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Research Article

Is the recycling of purified water from the Ain El Arbaa region for agricultural purposes possible?

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Abstract

The region of Ain El Arbaa, like all Algerian municipalities, suffers from a water shortage crisis. The main objective of this work is to investigate the possibility of reusing treated water from the region.

For this purpose, we have examined the quality of the water treated by the D'Ain El Arbaa treatment plant.

The analyzes carried out on the incoming sewage and outgoing waste water from the lagoon focused on the following parameters: (pH, total suspended solids (TSS), biological oxygen demand (BOD_5), chemical oxygen demand (COD), NH_4, electrical conductivity). This during the period from January 2021 to May 2021 with a sampling frequency of twice a month.

The results obtained show that this purification process using two sectors (pre-treatment, secondary treatment) is insufficient and does not meet the quality standards required for agricultural use for the parameters: TSS, COD, and electrical conductivity. For the preservation of the receiving environment, the results did not comply with the standards for the parameters TSS, DOC, NH_4.

The abatement yields of the lagoon treatment plant studied were average for all the parameters studied.

So according to this work we can conclude that natural lagooning alone is not sufficient to have purified water that complies neither with the quality required for agricultural reuse, nor with the quality required for discharge into the natural environment.

Then the addition of a complementary tertiary treatment, such as filter basins planted with macrophytes is necessary.

Keywords: wastewater, purification, Algeria, Ain El Arbaa. recycling of purified water,

Ain El Arbaa bölgesinden arıtılmış suyun tarımsal amaçlar için geri dönüşümü mümkün mü?

Öz

Ain El Arbaa bölgesi, tüm Cezayir belediyeleri gibi bir su kıtlığı krizi yaşıyor. Bu çalışmanın temel amacı, bölgeden arıtılmış suyun tekrar kullanılma olasılığını araştırmaktır.

Bu amaçla D'Ain El Arbaa arıtma tesisi tarafından arıtılan suyun kalitesini inceledik.

Lagüne gelen kanalizasyon ve lagünden çıkan atık sularda yapılan analizlerde şu parametrelere odaklanılmıştır: (pH, toplam askıda katı madde (TSS), biyolojik oksijen ihtiyacı (BOD5), kimyasal oksijen ihtiyacı (COD), NH4, elektriksel iletkenlik) . Bu, Ocak 2021'den Mayıs 2021'e kadar ayda iki kez örnekleme sıklığı ile yapılır.

Elde edilen sonuçlar, iki sektör (ön arıtma, ikincil arıtma) kullanılarak yapılan bu saflaştırma işleminin yetersiz olduğunu ve TSS, KOİ ve elektriksel iletkenlik parametreleri için tarımsal kullanım için gerekli kalite standartlarını karşılamadığını göstermektedir. Alıcı ortamın korunması için, sonuçlar TSS, DOC, NH4 parametreleri için standartlara uymadı.

İncelenen lagün arıtma tesisinin azaltma verimleri, incelenen tüm parametreler için ortalamaydı.

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Dolayısıyla bu çalışmaya göre, ne tarımsal yeniden kullanım için gerekli kaliteye ne de doğal çevreye deşarj için gerekli kaliteye uygun olmayan arıtılmış suya sahip olmak için doğal göllenmenin tek başına yeterli olmadığı sonucuna varabiliriz.

Ardından, makrofitlerle ekilen filtre havuzları gibi tamamlayıcı bir üçüncül işlemin eklenmesi gerekir.

Anahtar Kelimeler: atık su, arıtma, Cezayir, Ain El Arbaa. Arıtılmış suyun geri dönüşümü.

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1. Introduction

Natural lagooning is a purification system grouping together two or three ponds in series or more, whose principle of operation is based on natural forces, without any energy input.

Among the most used configurations, we find: anaerobic lagoon, facultative lagoon, maturation lagoon. Therefore it is a question, on the one hand, of promoting the slow flow of water in successive basins, and on the other hand of relying on a biological association covering an entire food chain (aerobic bacteria, anaerobic bacteria, algae or phytoplankton, zooplankton in some cases. [1].

Natural lagooning has many advantages, among which we can cite:

- The low operating cost, little or no electricity, and the good landscape integration. In addition it is very effective in the elimination of pathogens, nitrogen and phosphorus;
- Lower sludge production (compared to an activated sludge treatment plant); therefore the need for cleaning is infrequent once every 10 years in the first basins and more easily recoverable sludge. [2]
- On the other hand, the disadvantages of natural lagooning are as follows:
- The strong grip on the ground;
- the presence of a high concentration of suspended solids in the discharged water**;**
- Seasonal variations in the quality of purified water;
- In the event of low purification performance, the risk of odors and the development of insects (mosquitoes) is very high. [3].

Due to the low purification performance of natural lagoons, an association of existing lagoons + 2 vertical planted filter floors is used in several cases around the world. Increasing quality requirements for sensitive environments leads to the necessity to development of complementary treatments.

A study in an experimental station in the commune of Aurignac (France) has shown that the introduction of a percolation infiltration system downstream of a lagoon improves the quality of the effluent and respects the level D4: COD≤125mg/l, BOD5≤25 mg/l.[4]

2. Material and Method

To study the quality of treated water in the municipality of Ain Arbaa. we analyzed incoming and outgoing wastewater during the period from January 2021 to May 2021. The physicochemical parameters studied are: pH, biological oxygen demand (BOD5), chemical oxygen demand, total suspended solids (TSS), dissolved oxygen, ammonium (NH_4^+), and electrical conductivity.

2.1. Geographical location of the study area:

The municipality of Ain El Arbaa is located east of the capital of Wilaya de Ain Témouchent, 35 km away, covers an area of 71 km^2. It is delimited:

- to the north by the great Sebkha.
- to the south-west by the municipality of Sidi Boumedienne,
- to the south east by the municipality of Tessala.
- to the east, the commune of Oued Sebbah
- to the west by the commune of hammam Bouhadjar.

The geographical location of Ain El Arbaa is shown in Figure 01.

Figure 01: Geographical location of Ain El Arbaa

2.2. Climate:

In the climatic context we will describe precipitation, temperature, and evaporation. The temperature and precipitation values were recorded in the Hammam Bouhdjar station during the period: 1994-2001.

a. Precipitation:

The rainfall of the region is shown in figure 02.

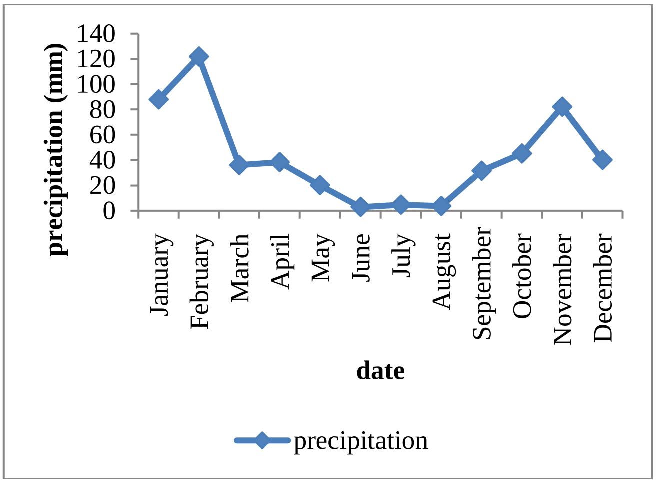

Figure 2: Monthly average rainfall (1994-2001)

From figure 02, we notice that the precipitation has imploring values during the winter season (December, January, February), the maximum value was recorded during the month of January with 120 mm, then the precipitation begins to decrease gradually

during the period: March to August, the minimum value is recorded in August 3.67mm. In September the precipitation begins to have the important values wich are between 31.63 mm in September to 88.25 in November.

b. The temperatures:

The temperatures are shown in Figure 3.

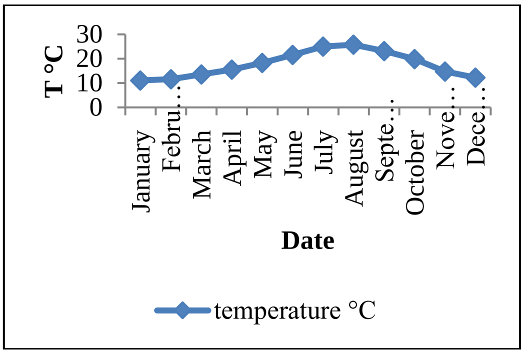

Figure 3: Monthly temperature variation (1994-2001)

From Figure 3, we notice that the minimum temperature is recorded during the month of January (with11.1°C) ,then they begin to increase to record the maximum value during the month of August (with 25.75°C). From September the temperature begins to decrease until December when the value of 12.2 °C is recorded.

c. **Evaporation** :

The maximum evaporation is reached in August (with 165mm) and the minimum in January (with 69.1mm). It is greater than 100 mm for seven months of the year.

2.3. Description of Ain El Arbaa treatment plant:

The lagoon of Ain El Arbaa is composed of:

2.3.1. Pretreatment:

The pre-treatment of the Ain arbaa lagoon consists of a screen with a spacing between the bars: E = 60 mm, and two grit and oil separators

2.3.2. Biological treatment:

The biological treatment consists of two anaerobic basins, two facultative basins and two maturation basins.

3. Results and Discussion

3.1. Results

The results obtained are shown in figures 04, 05, 06, 07. 08, 09, 10, 11.

- **pH :**

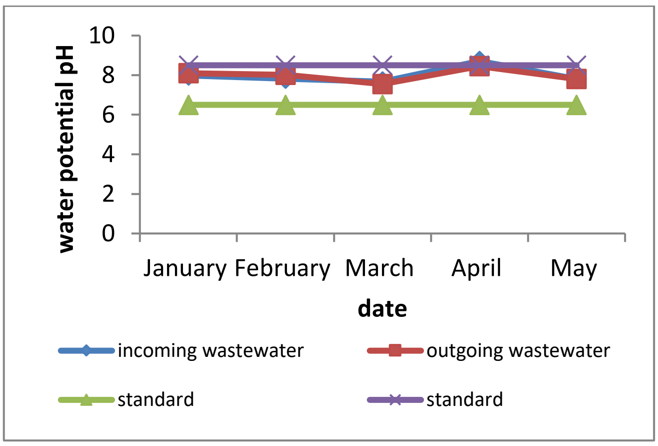

Figure 04: Changes in pH

- **Dissolved Oxygen:**

The dissolved oxygen values are shown in figure 05 in mg/l.

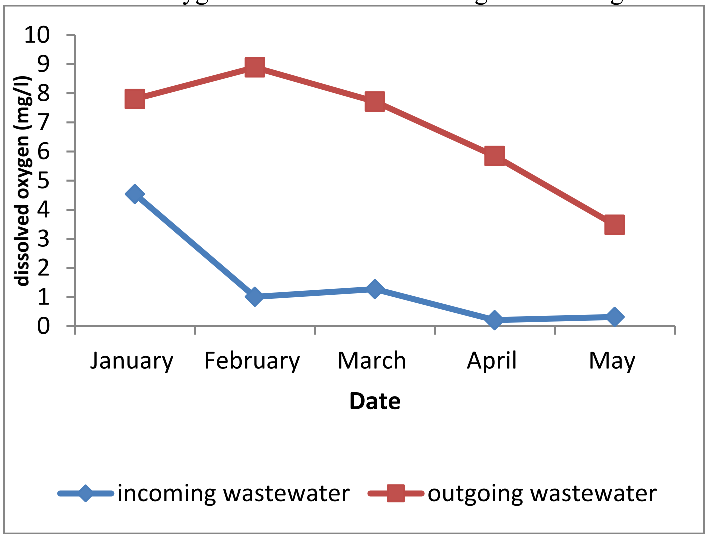

Figure 05: Changes in Dissolved Oxygen

- **Total Suspended solids (TSS):**

The concentrations of incoming and outgoing wastewater in total suspended solids are indicated in figure 06.

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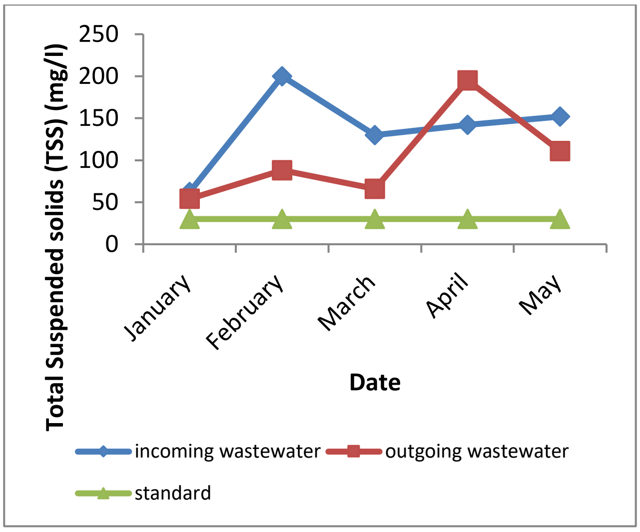

Figure 06 : Changes in TSS concentration

- **The biological oxygen demand (BOD_5):**

The concentrations of incoming and outgoing wastewater in BOD_5 are indicated in figure 07 in mg/l.

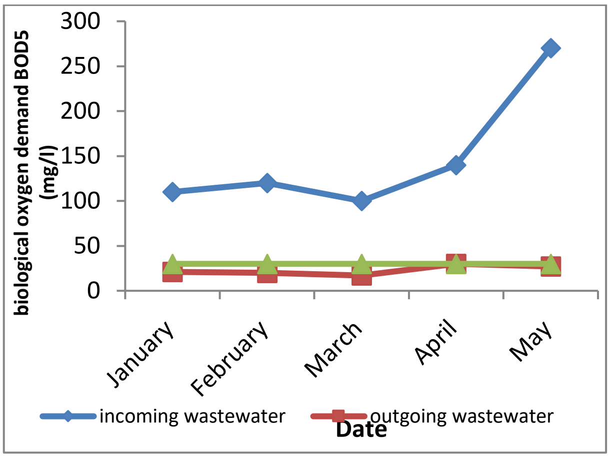

Figure 07: Changes in BOD_5 Concentration

- **The chemical oxygen demand (COD) :**

The concentrations of wastewater entering and leaving the lagoon are shown in figure 08.

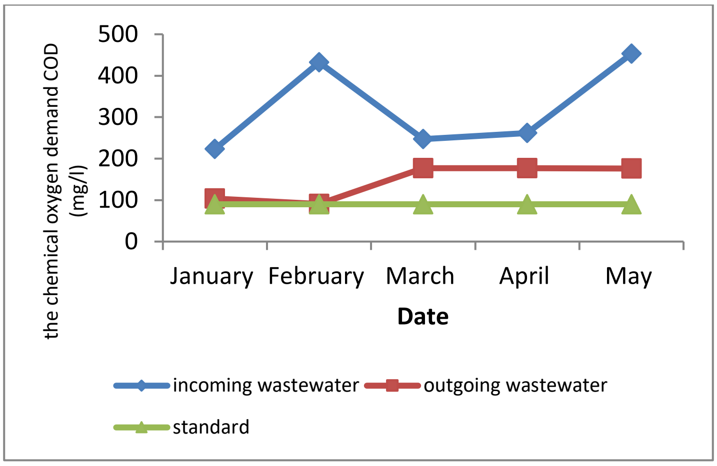

Figure 08: Changes in COD Concenration

- **Ammonium NH_4:**

The NH_4 concentrations of incoming and outgoing wastewater are indicated in figure 09 in mg/l.

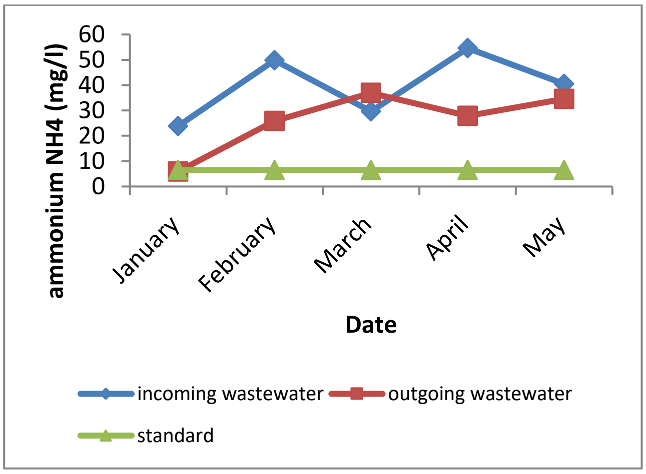

Figure 09: Changes in NH_4

- **Electrical conductivity (EC) :**

Incoming and outgoing wastewater conductivities are shown in Figure 10.

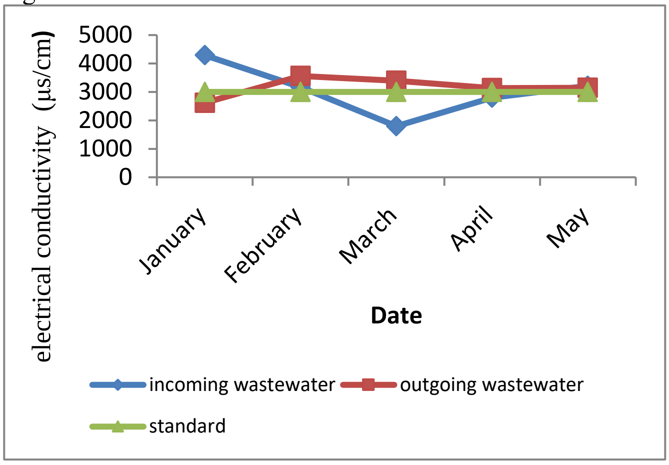

Figure 10: Changes in Electrical conductivity

3.2. Discussion

- **pH:**

From Figure 04, we notice that: the pH graphs of the incoming and outgoing wastewater are almost confused, which leads us to conclude that the pH variation is very small. In addition, the pH values of incoming and outgoing wastewater are located between the values limited by Algerian standards ($6.5 \leq pH \leq 8.5$). So for the pH we can say that the quality of the water purified by this process complies with the standards of agricultural reuse, and with the standards for discharge into the natural environment.

- **Dissolved Oxygen:**

From Figure 05, we see that there is a very good improvement in the level of oxygen saturation in the purified water. This can be justified by the good degradation of organic pollution. This increase in oxygen concentration comes from dissolved oxygen in the atmosphere, without forgetting the additional quantity provided by the operation of photosynthesis by algae.

- **Total Suspended solids (TSS):**

From figure 06, we notice that the concentrations of incoming wastewater are very high, varying between 60 to 200 mg/l. the concentrations of outgoing water are less significant, which means that there is a degradation of suspended solids which varies between low and medium.

The minimum yield of removal of TSS is recorded in January with 12 %, and the maximum yield is 56 % during the month of February. In the lagoon of Ain El Arbaa, we had a low average yield of TSS reduction like all natural lagoons without tertiary treatment around the world.

This high concentration of suspended solids in the purified water can be explained by the quantity of algae remaining in the purified water.

The concentrations of the outgoing wastewater are all above the standard (30 mg/l), so the efficiency of the Ain El Arbaa lagoon is very low in the elimination of suspended solids

- **The biological oxygen demand (BOD_5):**

From Figure 07, we notice that the BOD_5 abatement is significant, such that the minimum yield is 70%, the maximum yield is 90%, and the average yield is 82.8%.

The concentrations of the outgoing wastewater are all below the value limited by the standards for agricultural reuse and the preservation of the natural environment (30 mg/l). So the natural lagoon treatment process is effective in eliminating organic pollution.

- **The chemical oxygen demand (COD) :**

From Figure 08, we notice that the graphs of incoming and outgoing wastewater are not very far from each other, which means that there is an average removal of COD.

The values of the average, minimum and maximum COD abatement yields are as follows: 50.6 %, 28 %, and 79 %.

We also notice that all the concentrations of outgoing water are higher than the value set by the standards for agricultural reuse.

- **Ammonium NH_4:**

We note that there is an average decrease in the concentrations of wastewater in NH_4, but the outgoing values remain above the standard for the preservation of the receiving environment (6.5 mg/l). The average ammonium abatement yield is low 32.51%, the maximum yield is 75.14%, and the minimum yield is -24.33%.

For the standards of agricultural reuse there is no limit value, because this element is considered as fertilizing material.

- **Electrical conductivity (EC) :**

We notice that there is a decrease in conductivity in the months of January and May, and an increase in February, March and April. This increase can be explained by the quantity of salts added by the degradation of organic matter.

The electrical conductivity values of the outgoing water exceeded the maximum value set by the standard for agricultural reuse.

4. Conclusions and Recommendations

From this study, we can conclude that:

Natural lagooning containing two purification channels (pre-treatment and biological treatment) gives satisfactory results for the parameters: pH and BOD_5. On the other hand, the purification is insufficient and the concentrations of purified water are higher than the maximum values fixed by the standards for the parameters : TSS, COD, and conductivity.

For the NH_4 parameter, the results are acceptable for agricultural reuse and unacceptable for discharge into the natural environment.

We recommend to complete the lagooning of Ain El Arbaa with a tertiary treatment ..

5. Acknowledge

- Recycling purified water is a solution for reducing water stress.

- The quality of the purified water of Ain El Arbaa is not adequate with the standards for reuse or with the standards for the preservation of the environment.

- Tertiary treatment is essential and makes it possible to reuse treated water.

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