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The agricultural use of treated effluent from the WWTP of Boumerdes algeria

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RESUME: *OUR STUDY IS BASED ON CHARACTERIZATION PHYSICOCHEMICAL, BACTERIOLOGICAL AND PARASITOLOGICAL OF SECONDARY EFFLUENT OF THE WWPT OF BOUMERDES ; WITH A CAPACITY OF 75,000 PEOPLE EQUIVALENT (EH) AND ON THE OPTIMIZATION OF CONTRIBUTION IN NITROGEN, PHOSPHORUS AND WATER FOR CROP, TO IMPROVE AGRICULTURAL PRODUCTIVITY WITHOUT HARMING THE QUALITY OF RECEPTORS ENVIRONMENTS. THE RESULTS OF ANALYSIS SHOWS THAT POLLUTION PARAMETERS WASTEWATER TREATED HAVE ONE NEUTRAL CHARACTER (PH = 7,55) AND THE MEDIUM MERGER OF TOTAL NITROGEN OF 42,17 MG/L AND OF 13,86 MG/L IN TOTAL PHOSPHORUS, BOD_5 OF 29,52 MG/L, COD OF 48,50 MG/L, MES OF 20,30 MG/L. FOR HEAVY METALS THE AVERAGES CONCENTRATIONS : 0,14 MG/L FOR COPPER; 0,2 MG/L FOR CADMIUM ; 0,02 MG/L FOR NIKLE ; 0,08 MG/L FOR ZN;1,3 MG/L FOR THE CR ;0,009 MG/L FOR SE;0,3 MG/L FOR THE AS;THE CO< 0,2 MG/L; FE < 0,2 MG/L; PB = 0,05 MG/L. THE RESULTS ARE LESS THAN THE VALUES GUIDE AFNOR NFT 90-110, AND NOT PRESENT ANY RESTRICTION AS THEIR AGRICULTURAL USE. THE GLOBAL CONTRIBUTION OF THE WWTP IN NUTRIENT CAN SATISFY THE NEEDS IN NITROGEN OF 1254 HA OF CITRUS CULTURE, OF 1649 HA OF VITICULTURE AND / OR 710 HA OF CULTURES HERBACEOUS. FOR PHOSPHORUS THE WWTP CAN ANSWER THE DEMAND FOR 1 143 HECTARES OF CITRUS, 632 HA OF VITICULTURE AND 446 HA OF CULTURES HERBACEOUS. THESE VALUES OBTAINED ARE INTERESTING FOR AGRICULTURAL VALORIZATION.*

KEYWORDS : *WWTP, USED WATER, NUTRIENTS, IRRIGATION, ENVIRONMENTAL*

I. INTRODUCTION

The treated waste water collected downstream of urban sewerage systems, represents a non-conventional renewable water, which could be an interesting source, to be used in agriculture in the vicinity of urban centers [1]. The idea to promote this resource comes from the producers of this effluent and farmers who are attracted by that low-cost water and his nutrients [2]. Due to the variable nature of its composition (its load in mineral constituents, organic and biological); its realization should be managed and controlled by experts so check the potential risks and threat to soil, irrigated crops and users [3]. Recycling of treated wastewater on a large scale and long term by agriculture requires that specifies the code of good conduct of these projects and the optimization conditions for such practices [4] and [5]. one has to lift all limits of agricultural reuse of water, expanding the range of crops used, adapt irrigation systems to effluent quality and irrigated crop and adjust the inputs

and outputs of fertilizer to crop needs in place order to guarantee the quality objectives of natural environments receptors [6]. Treated wastewater represents a considerable mobile cool water, they contain significant amounts of nutrients (nitrogen, phosphorus and potassium) ranging from 20 to 60 mg / l nitrogen, [7] 6 to 15 mg / l phosphorus and 10 to 40 mg / l for potassium [8]. These nutrients are essential to farmers in the soil compartment, for intensifying their agricultural yield, and undesirable for environmentalists in aquatic compartments, whose excess presence is detrimental to the environment and public health [9] and [10].

Algeria is a semi-arid to arid region, the country suffers from the insufficiency and erratic rainfall, their poor distribution in time and space. Climate constraints, population growth and economic and social transformations are causing a water demand ever growing. Currently, Conventional natural resources approach their quantitative and qualitative limits. The use of non-conventional water becomes an essential alternative and is part of the current strategy of Mobilization all available resources; in order to satisfy global water needs of the population and preserve good quality conventional resources for the more noble uses. The national volume of domestic wastewater discharged is estimated at around 1.2 billion m3 / year, it represents significant amounts, reliable and well located that the country can not be overlooked. The objective of this study is to optimize the agricultural use of urban secondary effluent, by quantifying the flow of inputs and outputs of these, in particular nutrients of nitrogen and phosphorus in agricultural soils, in order not to infringe natural of self purification processes (soil / plant) and respond positively to the request of crops without affecting the receiving environments. We chose to work on the secondary effluent of the WWTP of the city of Boumerdes Algeria.

II. MATERIAL AND METHODS

A. *A. Presentation of the wastewater treatment plant (WWTP) of Boumerdes*

The WWTP Boumerdes is located at the southern boundary of the city of Boumerdes on the left bank of the Oued Tatareg on the road connecting Boumerdes at Corso (Fig.1). It covers a surface of 35 hectares, with a capacity of 75000 EH / ha, designed to protect the receiving environment, namely the Mediterranean Sea.

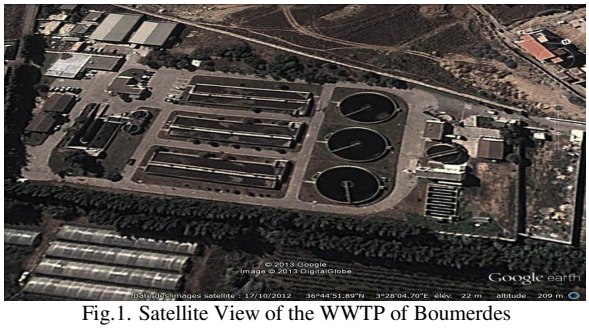

Fig.1. Satellite View of the WWTP of Boumerdes

(Google Earth, 2013).

The general characteristics of the WWTP are shown in Table I.

Table I.

Specifications of WWTP of Boumerdes

Designation	Values
Commissioning	January 2001
Type of treatment	biological treatment with activated sludge at low load
Type of network	unitary
Nature of the raw water	household
population connected	75000 EH / ha
hydraulic load	
Capacity	15.000 (m³/d)
Average flow	26.04 (m3/h)
Dry weather peak flow	1063 (m³/h)
wet weather peak flow	1944 (m³/h)
BOD5	4050 (kg/d)
MES	5250 (Kg/d)

B. *Presentation of the perimeter and cultures irrigated by treated effluent*

The farm has an area of 80 hectares, located 5 kilometers from the WWTP. It has two storage ponds of water with a total capacity of 11 000 m3, the adduction of treated water to storage basins is performed by Conduct of 5000 m the water discharge is provided by three electric pumps of 80 m^3/h each one, placed at the downstream of the chlorination step. The water in storage ponds pass stays up for at least 72 hours to ensure proper clarification and evaporate the residual chlorine.

For intensive and rational agriculture, a localized irrigation is advantageous in terms of saving water. This is the most compatible technology with sustainable agricultural practices that expose the least professional populations and consumers to health risks. The cultures applied are table grapes (40 ha), orange (20 ha), sorghum (15 ha) and alfalfa (5 ha).

C. *Sampling*

The sampling was made at the level of exploitation storage ponds, the samples were taken over a period of

six months from January to June 2013. The sample must be homogeneous, representative and obtained without changing the physical and chemical characteristics of water (dissolved gases, suspended solids, etc.) [11].
For this, the method applied in the Boumerdes WWTP is that of the composite sample following the norm of sampling NF EN25667-1 and 2, it consist to be levied each hour a predetermined volume (at least 200 ml) in glass bottles, all samples should be stored refrigerated. All samples are well mixed to form a composite sample on which the analysis will be performed. This method allows to collect a fraction of all pollutants flowing during the day.

III. RESULTS AND DISCUSSION

For the avoidance of reserves in connection with the physicochemical quality, parasitological and bacteriological, that could limit the valorization of these effluents in agriculture, a comprehensive analysis of these parameters was performed.

• The pollution parameters
The averages of the values of the treated effluent pollution parameters were followed for a period of six months, they are represented in Table II.

Table.II.

Moyennes des valeurs des paramètres de pollution de l'effluent traité

Parameters analyzed	**treated wastewater**		
	average values	***Repetition***	***Gap - types***
pH	7,55	24	1,20
Temperature (° C)	21,12	24	1,11
Turbidity (FTU)	14,44	24	8,09
MES (mg / l)	20,30	24	7,14
COD (mg O2 / l)	48,50	24	5,95
BOD5 (mg O2 / l)	29,52	24	3,60
N-NH4 + (mg / l)	7,18	24	11,33
N-NO 2 (mg / l)	1,12	24	0,14
N-NO3 (mg / l)	25,29	24	2,93
N total (mg / l)	42.17	24	5,08
total P (mg / l)	13.86	24	4,15

In general the pH of the effluent is studied relatively stable in the vicinity of neutrality, temperature values are within the range favorable for biological activity(≤ 30°C) This promotes biological wastewater treatment therefore has no limit agricultural of use. Suspended matter recorded at output is low (20 mg /l).
The average value of the COD is of 48,50 mg/l this reduction is due to the degradation of organic matter and oxidation of minerals. These values are within the standards laid down at 90 mg / l. The average value of BOD is 29 mg / l, lower the discharge standards of 30 mg / l. They Indicate the efficiency of the biological treatment of the WWTP.

• The crop needs in terms of water, nitrogen, and phosphorus
Nitrogen requirements and phosphorus crop for intensive agriculture are defined in Table III, calculated on the basis of the average potential soil fertility in place.
Besides the annual water deficit calculated over a period of 23 from where the necessity of artificial water supply obligation for this shortfall which is 800 mm / year, (8000 m^3/ha) [12].

Table III.

Nitrogen requirements and phosphorus crop in Boumerdes

species	Nitrogen (kg / ha / year)	Phosphorus (kg / ha / year)
Citrus	***184***	***53***
vineyards	***140***	***120***
herbaceous crops	***325***	***170***

Estimate of the contributions of Nitrogen and phosphorus of the WWTP
A. Estimate of the Nitrogen contributions of the STEP

The nitrogen is in organic form in the secondary effluent, its average concentration is about 42.17 mg/l, we deduce the annual total organic nitrogen contribution from the station which rises with 230.88 tons of nitrogen. This quantity can satisfy the needs for 1254 hectares citrus fruit cultivation, of 1649 hectares viticulture and/or 710 hectares herbaceous cultures.

B. Estimate of the phosphorus contributions of the STEP

The organic phosphorus contribution is done by a slow mineralisation which makes it gradually available for the plants; in our effluent the organic shape of phosphorus is dominant, this last will be able to be the object of an agricultural valorization. While referring to the characteristics of the effluent of exit of the sewage treatment plant of Boumerdes, enumerated in table II, the concentration of the phosphorus which is about 13.86 mg/l, makes an annual office plurality of 75.88 tonnes/year. This quantity can also satisfy the needs for 1431 hectares citrus fruit cultivation, of 632 hectares viticulture and/or 446 hectares herbaceous cultures.
To balance these rates of contributions of this water station, out of nitrogen and phosphorus of the specific treatments to correct these variations must be under consideration with the upstream or the downstream of the process of purification, if not of the additional contributions or dilutions must be carried out.

C. Estimate of the contributions out of water of the STEP
Calculations are carried out on the basis of population connected to the network of cleansing to knowing

75,000 HEY and with daily rejections of about liter/inhabitant [13]. Daily volume will be of 15000 m3 with an annual total of 5 475000 m3. The irrigable surface is of:
- 1291 hectares for the vine with a farming coefficient of 0.53;
- 1006 hectares for the orange tree with a farming coefficient of 0.68;

- 900 hectares for the herbaceous cultures with a farming coefficient of 0.76. With 8,000 m3 of water per hectare and a year, we can have 337 kg/ha/year of nitrogen and 110 kg/hab/year of phosphorus. Calculations to come are carried out on the basis of agricultural deficit of the cultures in places, their needs as regards nutrients and for the annual nitrogen flow and phosphorus present in the secondary effluent.

- Heavy metals

The analyses of heavy metals were carried out on purified water of the STEP by the spectrophotometric method with atomic absorption, the values guides are taken again Algerian official journal [12]. The results are presented in table IV.

Table IV.
Analyses of heavy metals

Metals	Concentrations	Units	Values guides in mg/l
Cu	***0,14***	***µg/l***	***5***
Cd	***0,2***	***µg/l***	***0,05***
Ni	***0,02***	***mg/l***	***2***
Zi	***0,08***	***mg/l***	***10***
Cr	***1,3***	***µg/l***	***1***
Se	***0,009***	***mg/l***	***0,02***
As	***0,3***	***mg/l***	***2***
Co	***< 0,2***	***mg/l***	***5***
Fe	***< 0,2***	***mg/l***	***20***
Pb	***0,05***	***mg/l***	***10***

The concentrations in metal elements traces (mercury, Nickel, zinc, selenium, arsenic, cobalt, iron, manganese, lead and copper, chromium and cadmium) remain weak, lower than the values guides recommended by the Algerian legislation and do not present any operational limit of this water in irrigation; thus their use is without risk for the ground, the cultures and the consumers with short and long-term.

- Parameters parasitologic

The parasitologic analysis was carried out over one three months period (July June, August) which correspond to the period of irrigation. The analysis specifically related to water of exit of the STEP and the basins of the exploitation, it aims at the description of eggs of helminths, whipped and of cryptosporodium. The results are recorded in table V.

Table V.
Parasitologic analyses

Parasites	***Effluent treated (left STEP)***	***Basins of Storage***
Whipped	**+**	**-**
Helminths (Nematodes)	**-**	**-**
Cryptosporodium	**-**	**-**

we note the complete lack of eggs of helminths and cryptosporodium in the analyzed samples and the presence of whipped on the level of the treated effluent of the STEP; the latter were eliminated by sedimentation after the residence time applied in the basins from storage.
The aspect parasitologic of waste waters must be the object of a special attention to eggs of helminths (the intestinal nematodes: Ascaris, Trichuris, Ankylostoma) before any project of re-use or agricultural valorization of waste waters. Their presence is a principal constraint or limit of their recycling in agriculture because of their low dose infecting and their long survival in the environment. One can say that the studied effluent meets the standard required by the Algerian and international legislation concerning water of irrigation.

- Bacteriological parameters

The bacteriological analyses were carried out according to the method of quantification semi-automated fast for the research and the enumeration of the fecal bacteria coliforms; the value guide is also taken again Algerian official journal [12].The got results are 14 small wells and 24 large wells what corresponds to 52 UFC /100ml according to the table of NPP. These results are acceptable and does not present any bacteriological limit when to an agricultural re-use; the value guides Algerian legislation relating to the fecal coliforms is of 100 UFC/100 ml.

IV. **CONCLUSION**

Algeria regarded as being a sensitive hydro country, must update itself in the field of the re-use of treated wastewaters and initially envisage perimeters irrigated in the vicinity of the great urban areas. The use of manures in agriculture and more specifically the nitrogen, phosphorus and potassium were traditionally considered in a context of profitability and ideal efficiency.
Today, it is necessary to go obviously, that it is necessary to adapt these traditional practices and as well

as possible to harmonize them with the environmental factor.

The studied parameters of pollution show that treated water is in conformity with the standards and do not present any danger to their agricultural re-uses.

The contributions of the STEP of Boumerdes correspond to an annual total of 5,475,000 m 3 water which may undergo beneficiation, with a flow of 230 tons organic nitrogen and 75.65 tons of organic phosphorus. For this same area whose annual hydrous deficit is of 800 mm/ha/an, corresponding to 8000 m3 of water per hectare and a year, one can have a flow of 337 kg/ha/ an of nitrogen and 110 kg/ha/ an of phosphorus. These averages relating to water rates of participation are of 1291 hectares for the vine; of 1006 hectares for the orange tree and 900 hectares for the herbaceous cultures. For nitrogen these averages are of 1254 hectares citrus fruit cultivation, of 1649 hectares viticulture and/or 710 hectares herbaceous cultures. For phosphorus, the rate of participation of the STEP is of 1431 hectares for the citrus fruit cultivation of 632 hectares for the viticulture and 446 hectares for the herbaceous cultures. In addition, this way of proceeding also brings: réutilisation agricole ; la valeur guide de la législation algérienne relative aux coliformes fécaux est de 100 UFC/100 ml.

- A water supplement;
- An organic fertilization with progressive mineralization;
- An Improvement of the physicochemical properties and textures of the grounds;
- A cost cutting of tertiary treatments in STEP;
- A protection of the receiving natural environments;
- A saving of the pure resources, good quality for the nobler needs;
- A development of an urban periphery agriculture;
- Economic consequences for the farmers.

The recycling of treated waste waters can have an extraordinary effect for agriculture of the area, for that we make a point of making the normative and administrative recommendations following:

- to consolidate the knowledge and the experiences gained on the re-use in all the areas of the world;
- To provide agricultural advices of good practices in an approach of management integrated of an efficient re-use;
- To carry out analysis campaigns of the biological and physicochemical characteristics of these effluents;
- To ensure a chain breakage of the transmissions of the health risks, as well as an economy of water, one recommends the use of the localized irrigation;
- To generalize the infrastructures of ponding purified, like equipment of accompaniment of the stations (the lagunage); and perimeters irrigated in the vicinity of the sewage treatment plants, in order to facilitate the routing of this water.

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