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New approach: Exploitation of non-conventional water in irrigation

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ABSTRACT

Among the most common problems and currently rocking the world, quoting the reuse of raw wastewater, particularly in agriculture, which consumes more than 80% of water resources exploited. The reuse of untreated wastewater in irrigation for plants provides a source of nutrients that can reduce the purchase of fertilizers and organic materials. But it poses serious risks to health such as untreated sewage is a factor of transmitting pathogens and hazardous chemicals in the human body. The main constraints are then posed about the health risks, adapting the proposed use and the psychological and cultural barriers attached to the water deemed to be dangerous. The main objective of this work is to characterize the urban wastewater of Oran and recommend an appropriate treatment for their future use and reducing their harmfulness to the workplace receptors. Unfortunately uncontrolled industrial activities have created serious pollution of many natural water resources significantly degrade the quality thereof. The physicochemical characterization of wastewater has the support of different treatment plants studied in the watershed revealed that the liquid waste loads are very organic matter in terms of: DBO_5 with average of 146 mg O_2 / l, DCO averaged 300.25 mg O_2 / l pH 7.1, ammonium an average of 23.33 mg / l phosphate an average of 9.86 mg / l a nitrate average of 3.10 mg / l suspended solids averaging 111.06 g / l.

Keywords: Waste water, Pollution, Physico-chemical parameters, Sebkha of Oran, Principal component analysis.

1. INTRODUCTION

Considering that the bulk of the world's water resources are used in agriculture and that demand for food requirements is increasing rapidly, the role of water resources management, through efficient irrigation systems and techniques, has recently assumed greater importance in increasing food production in order to achieve global food security. The efficient use of water resources in agriculture through improving irrigation systems and techniques is, therefore, one of the most urgent needs and prerequisites for sustainable food production, particularly in water-scarce regions.

Water is a scarce resource in arid and semi-arid areas where most of those countries face severe pressures due to limited opportunities for the exploitation of new water resources. These pressures are expected to increase in the face of expanding populations and the increased per capita water use associated with economic development. In addition, with the recognition that climate change is a significant factor in water resource planning, there is a consensus that most of the arid and semiarid regions of the world can expect an increase in water stress. Oran is now among the poorest wilayas in terms of water potential. Its water resources are limited, vulnerable and unevenly distributed in space and time. Moreover, they have suffered of the drought, pollution and mismanagement.

2. MATERIALS AND METHODS

Sampling Stations

For the watershed sebkha of Oran, the resources in conventional waters of the region principally are underground. The hydrographical watershed of the sebkha of Oran is a natural physical entity. This space covering an area of 2 000 km^2. On the administrative plan, it exists three wilayas: Oran, Aïn Temouchent and Sidi Bel Abbes. The urban and industrial effluent at all the watershed of study are evacuated, treated at the level of the stations of treatment or no, are evacuated towards the sebkha itself, that represents the principal collector of the sewage system of waste water and storm water (Figure 1). The wastewater treatment plants that are located on the periphery of the large sebkha of Oran are:

1. Wilaya of Ain Témouchent: a lagoon treatment plant of Hassi El Ghalla, Ain El Arba, and El Amria. (Figure 1)
2. Wilaya of Oran: Wastewater treatment plant to activated mud of El Kerma, Wastewater treatment plant of Misserghin, A lagoon treatment plant of El Kerma, Wastewater treatment plant of Are Senia (Figure 1).

Unfortunately, for all stations only three wastewater treatment plants operate: A lagoon treatment plant of : Hassi El Ghalla, Ain El Arba and wastewater treatment plant to activated mud of El Kerma, the others are in shutdown state., or are downgraded. It is in the context of valorization of treated Waste Water, this non negligible hydrological resource that registers itself this quantitative approach centered essentially on the impact of the reusing of waste waters in agriculture. The study concerns the characterization of these waters, and on their effects on the environment receiver.

Figure 1
Localization of the Wastewater treatment plant.

Geographic context
The Watershed of the Large Sebkha of Oran located in south –west of Oran between 3°14' W - 3°80' W and 39°15' N - 39°66'N. It covers on an area of 1 878 Km^2 of which 298 Km^2 for the Sebkha itself (the lake), that covers itself on 40 Km long and 6 to 13KM wide (Figure 2).

Figure 2
Demarcation of the zone of study

Experimental protocol
Water samples were collected from three sampling stations (Hassi El Ghella, El Kerma and Ain Larbaa) in march 2012. The experimental work was based on the physico-chemical analyses of the polluting parameters carried out at the level of the laboratory LMST (Laboratory Materials Grounds Thermal USTO). These analyses were carried out on removed samples downstream of every Wastewater treatment plant functional established around the sebkha of Oran. The only measured parameter in situ is: pH-meter HANNA instrument HI 9811 as used for pH. To the laboratory, the treatment and the analysis have for object measures it: *suspended matter* (SM), additional parameters (NO_3^-), (NH_4^+) and (PO_4^{-2}) by Spectrometry (Spectrometer Optizen 2120 UV), the chemical oxygen demand (COD) (Photometer WTW – Photolab S6), and the biochemical oxygen demand for five days (BOD_5) (DOB-meter WTW T 606-2/ IS 602). In our investigation the analytical results were compared with Algerian and European Norms.

3. RESULTS AND DISCUSSIONS
The daily range of the parameters measured at the time of sampling after an important pluvial season, are represented on the figure 3.

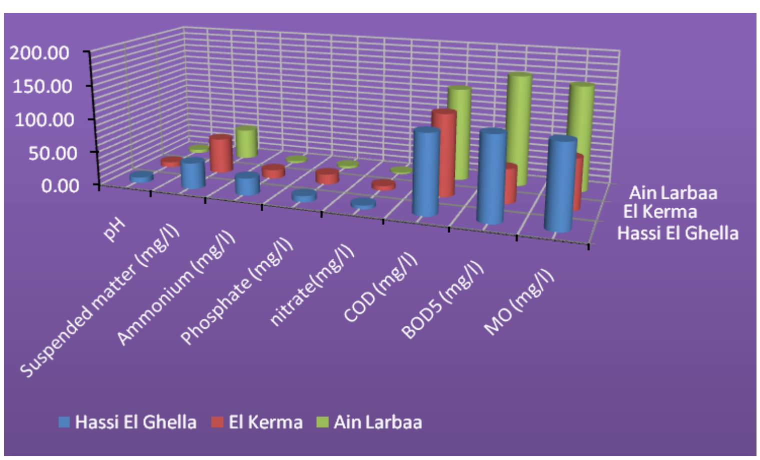

Figure 3
Variation spatio-temporelle of the polluting parameters of the effluents; A lagoon treatment plant: Ain El Arbaa, Hassi El Ghalla. Wastewater treatment plant to activated mud : El Kerma

Criterion physico-chemical

In accordance with the Official Newspaper of the Algerian Republic (23 April 2006) concerning the values limits of the parameters of rejection in an environment receiver, the values limits general of wastewater discharges respectively are (pH : 6,5 à 8,5, BOD_5: 35 mg/l, COD: 120 mg/l, SM : 35 mg/l and PO_4^{-2} : 0_2 mg/l).

According to the examination of the various studied parameters, that their concentrations are variable and being able to attain and surpass the values limits. This is valid for: SM, PO_4^{-2}, COD and BOD_5. In addition, the wealth of these waters in $NH_4^+$and PO_4^{-2}, surpasses, in certain cases, the international norms of reuse of waste waters in agriculture.

The pH conditions a large number of physic-chemical balance and depends on multiples factors, of which: origin of water, agricultural inputs, discharges of the urban areas and industries.

The pH of waste waters varies of 5.1 to 8.4, presents then a slightly basic character to basic (Figure 3). The spatial profile of the pH of the effluents does not present any significant difference of a station to the other, which indicates the systematic absence of spillages strongly acids or alkaline.

Generally, the pH of the studied effluents is relatively stable to the neighborhood of the neutrality as this is the case for most of waste waters domesticate (El Halouani 1990; Hassoune 2006). This is explained in part by the fact that the industries proceed to the neutralization of their discharge before their spillage (Hassoune and al. 2006). The nature limestone of consumer water and a moderate buffer capacity of waste waters there contribute equally to the neutrality of the pH.

The suspended matter record minimal values of 39mg/l at the level of the station Ain El Arbaa and maximum values of 53 mg/l at the level of the station El Kerma (Figure 3). The form of the nitrogen targeted by this study is the mineral form, ammonium (NH_4^+) and nitrate (NO_3^-). The values submitted of nitrates in the zone oscillate between 2.3 and 5.6 mg/l. the lower nitrate wells is due to the fact that the nitrogen, is located under its ammoniacal or organic forms, strongly present in waste waters domesticate, then progressively, the latter oxidize themselves, generating the nitrates (Rodier 1996).

At the level of the three studied stations, the denitrification conditions are met (slowing down or stagnation) to generate the noticed reduction of the values of nitrates. This can explain by the effect of the large dilution after the rainwater influx, which corresponds to the period of the sampling (Figure 3).

The values in nitrates are in lower but they are accompanied of an increase of the ammonium content, a process of reduction of nitrates in nitrites finally in ammonium, probably took places (Figure 3).

Phosphorus was identified as the element key of the eutrophication in waste waters by a large number of researchers (Hutchinson 1957; Doemel and Brooks 1975; Doran 1979; Baroin 1984; Gros 1984; Holmgren 1985; Peirce and al. 1997). The contents vary between 3.66 mg/l for the station Hassi El Ghella and 15.24 mg/l for the station of El Kerma.

The variability of the values of the apply phosphates to explains, spatially, by the additional discharge of the urban area and industrial unities, while temporally, by the due dilution to the water influx from the precipitations during the sampling campaigns.

The biochemical oxygen demand (BOD_5), the chemical oxygen demand (COD) and the oxidizable matters (OM) represent the habitually parameters used indirectly, to describe the organic load of waste water.

The values, recorded during the study period, are between 122.6 mg/l for the station Ain Larbaa and 165 mg/l for the station Hassi El Ghalla for the BOD_5. They are of 116,5 mg/l for the station Ain Larbaa and 139 mg/l for the station Hassi El Ghalla for the COD. The values of the oxidizable matters (OM) vary of 87.87 for the station Ain Larbaa and 112.33 mg/l for the station Hassi El Ghalla (Figure 3). So, the Wastewater are mostly of a domestic nature (COD/ BOD_5 < 2.5), this is indicates that the oxidizable matter (OM) of these waste waters is easily degradable (Bechac and al. 1987). This shows that the contribution of the industrial activities to the evolution of the BOD_5 and the BOD_5 is weak.

The increase of the values of the COD and of BOD_5 recorded particularly at the level of the station of Ain Larbaa and Hassi El Ghalla is due to the additional untreated discharges (septic tanks) and relating to the intense rearing bovine and ovine animals and poultry for the communities that is located in study area.

The increase of the contents in SM, COD and BOD_5 particles of waste waters, meaning a production of more mineral particles during the sample taking.

The maximum value attained in oxidizable matters 12.57 mg/l at the level of the station Ain Larbaa is of 29.25 mg/liters and the minimal value is of 74.76 mg/liters.

Statistical processing of data, statistical processing of physical and chemical data

Data collected were subjected to statistical analysis. The analysis was carried out on 3 individuals (represented the stations), and the 7 variable physic-chemicals (Figure 4). The plan factorial F1 F2 explains about 100% of the variance (69.91% for F1 and 30.09% for F2). The realized principal component analysis (PCA) shows a zonation by group of individuals corresponding to the water qualities.

The axis F1 is considered as the pollution axis, it is positively defined by the 7 grouped variables that are: pH, SM, PO_4^{-2}, NH_4^+ and NO_3^-. The strong contents of these parameters characterize highly mineralized waters rich in organic matter and in nutritious elements (phosphates and ammoniums), the pH guides especially the axis F2, we do not have special observations. The values characterize a lightly alkaline environment increase notably the risk of presence of metals under an ionic form more toxic for weak pH to lightly basic. An industrial influence striking was not observed.

The suspended matter guide the axis F 1, these matters are considered pollution vectors, for many pollutants, notably the heavy metals are absorbed by these particles. The high rate in suspended matter will produce large quantities of muds at the level of the station El Kerma.
The values of nitrates vary little a station to the other. This content have variable average values of a station to the other, due to the mechanisms of the elimination of the nitrogen, allowing thus to characterize every station.

For the phosphates, the concentration not very high in phosphates is essentially due to the use of laundry product and detergents. For the ammoniums, the fluctuations more important are obtained for the ammonium that is the only micro pollutant for which observed us a net difference. There are mainly issues to the decomposition of natural proteins contained in the phytoplankton and the micro-organisms. From the contents point of view, among the three stations of which analyzed us the quality of waters, the station Ain Larbaa is distinguished by higher ammoniums concentrations, which indicates an anthropogenic pollution.

Table 1
Correlation between chemical elements

Correlation	pH	MES	NH_4^+	PO_4^{-2}	NO_3^-	DCO	DBO_5
pH	1,000	-,171	,914	,739	,893	-,998	-,666
MES	-,171	1,000	-,556	,538	,290	,234	-,621
NH_4^+	,914	-,556	1,000	,401	,634	-,938	-,305
PO_4^{-2}	,739	,538	,401	1,000	,963	-,693	-,995
NO_3^-	,893	,290	,634	,963	1,000	-,862	-,930
DCO	-,998	,234	-,938	-,693	-,862	1,000	,616
DBO_5	-,666	-,621	-,305	-,995	-,930	,616	1,000

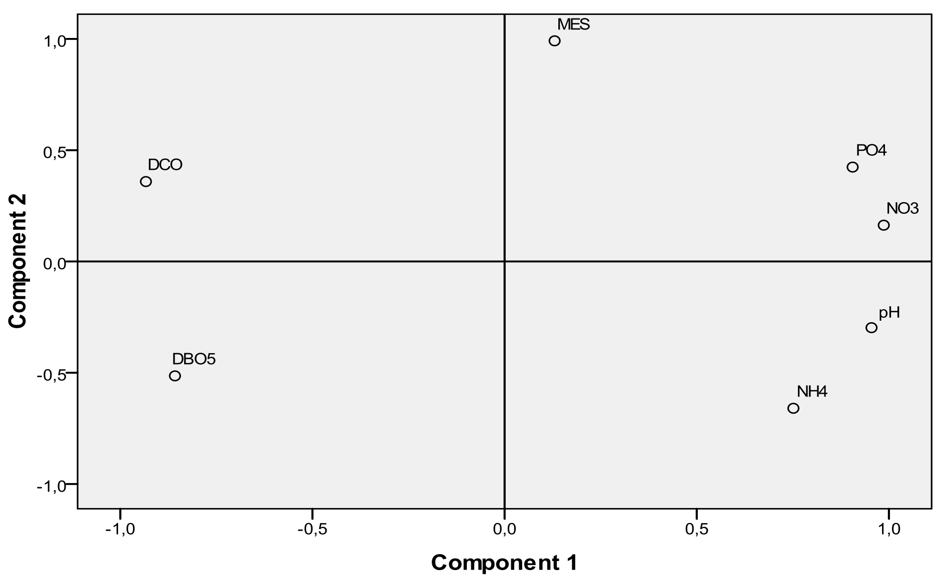

Figure 4
Projection of physico elements in the plan factorial (F1xF2)

4. CONCLUSION

The objective of this study is to highlight the reuse of the wastewater and to evaluate their aptitude to the agricultural irrigation. After taking knowledge with the polluting parameters of the quality of the waters respecting regarding an eventual reuse:

- The effluents do not show any unfavorable effect on surface waters, of which the pH is in the range of 5,5 to 8,5 (Mara 1980; JORA 2006) and to the tolerant cultures of the varying pH of 6,5 to 8,4 (Ayers and Westcot 1994; David and al. 1996). But in the case of waste waters acids because of industrial or accidental discharges, there is then risks degradation of the structure of the ground and the solubilization of the toxic metals for the plant and man (Ashwini A Waoo et al. 2015; Scokart and al. 1983; Ratel and al. 1986; El Halouani 1995).

- The existence of the suspended matter in waste waters in quantity surpassing the norm of 35 mg/l, recommended by the Official Newspaper of Algeria (2006) and 30 mg/l for the World Health Organization WHO (1989) for surface waters does not impede their usage in the irrigation of the cultures. According to Ayers and Westcot (1994), the maximum value permissible can attain 2000 mg/l. The usage of the waters with such loads must be done with precaution to avoid the silting of the porosity of the ground to the harmful consequences on the permeability (Landreau 1987; Ratel and al. 1986; Ayers and Westcot 1994; Faby 2003; CAM 2003). To compensate for to the silting problems, Landreau (1987), proposed to: reduce the rate of the suspended matters by treatment (primary and secondary decantation) and work the ground to assure, at once, the degradation of the organic matter and the ventilation of this last.
- The rate of the suspended matters is widely superior to the norm, therefore the localized irrigation and by sprinkling shall be screened out in order to prevent equipment hydro- agricultural closure.
- The one of the nitrates, are situated in the range of the waters of surface (JORA 2006), and does not surpass in the three studied stations, the admissible value for waters of irrigation (Ayers and Westcot 1994; CAM 2003).
- For the average values of the phosphate surpass the threshold of waters intend for the irrigation that is of 2 mg/l, such as recommended by the WHO and FAO.

This study constitutes the first exhaustive description, but the limited number of sampling sites hardly constitutes an “exhaustive description”; at best, it represents a preliminary study indicating that the waste waters contain relatively high concentrations of *suspended matter*, BOD_5, ammonium, and phosphates to, which can be harmful to water, to the ground and to aquatic life of the environment receiver. The findings of the analysis will prove to be quite informative. The results of the analyses of waste waters reiterate on the necessity of treating the wastewater before being discharged into the environment because the rate of phosphate surpasses the norm and the risk of the contamination of the tablecloth is inevitable. The usage of this new resource of water puts technical problems, sanitary problems and organizational. These problems must be treated with precaution, notably the aspects relating to the control of the quality of water treated. To the current state, the quality of waters does not reply, therefore, to the recommendations of the FAO of the WHO of waters used for irrigation.

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