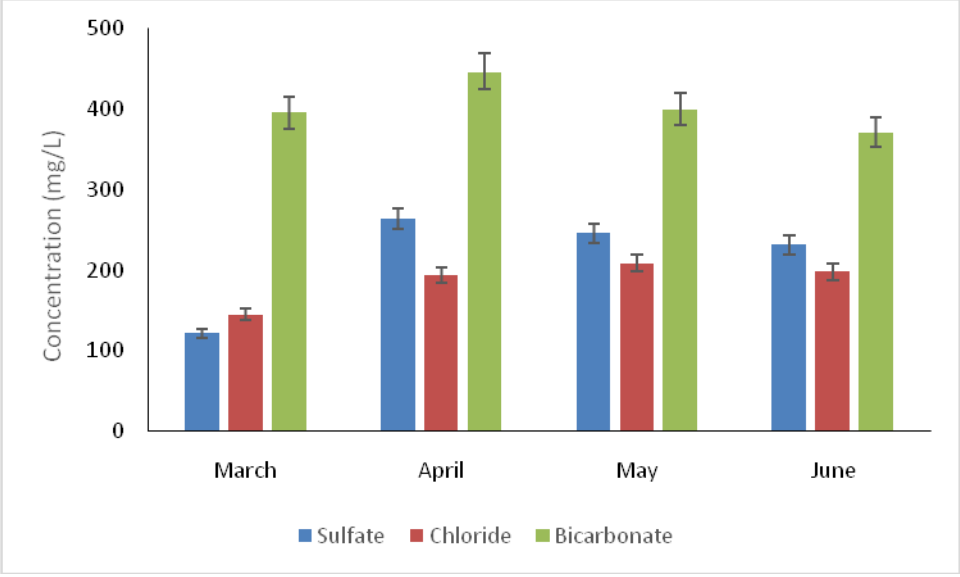

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Figure 4: Evolution of Bicarbonate, Chloride and Sulfates in treated water of Sidi Merouane plant

The treated water of Sidi Merouane is not charged with organic matter. The measured COD values which corresponds to the content of all organic materials whether they are biodegradable or not, are low (Figure 5); they do not exceed 50mg/L. Generally, a higher content of organic matter is taken as an indication of low water quality.

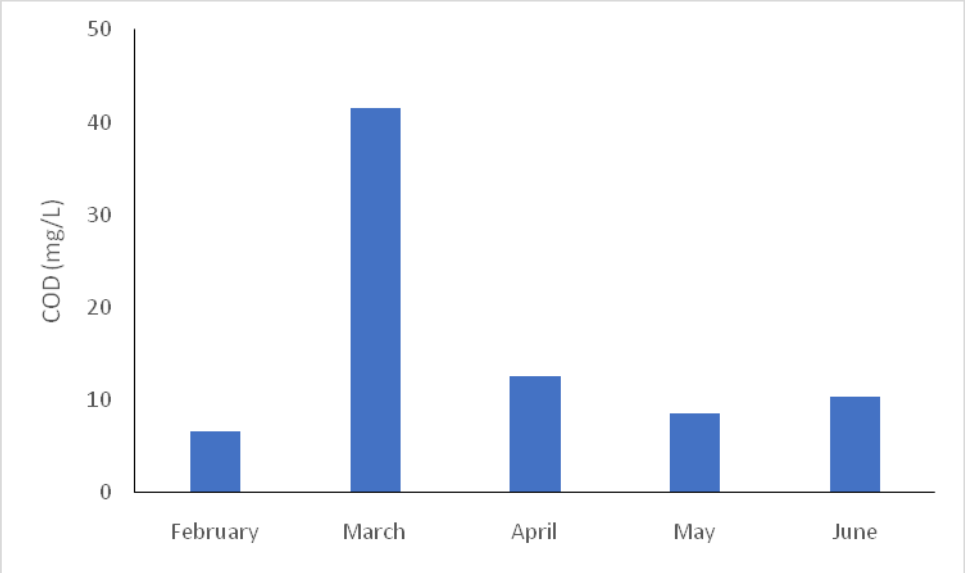

Figure 5: Evolution of COD in treated water of Sidi Merouane plant

Phosphate concentration ranges between 0.12 and 1.47 mg/L (Figure 6). The most important quantity is lower than the standard set by OMS (<2 mg/L). Consequently, the biological activated sludge treatment carried in Sidi Merouane plant is effective as regards to phosphorus. The weak values observed in February and March can be in relation to the photosynthesis processes and the uptake by aquatic plants. The most important ammonium content in the treated water is recorded in April. Generally, the raw wastewater contains predominantly organic nitrogen. The ammonification of this nitrogen continues until it is present at the inlet of the activated sludge basin mainly in the form of ammoniacal nitrogen [5]. In addition to their content in raw water, nitrate and nitrite are produced from the nitrification reaction of organic nitrogen. In biological treatment, ammoniacal nitrogen is transformed into nitrites and then into nitrates through the supply of oxygen**.** The concentration of nitrates in Sidi Merouane treated waters is less than OMS standards value (50mg/L). Among the mineral nitrogen species, $N\text{-}NH_4$ is the highest (Figure 7). Consequently, ammonification is more important than nitrification in Sidi Merouane treatment plant.

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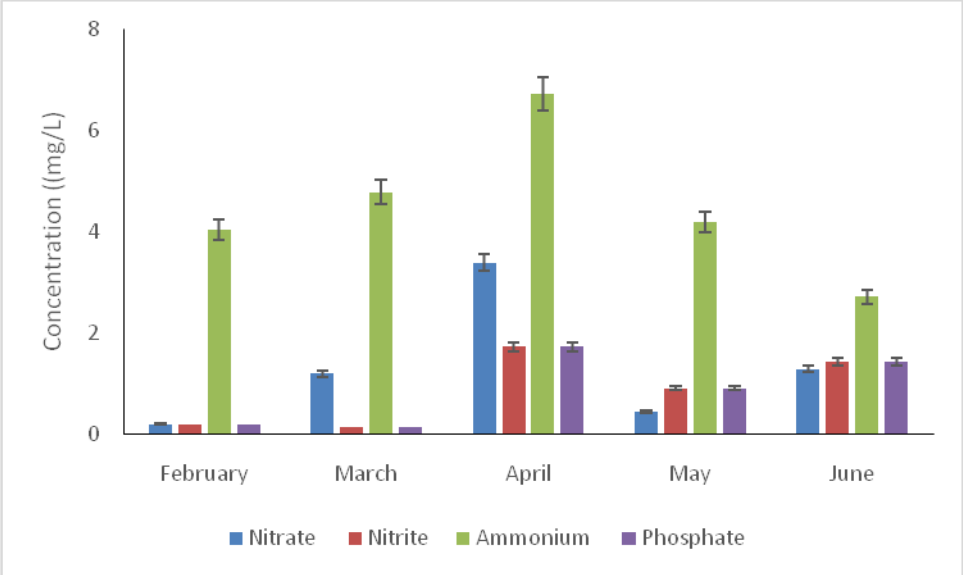

Figure 6: Evolution of nutritional elements in treated water of Sidi Merouane plant

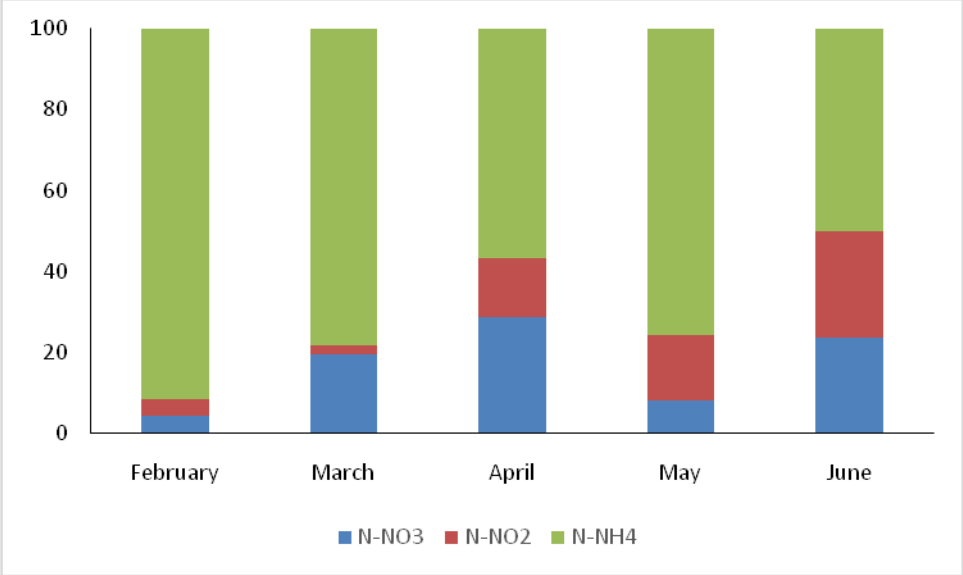

Figure 7: Distribution of mineral nitrogen species in treated water of Sidi Merouane plant

Among the analyzed heavy metals, iron and zinc have the highest concentrations (Table 3). The content of the other metals are very low. In all cases, metals concentrations are lower than the discharge limits.

Table 3: Evolution of heavy metals in treated water of Sidi Merouane plant

	Iron (µg/L)	Manganese (µg/L)	Aluminum (µg/L)	Zinc (µg/L)	Chromium (µg/L)
March	26± 0.005	26 ±0.005	80	593± 0,051	23±0.0015
April	52 ±0.007	1.5	71 ±0.02	743 ±0.051	19 ±0.003
May	105± 0.013	1,3±0.0002	N.D	623± 0.308	N.D
June	110± 0.03	-	-	297± 0.13	1.3

According to the exigency of the Food and Agriculture Organization (FAO) [6], the treated water of Sidi Merouane plant can be used for irrigation (Table 4).

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Table 4: Comparison of the quality of Sidi Merouane treated water with requirement of FAO for irrigation

Paramètre	Min	Max	Mean	Concentrations required for irrigation (FAO, 2003)
pH	7.81	8.11	7.95 ±0.11	6.5 à 8.5
Hardness (mg $CaCO_3$/L)	408	533.33	482.93±48.39	
Calcium (mg/L)	134.4	151.4	142.99±7.26	400
Magnesium (mg/L)	17.5	41.79	30.52±10.22	60.75
Chloride (mg/L)	144.36	377.48	224.36±89.07	1065
Sulfate (mg/L)	54.17	263.64	185.84±89.09	400
Nitrate (mg/L)	0.438	3.386	1.29± 1.45	500
Nitrite (mg/L)	0.126	0.901	0.87±0.74	
Ammonium (mg/L)	2.713	6.728	5.80±1.29	
Phosphate (mg/L)	0.126	1.72	0.87±0.72	
Iron (mg/L)	0.026	0.11	0.073±0.04	
Manganese (mg/L)	0.001	0.026	0.009±0.014	
Aluminum (mg/L)	0.071	0,08	0.075±0.006	
Zinc (mg/L)	0.297	0.743	0.552±0.166	
Chromium (mg/L)	0.001	0.0023	0.0158±0.009	

CONCLUSION

In the present study, the effectiveness of the biological treatment undertaken in Sidi Mereouane treatment plant is evaluated through analysis of various parameters. The obtained results lead to the conclusion that the treated water of Sidi Merouane plant complies with the discharge standards for both nutritional elements and heavy metals. Consequently, this water can be used for irrigation.

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