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The releases of wastewater in the Oued Righ valley: the palm groves in decline

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ABSTRACT

The Oued Righ valley located in the south-east of Algeria consists of 50 palm groves containing 2 million palm trees. The drainage flows in a traditional canal 136 km to discharge into downstream in depressions. However, the rate of urban waste in the canal increased for over the past 20 years. The physico-chemical analyses of the canal waters showed that the quality of the water is poor. With the absence of a sewage network and poor quality of water in the canal network, the waters are polluted groundwater. This new situation has caused the death of more than 50% of the palm trees.

Keywords: Channel; Oued Righ; Palm grove; Wastewater

1. Introduction

The increase in the points of wastewater discharges and drainage in the Oued Righ canal has caused upwelling in several oases which resulted in asphyxiation of hundreds of palm groves. The wastewater discharge is found at several points, in an anarchic way. Some points are near the palms. A portion of the wastewater has no pre-treatment, joins the main and can be mixed with water drainage. The channel has an average channeled rate of about 5 m^3/s or over 150 million m^3/year.

The absence of an effective drainage system has had a negative impact on both the ecological and economical plane. Large areas with high agricultural potential including the palm Oued Righ is now threatened by the rising water table. This has resulted in the flooding of many palm groves and degradation of thousands of palm trees by asphyxiation (Fig. 1). The majority of palm groves are located near Sebkhas which are superficial aquifers and salt does not exceed the depth of 1 m 50. For example, the palms of Tinedla, Gama'a and Ferdjaounne El Goug are flooded every winter. The rise in the water table causes the accumulation of harmful whitish salt crust at the surface due to evapotranspiration salts (Fig. 2). The salinity of the groundwater of Oued Righ varies from 6 to 7 g/L [1].

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Fig. 1. View of degradation of palm in Oued Righ.

Fig. 3. View of a point of sewage discharge in Oued Righ.

To contribute to the resolution of these problems, we set the objective of water analysis in various discharge points in the collecting channel communicating with groundwater. This channel has become an outlet where is discharged water drainage and untreated wastewater from the surrounding neighborhoods (Fig. 3). The salinity of the water is expected but it should not exceed the value of 8–9 g/L.

2. Location of the Oued Righ valley and presentation of channel

The Oued Righ valley is a geographical entity located on the road Biskra–Ouargla and is 150 km in length (Fig. 4). The Oued Righ valley closes 50 palm groves whose drainage flows to the main collector (channel) with a length of 136 km. The channel has an average channeled rate of about $5\,m^3/s$ or over 150 million m^3/year [2]. The main agriculture of the Oued Righ valley is the palm tree. More than 2 million date palms exist in the valley of Oued Righ of which 60% is the Deglet Nour [3].

Three rounds of sampling water were performed during the period 2009–2010 on nine stations flowing into the channel on a stretch of about 30 km. The waters of groundwater were collected from the piezometers in five stations from the station to Sidi Slimane Kerdeche over a distance of 46 km. The samples were taken manually using numbered plastic bottles. The objective of the study of spatio-temporal variation of water composition of the water and the canal is to

Fig. 2. View of salt deposits in a section of Oued Righ.

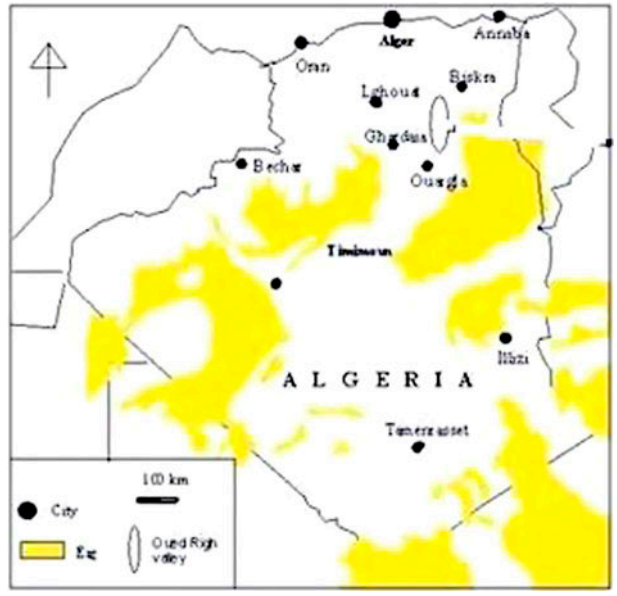

Fig. 4. Location of the valley of Oued Righ.

determine a possible communication between the two. The impact of mixed water on growth in the date palmwill be the subject of this study. The roots of the palm are of varying depths from 30 to 150 cm and the height of the water does not exceed 150 cm.

3. Results and discussion

3.1. Process of pollution of groundwater in the valley of Oued Righ

The Oued Righ valley is powered by three superimposed aquifers: the water table, the Complex Terminal aquifer and the Continental Intercalary aquifer. Since the 50s, the exploitation of deep aquifers: the Complex Terminal and the Continental Intercalary increased daily discharges for irrigation and domestic purposes. This situation has created an increase in releases of drainage water and wastewater. Fortunately the Oued Righ valley has a traditional channel with a length of 136 km, which evacuates the water (estimated at 5 m^3/s) to depression of Chott Melghir. The channel is considered the lungs of the Oued Righ valley, as it is expected to save the whole region of the rising level of groundwater. However, the existence of septic tanks and infiltration of water from the canal caused the pollution of groundwater. The diagram in Fig. 5 describes the process of contamination of groundwater.

3.2. Study of physico-chemical parameters and pollution in the canal Oued Righ

The canal is subjected to seasonal variations. The results show an evolution over time of the physico-chemical properties of the waters of the canal. The concept of temperature has a very important role and should be taken into account when attempting to perform analyses, generally varying from 12°C in winter to 38°C in summer, with an annual average of 22.5°C.

The pH of the water channel varies from 7.3 to 8.3. Most of the waters of the canal have been of particularly bicarbonate alkalinity (Table 1).

The conductivity shows that all the measured values indicate a very high mineralization. We see that this conductivity ranges from 1,500 to 26,300 mmhos/cm, however, it is very high in May and October at the station St1 (Station Kerdeche upstream from the canal) and station St9 (Station Zaouia el Abidia out let Touggourt after discharge). The lowest values were recorded during floods (February). Exceptional water, strictly utilizable for irrigation gravel with finely drainage and for the cultivation exceptionally to endure salt [4].

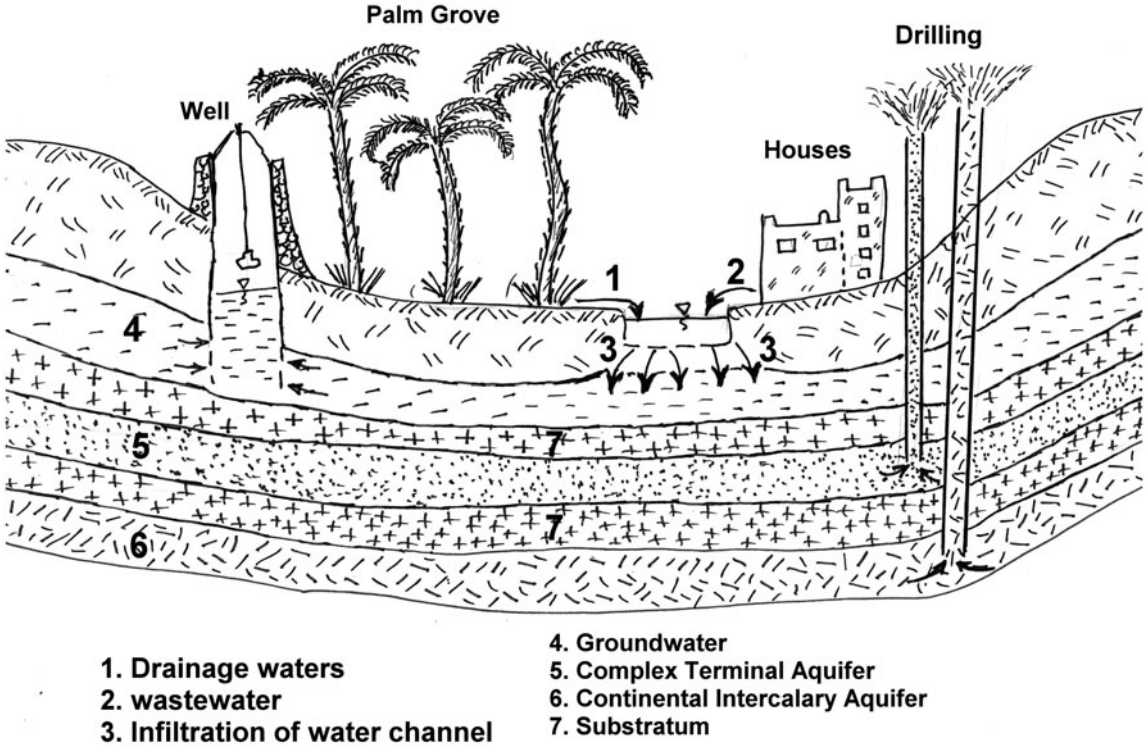

Fig. 5. Schematic diagram of the process of groundwater of the valley of Oued Righ.

The total hardness (TH) measures the hardness of the water, the values of TH vary from 73 to 368˚f in February, and its content increase from 344 to 582˚f in October (Table 1).

The complete title alkalinity (TAC) varies from 17˚f in station St6 (Station Aïssou urbain environment of Touggourt) to 34˚f in station St1. The TH and the TAC confirm the high hardness of the canal water.

3.3. Study of the spatial and temporal variation in dosage element and salt balance

The salinity of the canal waters is very high hence the sodium (Na), which is very important, contributes directly to the total salinity of the canal. The increase of Na in water makes it more difficult to absorb minerals by the plant, giving palm trees root burns and leaf burns, so it is possible that the accumulation of Na is associated with a reduction in the accumulation of other cations as to create a cationic negative balance (antagonist) [5].

Calcium (Ca) and magnesium (Mg) are recognized as toxic when they accumulate in high concentrations in saline soil.

The rate of chloride in the channel is very high, chloride give a toxic effect and cause a signification reduction in plant growth resulted in burning leaves, it does not even be reducing production, but also size fruit [6].

The sulfates may be subjected to the inhibitory effect on the growth disturbance of the cationic balance in the plant. We note the high values in the channel.

The bicarbonates are very important at the station (St1), (St5) (Station Rannou), and (St7) (side of STEP, upstream discharge) and in May, the deposited bicarbonate can produce little symptoms of chlorosis by acting on the mineral nutrition of the tree. In conclusion, the majority of the canal water are concentrated with Na^+ and Cl^-. SO_4^{2-} ions are higher than the Ca^{2+}. The majority of water is relatively more concentrated in Cl^- than in SO_4^{2-} (Fig. 6). Saharan climate is characterized by a rainfall range of 20–150 mm/year and an aridity index of 4.6–5 corresponding to the type of arid climate. The combined action of a climate is characterized by the intense evapotranspiration and the presence of shallow groundwater where most soils undergo the phenomenon of secondary salinization.

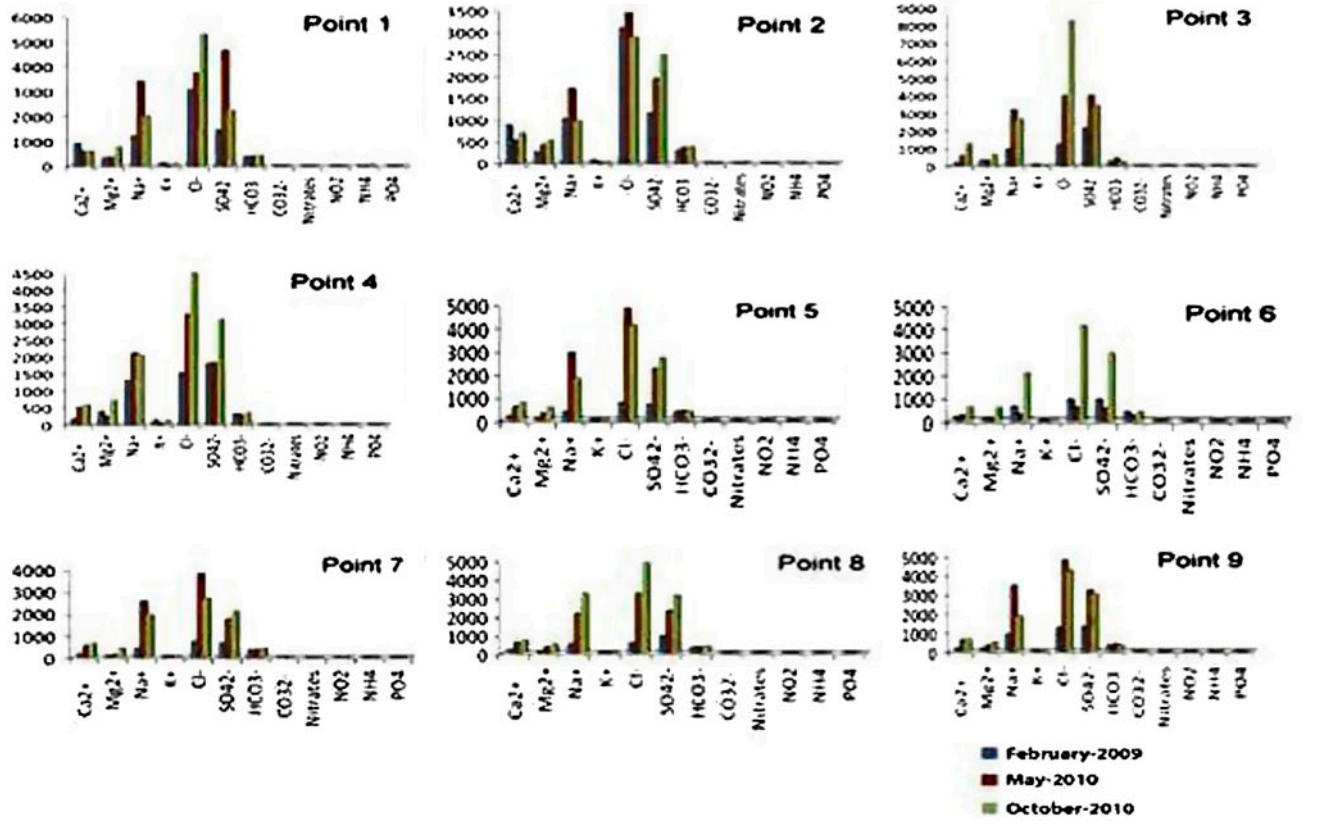

Fig. 6. Evolution of different chemical parameters of the canal waters of Oued Righ valley [7].

Table 1
Water quality of Oued Righ canal

PH	7.3–8.3
C.E (ms/cm)	1,500–26,300
TH (°f) – February	73–368
TH (°f) – October	344–582
TAC (°f)	17–34

The type of salinity is calcium sulfate or magnesium and average sodium and chloride concentration in general.

3.4. Water quality of the groundwater

Ground waters have a high rate of (Na) above the station St.12 (Sidi Slimane station located near the channel). In other stations, the values of (Na) are lower than those of the canal water (Figs. 7 and 8).

3.5. Water-soil relationship

The canal waters have a very high risk alkalizing with a sodium adsorption ratio (SAR) between 20 and 160. The highest values were obtained in May (Fig. 9). However, the limits for a strongly sodic waters are between $26 < SAR < 100$. So, the canal can be classified as S4 class. Water is strongly sodium [4].

The calculation of the SAR of water leads to the estimation of exchangeable sodium percentage (ESP). For our water, the values of ESP oscillate between 31.5 and 70.6. The percentage sodium (Na%) varies between 44.17 and 79. The maximum was recorded in May.

The total dissolved salts have very high values up to the value of 20 kg/L reflecting a strong accumulation of salt. This can affect the growth of palms, because the dates have been set in this area with bad

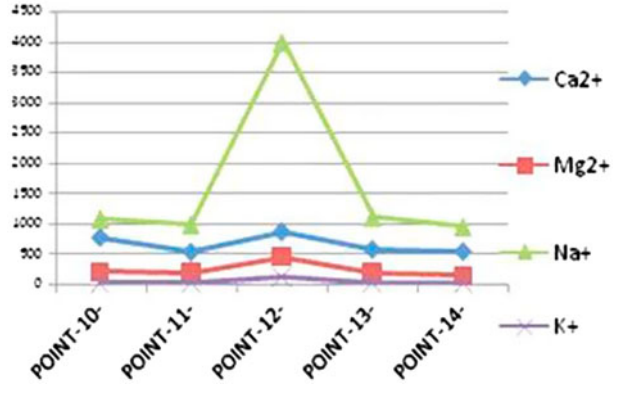

Fig. 7. Evolution of spatial-temporal water cations of Oued Righ region water table (October 2010) [7].

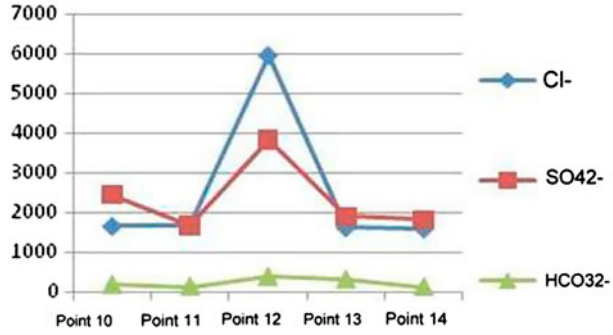

Fig. 8. Evolution of spatial-temporal water anions of Oued Righ region water table (October 2010) [7].

and very salty and polluted water. Only a few palm trees can survive a level of 2,500 ppm [8]. In our study, the values obtained may exceed these standards, where there is a decline in palms.

The high salt content in the water increases the osmotic pressure (OP) in the soil solution. In this region the texture of soil is sandy nature. This causes a concomitant decrease in the water available for the palm trees. The OP of cellular fluids tends to reach relatively high values [9]. Halophytes in the OP can exceed 40 atm in the roots [10]. In our work the values of OP shown in (Fig. 10) are relatively high at (St.1) (in May) reaching 94.68 atm values that reflect a net decrease in the growth of palm trees in this areas. The values of SAR and OP of the phréatic table are shown in (Fig. 11). We can observe that they are relatively high at the station St12 (Station Sidi Slimane).

The more there is salt in the water, the less it can penetrate into the plant. The ions of some salts can be toxic to the embryo palm. The date palm is one of the most salt-tolerant plants [11].

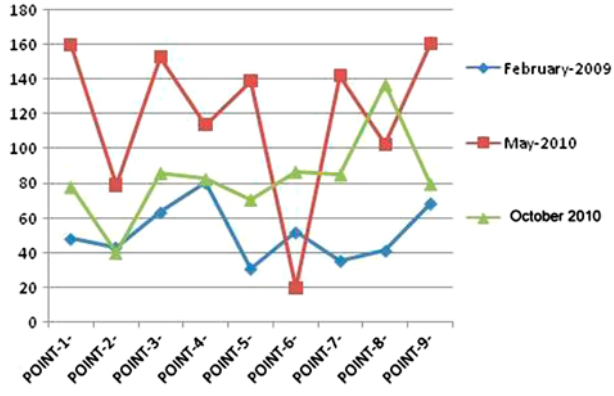

Fig. 9. Spatial-temporal evolution of different parameters (SAR) connecting to the soil and water of Oued Righ canal waters.

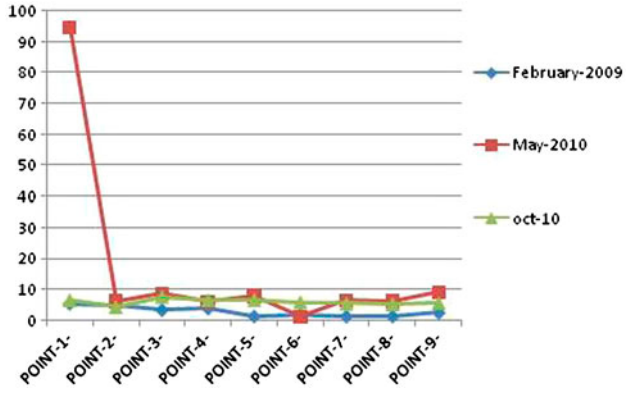

Fig. 10. Spatial-temporal evolution of different parameters (PO) connecting to the soil and water of wadi Righ canal waters.

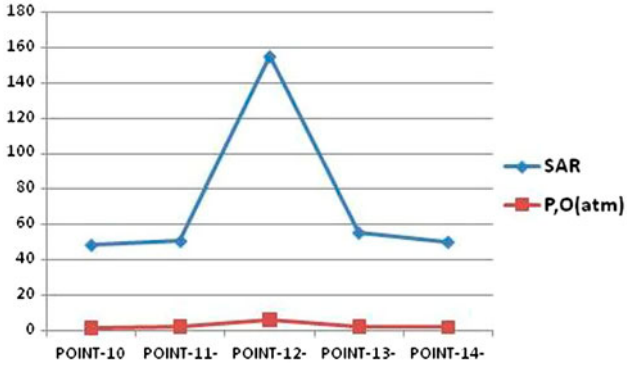

Fig. 11. Evolution of different parameters connecting to the soil and water table of Oued Righ region (October 2010).

4. Conclusion

In order to determine the influence of discharges into the channel on the degradation of palm of Oued Righ valley, a study of physico-chemical parameters of water in the aquifer and the canal waters was followed. The results show that the canal waters are of fairly degraded quality.

The presence of salts in the canal contaminates groundwater and this degrades the palm. The type of salinity is calcium sulfate or magnesium and average sodium and chloride concentration in general. In fact, the salinity is very high resulting in an unfavorable date palm OP. This gives small fruits with a very slow growth. In some places, we see the accelerated decline of palms.

The waters of the aquifer are characterized by less pollution than the station (St.12). This is a crop located near the collector channel station, which is as a result of the contamination of groundwater by the canal. The climate of the region is characterized by intense evapotranspiration. Due to the presence of shallow groundwater, soils undergo secondary salinization. The fight against the degradation of palm must:

(1) Provide for the installation of a sewage treatment plant in aerated lagoons. The wastewater should undergo treatment before being returned to the main channel.
(2) Increase the frequency of irrigation in order to increase the water supply to the plant for leaching.
(3) Master the exploitation of deep groundwater to prevent the rise of groundwater.

References

[1] A. Djennane, Certified report situation of the Algerian oasis south zone. National office of the date (Algeria) Mediterranean option, (1990), Ser. A/n°11-The oasis agricultural system, p. 30.
[2] A. Khadraoui, Soil and agricultural hydraulics in the Algerian Oasis Characterization-Constraints and proposals for the development. EMPAC (Algeria) Editions, 2005, 324p.
[3] E.M. Messar, Algerian phoenicol sector. Situation and prospect on the horizon, Direction of Agricultural Service, 30000 Ouargla, Algeria, 2010, p. 23.
[4] E. Braudeau, M. Hachicha, Irrigation project in the lower valley of the Medjerda and Ras Jebel. Guide for monitoring water salinity and soil. Bull. Manage. Soils Tunisia, (Orstom-Inrgref) n° 18, 1998, 247p.
[5] E.I. Ratner, The influence of exchangeable sodium in the soil on its properties as a medium for plant growth, Soil Sci. 40 (1935) 459–471.
[6] H.E. Hayward, Program of the arid zone-plant growth in saline middle, Reverside, California, United States, May, UNESCO/N/AZ/81, Paris, 1952.
[7] S. Laradj, B. Remini, Impact of urban and drainage discharges in Oued Righ canal on the date palm heritage degradation. Arabian J. Sci. Eng. (2013).
[8] UNESCO, Use of saline waters, Proceedings of Research on Arid, NS.56 III, 5 F. 1957.
[9] M.S. Adriani, Research on community ecology of some associations' halophilic Mediterranean, Proceeding of International Seminar Geobotanical Mediterranean and Alpine, Montpellier, 1934, pp. 9–31.
[10] C.H. Killian, A. Faubel, Observation on the osmotic pressure of plants and sub-arid Algeria's, Bot. Soc. Fr. 80(9–10) (1933) 175–178.
[11] O.C. Magistrad, R.F. Reitemeir, Soil solution concentrations at the wilting point and their correlation with plant growth, Soil Sci. 55 (1943) 351–360.