WATER POLLUTION IN SOUF - ALGERIAN SAHARA-

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Abstract

In Souf, the bad management of waters provoked two important problems: the ascent and the pollution of waters. These two problems caused an ecological unbalance and the negative environmental impacts. In order to solve these environmental problems, some best technical solutions have been adopted: purification of waters by a aired lagoon for one time in 5 days to 10 days in order to preserve the public health and the integrity of the receiving environment, deletion of the nuisances and the present risks of contamination to the level of the urbanized zones, drainage and evacuation of treated waters without negative impact on the environment, preservation of water resources while reusing and valorizing the treated waters.

Keywords: Environment, Pollution, Groundwater rise, Souf, Sahara, Algeria.

I. Introduction

The northern Algerian Sahara is characterized by an aquifer system composed of two major deep aquifers (Figure 1), which are the Continental Intercalary (CI) and the Complex Terminal (CT) extend over areas respectively 700,000 km² (thickness can reach 1000 m) and 350 000 km^2 (the aquifer depth varies between 100 and 500 m), the theoretical reserves of these aquifers are estimated at nearly 60 000 billion m^3 (Khadraoui, 2006).

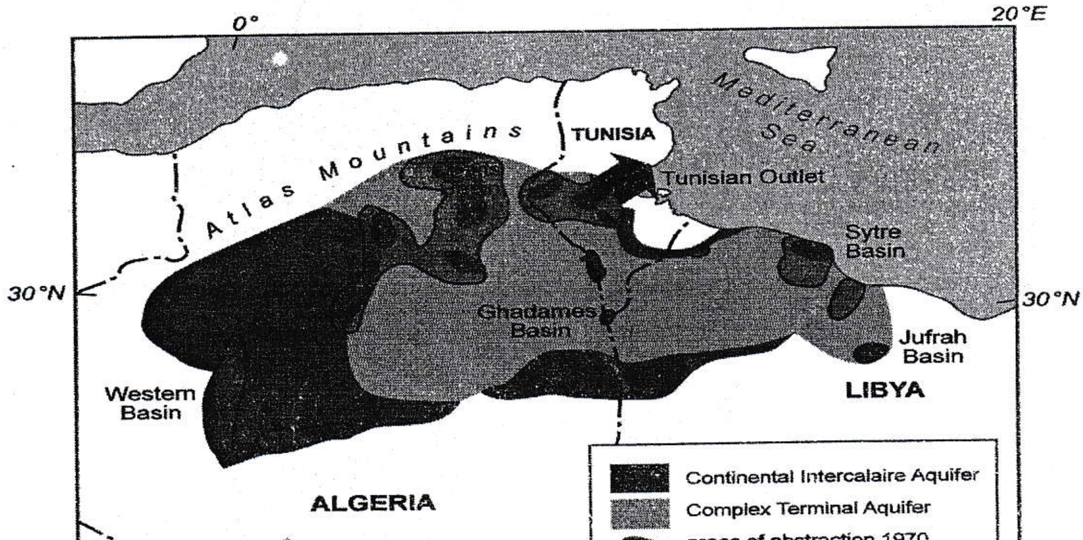

Figure1. The North-West Sahara Aquifer System (UNESCO, 2006).

The Souf region called as El-Oued is part of the northern Algerian Sahara is characterized by the availability of mobilized water reserve divided into three distinct aquifers: groundwater, Terminal Complex and Complex Intercalary. The volume consumed by the region was 393 Hm^3/year, the samples were 89 Hm^3/year and the water availability was 229 Hm^3/year (Khadraoui, 2006).

II. The problem of the Groundwater rise in Souf

Much has been written about the problem of groundwater rise in Souf which is attributed to the increased use of drillings for irrigation and drinking water consumption. In 1950, waters intended for human, animal consumption and for agriculture came from groundwater. The increase in population and expansion of crops has resulted in overexploitation of the aquifers (Meziani *and al*, 2013). In the other hand, wastefulness of waters and leaks in networks of drinking water have made the region in very alarming situation. However, the important number of septic tanks and absence of sewerage network and also outlet caused the pollution of the water aquifers. We can summarize the problem of groundwater rise problem in 4 steps:

- ✓ 1950: well reaching the groundwater table and use of septic tanks
- ✓ 1970: Intense water withdrawals of the terminal complex aquifer followed by the rise of waters
- ✓ 1980: Emergence of groundwater table: Beginning of the problem.
- ✓ 1990: Water withdrawals of the continental intercalary and absence of outlet.

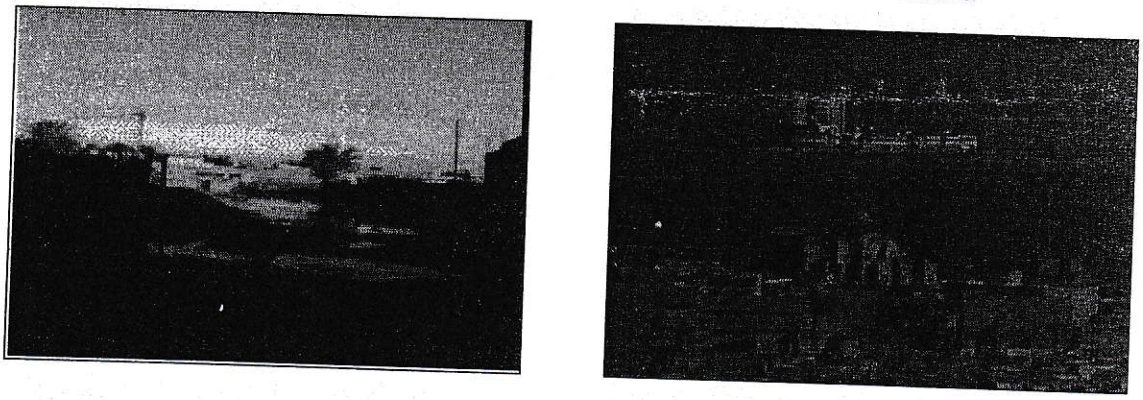

Figure 2. Photos of the groundwater rise in Souf.

III. Impact of the groundwater rise on the environment

The phenomenon of upwelling groundwater is a major problem experienced in many parts of the Algerian Sahara. This problem is becoming increasingly serous particularly in El Oued and Ouargla areas. As example, in the region of El-Oued, the inhabitants live mainly from farming and the cultivation of dates. This culture is now threatened by the problem of groundwater upwelling whose result is directly reflected in the groves crops. The statistics shows that thousands of palm trees die each year from asphyxia (Ouali and al, 2011), The groundwater rise and the continual degradation of the groundwater quality constituted serious problems and still one of the handicaps for Sustainable Development (Chebbah, 2008). The groundwater table is mainly supplied by the used waters (irrigation water, industrial and domestic water) and the absolute sources of these waters are the deep aquifers, followed by the appearance of water-borne diseases. In the other hand, the problem of soil salinity is also appeared and accompanied by the proliferation of reeds in drains and pits. These areas constituted refuges for wild boar that eventually damage the cultivated area. We note that the absence of outlet and disposal of wastewater in septic tanks contributed to ground water recharge and pollution of groundwater table (Remini, 2006).

IV. Water pollution of the groundwater table in Souf

Seventeen water samples are collected from drillings capturing groundwater table (Seven (07) traditional wells and drillings which some belong to the public sector and others to agricultural or rural areas), these waters were selected to cover the entire aquifer. The Analysis of 17 water points was made in the water Algerian laboratory of El Oued. The measured physico-chemical parameters are: The electrical conductivity, T°C, PH, Cl', SO_4^{-2}, HCO_3^-, NO_3^-, Na^+, K^+, Mg^+, Ca^+.

The analyses of Seventeen water samples from 1992 to 2010 were performed at the same laboratory. The concentrations of nitrate and phosphate were determined using the spectrophotometric method of molecular absorption (Rodier *and al*, 2007), kind of DR/2500.

Interpretation of geochemical facies by factor analysis

The projection of points on the diagram (Mg^+/ Na^+, $SO4^{-2}/Cl^-$) gives us an overview of the spatial distribution of geochemical facies in groundwater table (Figure 3). It appears that the most dominant facies is Sodium chloride (64.71% of the samples) and it has a lesser degree of Magnesium chloride facies (11.76% of the samples) and the sodium sulfate facies (23.53% of the samples). The presence of Magnesium Chloride and sodium sulphate can be the source of a base exchange occurring between Na^+ and Mg^+ (Meguellati , 2009).

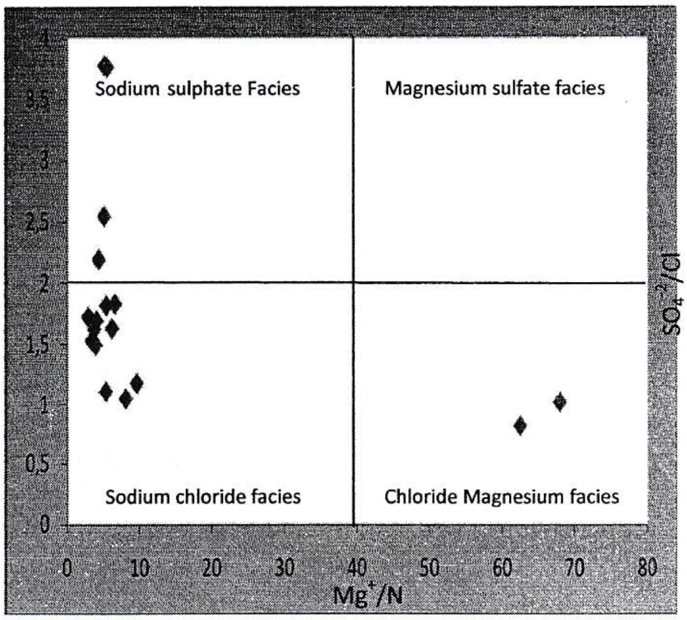

Figure 3. Geochemical facies waters reports (Mg^+/Na^+, $SO4^{-2}/Cl^-$)

Origin of the chemical elements

The couple SO_4^{-2}- Cl^-:

The graph shows a trend towards alignment points, possibly indicating a common origin; however, some points have excess sulfates. Other excess chlorides. The extent of the excess of chlorides or sulfates determines the dominant facies which is sulphate chloride facies (Meguellati , 2009).

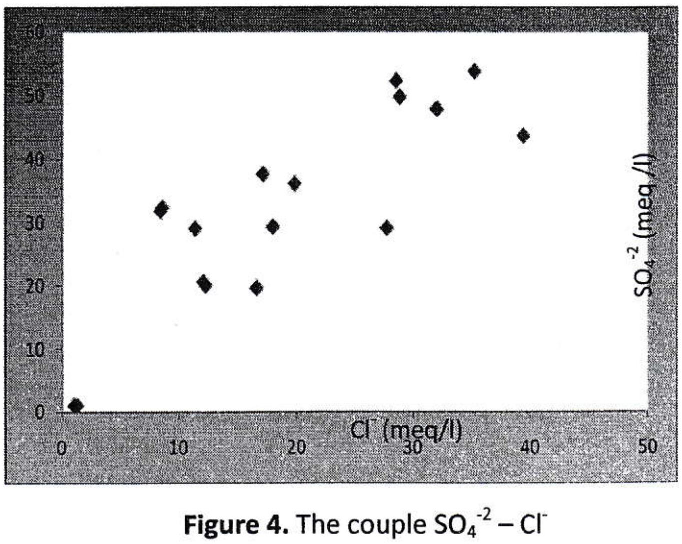

Figure 4. The couple $SO_4^{-2} – Cl^-$

The couple Cl^-/SO_4^{-2}- Conductivity

The diagram shows that all the points has a ratio less than 1, indicating indicating dominance of ions gypsum saliferous (Meguellati , 2009).

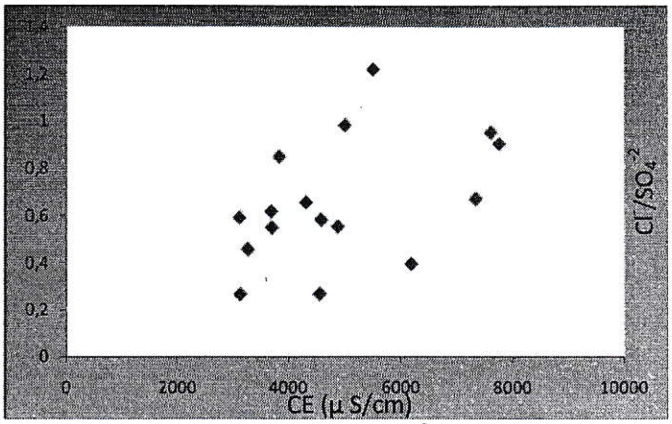

Figure 5. The couple Cl^-/SO_4^{-2} – conductivity

The couple Na^+–Cl^-

The graph shows an alignment of points implying the same origin of the two chemical elements probably the dissolution of the halite (NaCl). However, some points have an excess of sodium, the other an excess of chloride. This relationship confirms the existence of Sodium chloride facies (Meguellati , 2009).

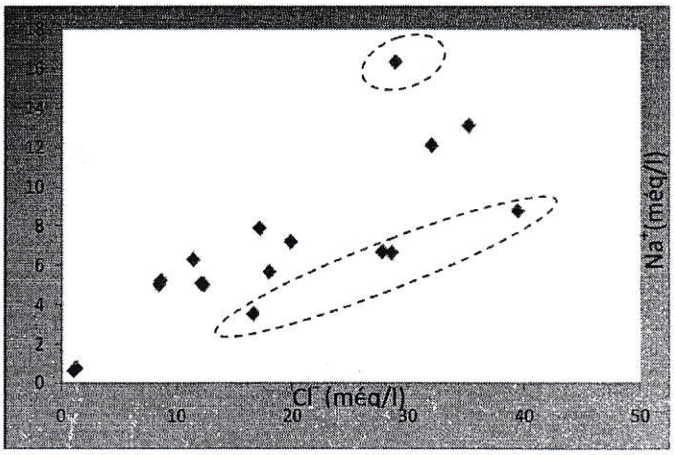

Figure 6. The couple Na^+- Cl^-

The couple Na^+ – SO_4^{-2}

The graphical representation of the sodium contents evolution in function of sulphate concentrations shows an alignment of points involving the same origin of the two chemical elements (Meguellati , 2009).

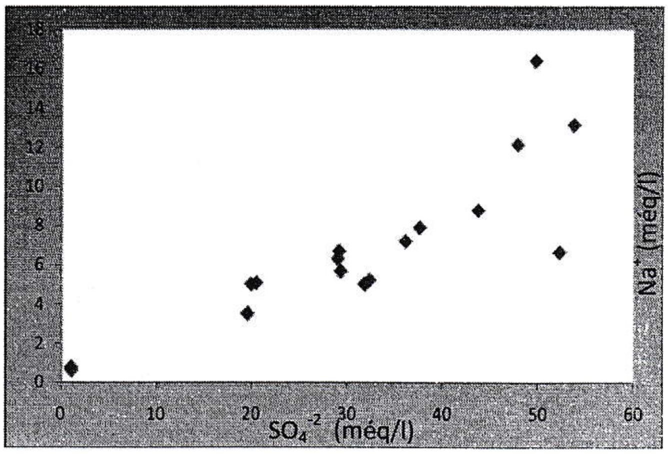

Figure 7. The couple Na^+- SO_4^{-2}

Pollution by nitrates and phosphates

The analysis of water samples H2, H4 and H5 are mentioned in Figures 8, 9 and 10, the nitrate concentrations range between 90.5 and 101.2 mg/l, these values are considered very high because the Algerian norm of nitrate in water is adjusted to 45 mg/l . While the norm set by World Health Organization " WHO" is 50 mg/l. These high values are mainly due to the frequent use of an intensive chemical fertilizers (artificial fertilizer) and natural fertilizers in agriculture. For phosphates, varied between 15 and 20 mg/l, these values are considered as indicators of pollution. WHO set the norm of phosphate to 0.5 mg /l. This high value is due mainly by the discharge of domestic sewage in the old septic tanks; the second factor is the artificial or natural fertilizers.

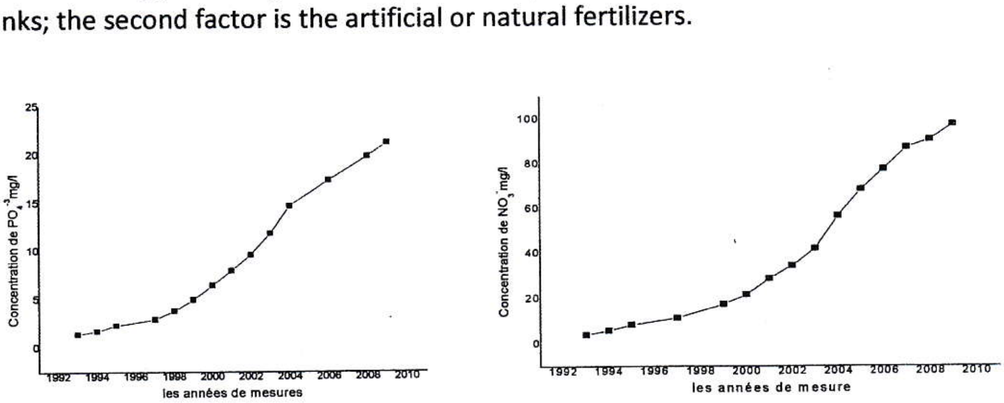

Figure 8. The concentration of nitrates and phosphates in the sampling point H2 (Laouini *and al*, 2009)

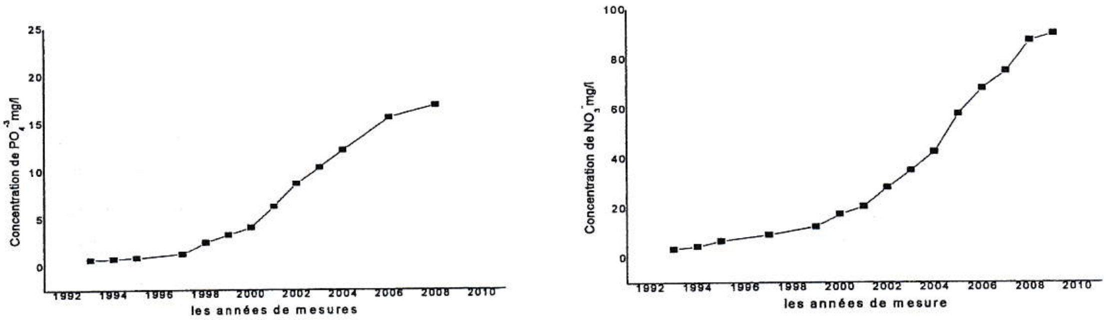

Figure 9. The concentration of nitrates and phosphates in the sampling point H4 (Laouini *and al*, 2009)

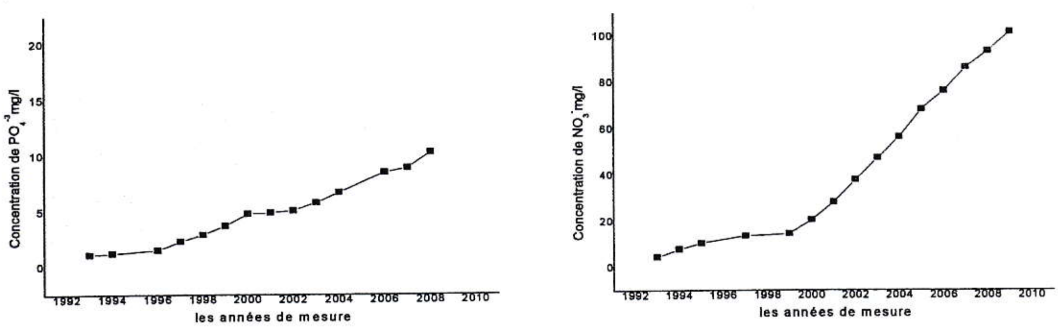

Figure 10. The concentration of nitrates and phosphates in the sampling point H5 (Laouini *and al*, 2009)

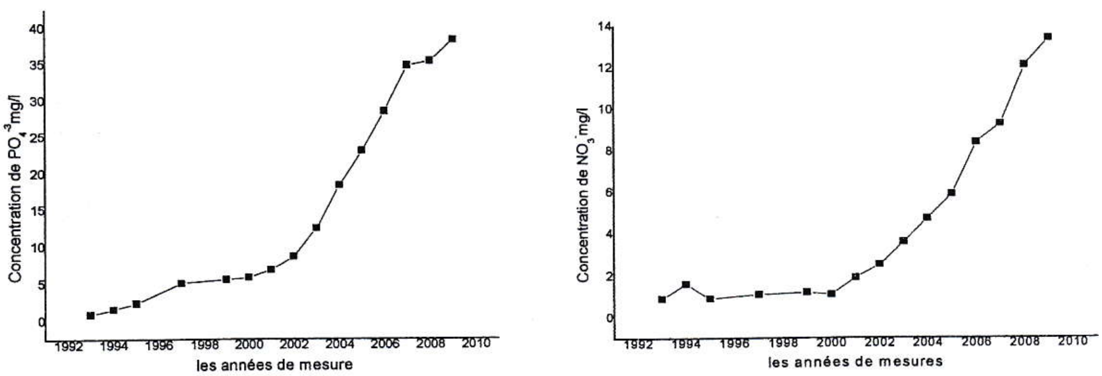

Figure 11. The concentration of nitrates and phosphates in the sampling point H1 (Laouini *and al*, 2009)

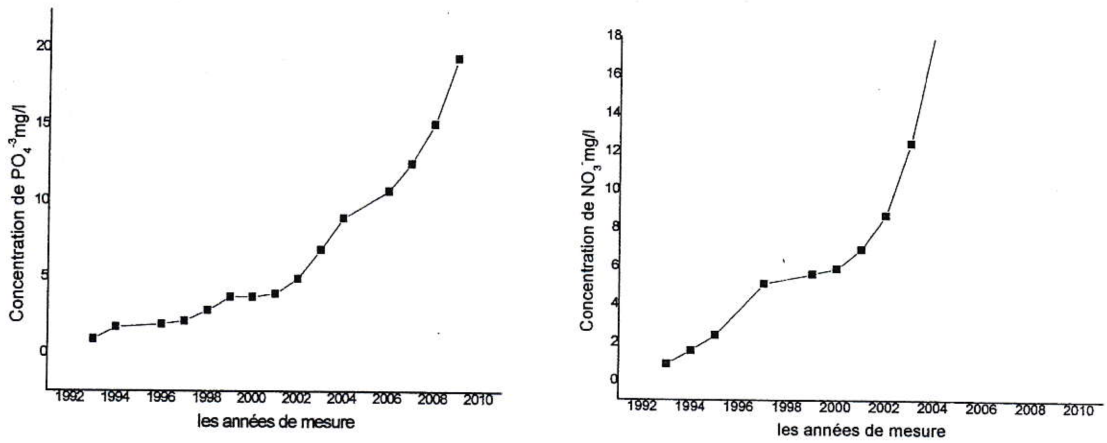

Figure 12. The concentration of nitrates and phosphates in the sampling point H3 (Laouini *and al*, 2009)

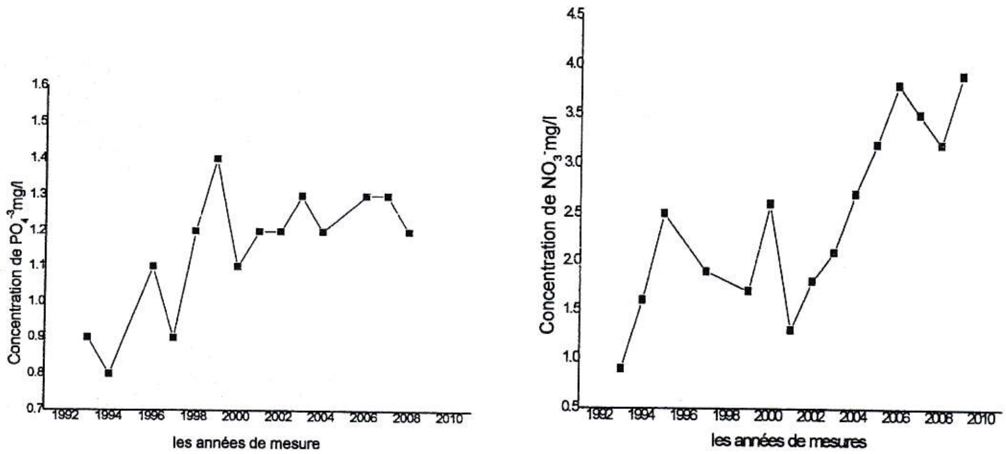

Figure 13. Concentration de nitrates et phosphates dans le point de prélèvement H6 (Laouini *and al*, 2009)

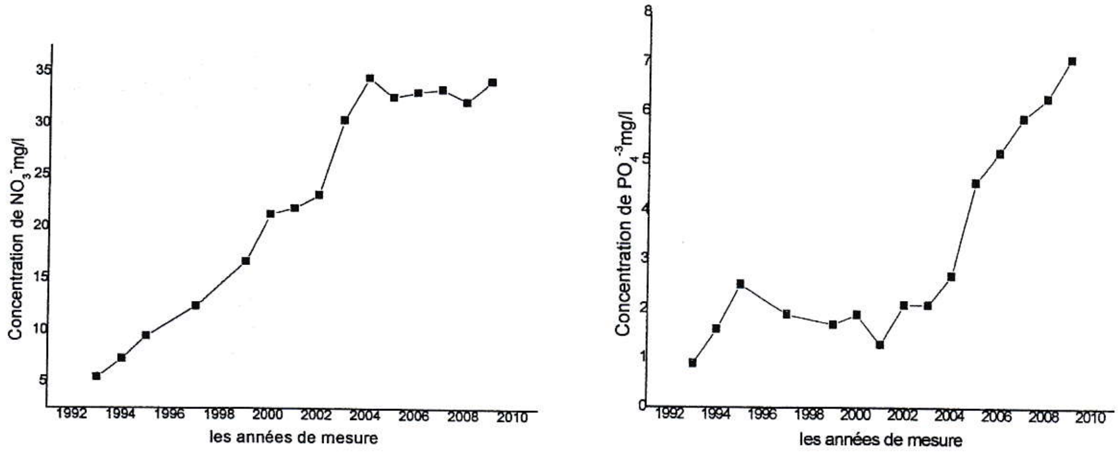

Figure 14. The concentration of nitrates and phosphates in the sampling point H7 (Laouini *and al*, 2009)

However, the analyses of nitrates and phosphates concentrations in H1 and H3 are mentioned in Figures (11 and 12). The results show that the nitrate varies from 15 to 20 mg/l and the phosphate varies from 19.4 to 38.5 mg/l. The nitrate concentration below the WHO norm which is fixed 50 mg /l, the highest value of phosphate is considered dangerous and remarkable indicator of pollution.

In the other hand, the analysis of water samples collected from points H6 and H7 mentioned in Figures 13 and 14, concerning the measurement of nitrate given various concentrations from 40.2 to 38.5 mg/l, these values are low and also below the WHO norm. For phosphate, the values are from 1.54 to 7.3 mg /l and they are considered high values. We note that the connection and operation of sanitation networks limit the increase of the concentrations of phosphates.

V. The realization of a complete system of wastewater treatment and discharge of treated water

The project aims to ensure the collection, transit of all polluted water and to make their treatment before their release into the environment. We note that the purification stations collect wastewater from all cities of Souf networks. For this purpose, four aerated lagoon treatment plants were distributed on area 300,000 m². The aerated lagoon is recognized as an effective and a Technical treatment method, particularly for oxidizable loads (90%).

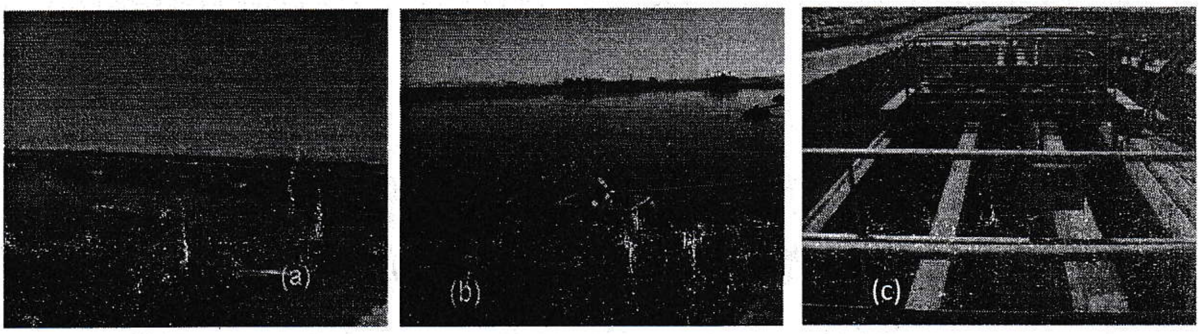

Figure 3. Purification station - Aerated lagoon.

Each station of aerated lagoons is comprised of pumping station and pretreatment device (screening and degritting), device against sandstorms and treatment of sludge by drying-beds. The Bituminous geo-membrane was selected for sealing these lagoons to take into account the typology of the land and the specific conditions of works. The wastewaters are first routed through a pre-treatment and directed through channels towards sedimentation basins. The main objectives of effluents treatment are to remove nuisances and current contamination in urbanized areas; discharging treated water to remove negative impacts on environment and to preserve water resources by using and enhancing the treated water. The evacuation of all treated wastewater is carried out through a collector of orientation South-North to the final discharge site located 50 km north of Souf.
The reuse of treated water can be beneficial because the treated water contains nutrients that are beneficial for agriculture, but should be done with caution because the excess of nutrients cause health risks, agronomic and environmental risks (Baumont et al., 2005).

VI. Conclusion

We note that groundwater of Souf has a fairly high salinity; the predominant chemical facies is Sodium chloride. It is specified by very high concentrations of nitrates and phosphates in agricultural areas and high concentrations of phosphates especially in rural areas then it is recommended to make permanent monitoring of water quality of wells and drillings and also well located the wastewater discharges, since they are heavily laden with pollutants.

Treated wastewater can be used in irrigation to satisfy most water demands, depending on the level of treatment, and must ensure that the reclaimed water quality complies to the standards and according to its end use.

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