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The assessment of the physicochemical quality of water intended for irrigation of Oued Méskiana (Oum El Bouaghi) Algeria.

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Abstract: *The aquatic ecosystem of the Meskiana Valley (wilaya of Oum El Bouaghi) covers a large area with a permanent flow and a semi-arid climate characterized by a strong evapotranspiration. In order to determine the Physico-chemical quality, pollution and salinity of the water of the river of Meskiana and more particularly in its downstream part which is exposed to wastewater discharges, analyses were carried out at the level of three sampling points: witness, the upstream (before spill), downstream (after spill)). In order to prevent the risk of alkalization and salinization of soil, the sodium absorption rate (SAR) and the percentage of sodium were determined and represented on the Wilcox and Riverside diagram. The high concentrations of polluting chemical elements and excessive salinity obtained at the downstream site show a high risk of pollution and salinization.*

Key words: the river of Meskiana, wastewater, water pollution, physical chemistry, salinity.

Introduction

For a few decades, the protection and the conservation of the natural environments have become a major concern and a main aim in the development programs [1]. Today with the climatic conditions of the arid and semi-arid areas, water became an undisputable issue, so the establishment of a balance between the increasing water demand and the availability of the water resources remains a big challenge. Agriculture consumes more than 70% of the water resources, particularly in the developing countries such as the Arab countries [2]. Currently, the untreated waste waters are used in the irrigation of 10 % of harvests in the world according to the first world study on the irrigation by the waste waters [3]. The irrigation by raw waste waters is used in several areas of our

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country, due to the deficit of water situation and the more request of the agricultural products. Although this practice is prohibited by the regulation, the farmers considered it as regular, abundant and free water resource and moreover rich in fertilizing elements [4].

In 2015 Algeria recorded an annual volume of wastewaters generated by the Algerian population, estimated at 927million m3 /year; in which 700 million m3/ year were treated by the ONA (National Office of Weather) and reused in industrial activities and agricultural irrigation [5]. And the rest was directly rejected in natural environment (the rivers) from where they reused for the irrigation. The irrigation non-conventional can be direct before dilution of waste waters with any other water resources or indirect by implying dilution before being used on downstream [6]. Under these conditions, the study of the physio-chemical and ecological properties of the soil when they exceed the tolerable content in nature or the indicative values with which each country was equipped. The development of the irrigation is accompanied in the majority of cases by the appearance of salinization and degradation of soil structure and the loss of permeability, what generates the asphyxiation of the plants in different degrees [1], [7]. Therefore, the main purpose of the present study was to evaluate the impact of waste water discharge in the downstream of the studied river on the physic-chemical quality and salinity of soil. Thus a qualitative characterization through various parameters will be carried out on water samples (different sites) taken in a random and systematic way.

Material and Methods

General data on the site of study:

Our study war carried out on the level of the Constantinois- Seybousse - Mellegue hydrographic basin (North-Est of Algeria) which shelters Meskiana Oued under the code 12 02 which is concerned with our study. The site is to 80 km of the Algéro-Tunisian border. It covers a surface of 465.6 km ^{2} and a 53.80 km length with the following geological co-ordinate: Latitude: 35.51' North, 35.13' North; Longitude: 7.50' Est, 7.14' Est. Several urban areas sit there [8] (Figure 1). Water of Meskian river which represents a fundamental source of in the region is exposed to discharges of domestic waste waters without treatment from several villages; they are used in domestic, industrial, and agricultural purposes. Along its passage the residents use it for the irrigation of vegetable farming, cereal and forage crop.

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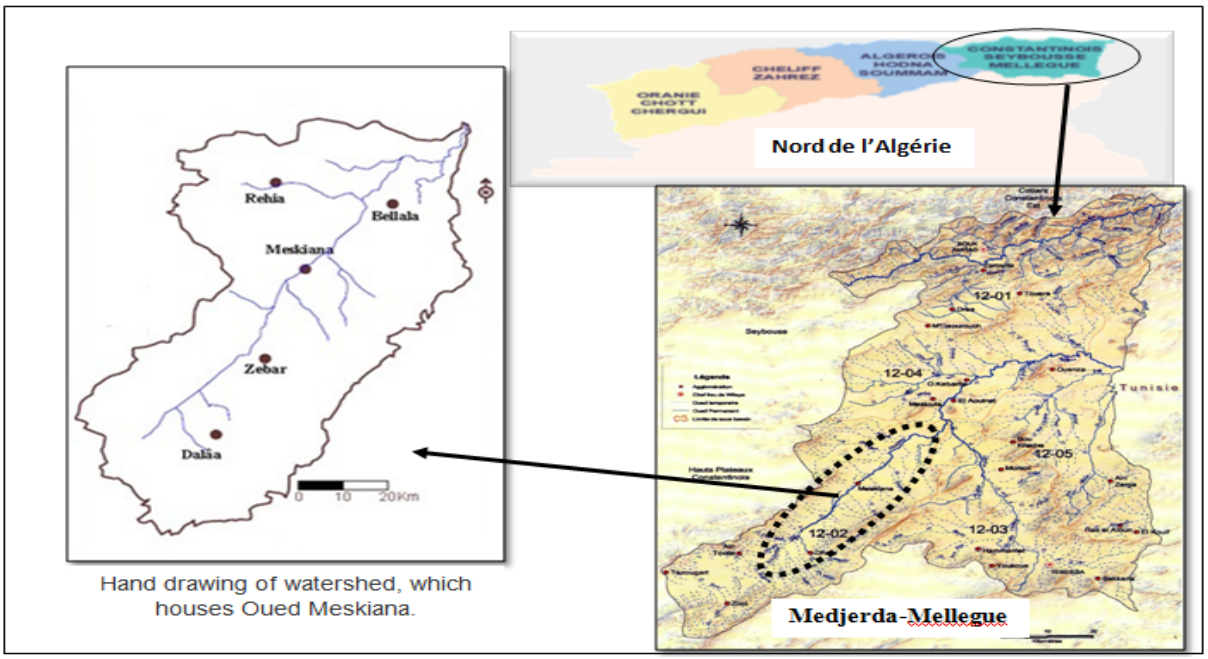

Figure 1 : Map of hydrographic network - of Medjerda-Mellegue basin and its downstream part which shelters the studied river of Meskiana.

Climatology

The climate of the area which shelters our site of study is of the continental type, cold in winter, hot and dry in summer. The pluviometric study in of the continental type, cold in winter, hot and dry in summer. The pluviometric quotient of Emberger indicates that it belongs to the bioclimatic floor of semi-arid vegetation at fresh winter [9]. The average temperatures of the air over one 25 years' period (1990/2015) show that July is the hottest month with a maximum temperature of 34.71°C and January is the coldest month with a minimal temperature of 1.45°C. Annual precipitations are irregular, insufficient and vary between 665 mm and 179 mm (1990/2015) [10]. The pluviothemal diagram of Bagnouls and Gausses [11] enables us to highlight the dry period which spread out over five months, from May until the end of October.

Pedological situation (Soil)

In general, the soil of the semi-arid areas is characterized by: the presence of calcareousaccumulation; low content of organic matter and biogenic elements which are very sensitive to erosion.

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Economic activity

The industrial infrastructure, whereas agriculture and the breeding were so developed following financial programs putting by the state since 2001 [12]. Vegetable farming, cereal and forage crop were present with a biennial or triennial rotation.

Sampling

In the goal of the search of physicochemical characterization and salinization of water, considering the waste water discharge, samples of geo-referencing water were taken in April 2015 from the river of Meskiana, exactly on the level of water pumping points used for irrigate different cultures and that for the two sites of study, also a witness sample was taken at the level of the Upstream of the Oued (Figure 2 and Tableau 1).

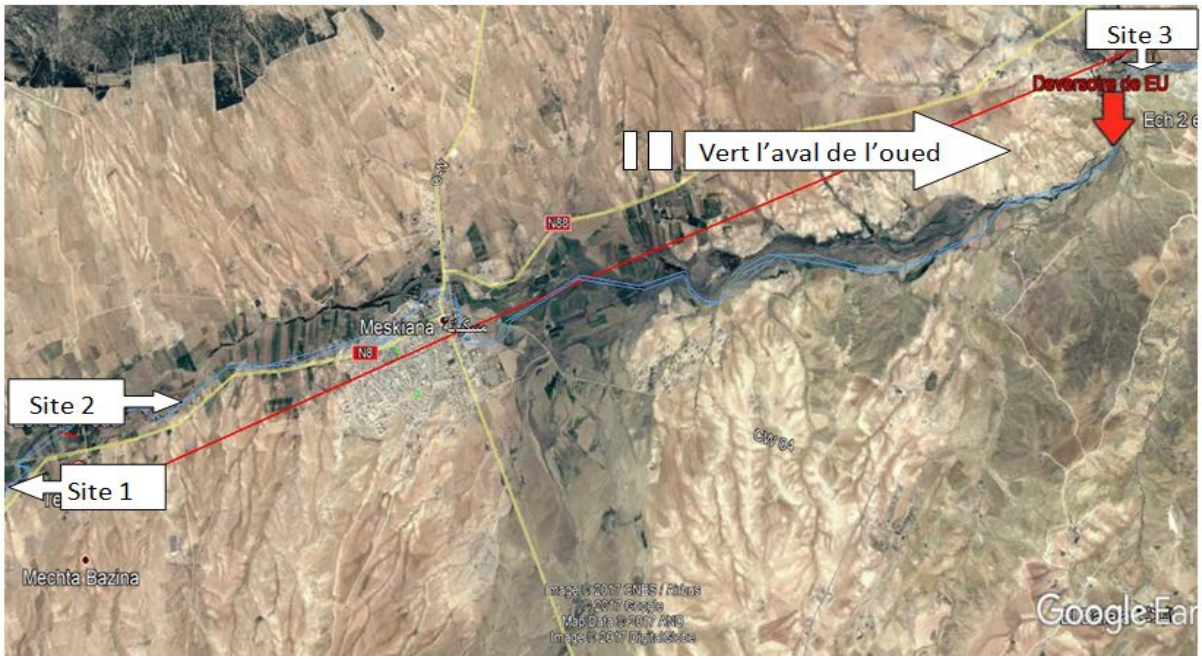

Figure 2: Satellite picture of sites in which samples of water were taken (Source: Google Earth 2017).

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Table 1: Characteristics of the site of study

Sampling points	Site 1(SIT)	Site 2(S2, AV)	Site 3 (S3, AP)
Cordonne shadow on card	N : 36°35'46.0" E : 7°32'31.3" Altitude : 840 m	N : 35°37'04.28" E : 7°39'5.22" Altitude : 838 m	N : 35°38'42.52" E : 7°40'42.41" Altitude : 807 m
Site	Upstream of the river	Upstream of the river	Downstream of the river
Type of water	Natural water of surface of a hill reserve.	Natural water of the surface	Natural water of surface + waste waters (100m of discharge)
Flora	Vegetations	Avenage vegetations	Vegetationsauthority
The entourage of sites	- Closed residence - Open areas - Steppe zone.	- Agricultural land	- Agricultural land
Activities and use of the site	- Pasture - Air of leisure.	-Pasture - Air of leisure. - Irrigation of vegetable farming (Parsley, carrot, salad…).	-Pasture -Air of leisure. - Irrigation of vegetable
Flow	Stagnant water	Running water	Running water
Color	Claire	Slightly disorder (greenish color)	Very disorder (color very sinks)

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Odor	Without odor	Without odor	Very strong odor

The water samples are taken in plastic bottles (clearly labelled), on the level of the three sites (3 repetitions par site), during their transportation the temperature must be 4°C and in total obscurity. The physicochemical analysis is carried out before 24 hours at the laboratory of Natural Resources and Management of Sensitive Environments -University of Oum-El-Bouaghi, Algeria where we were taking provisions for the conservation of samples [13].

Experimental

The pH, temperature measurement, CE and dissolved Oxygen were measured by a multi parameter. Concerning the color, it was evaluated visually in sampling location as well as the flow. Turbidity was measured by using a turbidimeter (Tyndall effect or opacimetry). Other parameters were measured by spectrophotometer, such as: Nitrates, Nitrites, Phosphates, Nitrogen Ammoniac and Sulphates. The concentration of chlorides, Calcium and Magnesium, was determined by a volumetry and Na, K by a spectrophotometer with flame and that according [13, 14].

Results and discussion

The quality of water is determined by the various substances which it contains [15]. The water which is essential to the needs for the plants must obey certain minimal quality standards, the excess of undesirable elements can harmful, and for this reason national and international standards fixed limiting quality values to ensure a good environmental, social and economic management. In this context our results were be compared with the regulations if for most country, the regulations are non-existent or incomplete, FAO (Food and Agriculture Organization) and WHO (World Health Organization) come to cover this lack [16]. The analyses results give the values which are represented on the graphs of (figure 3).

Result of the physicochemical analyses

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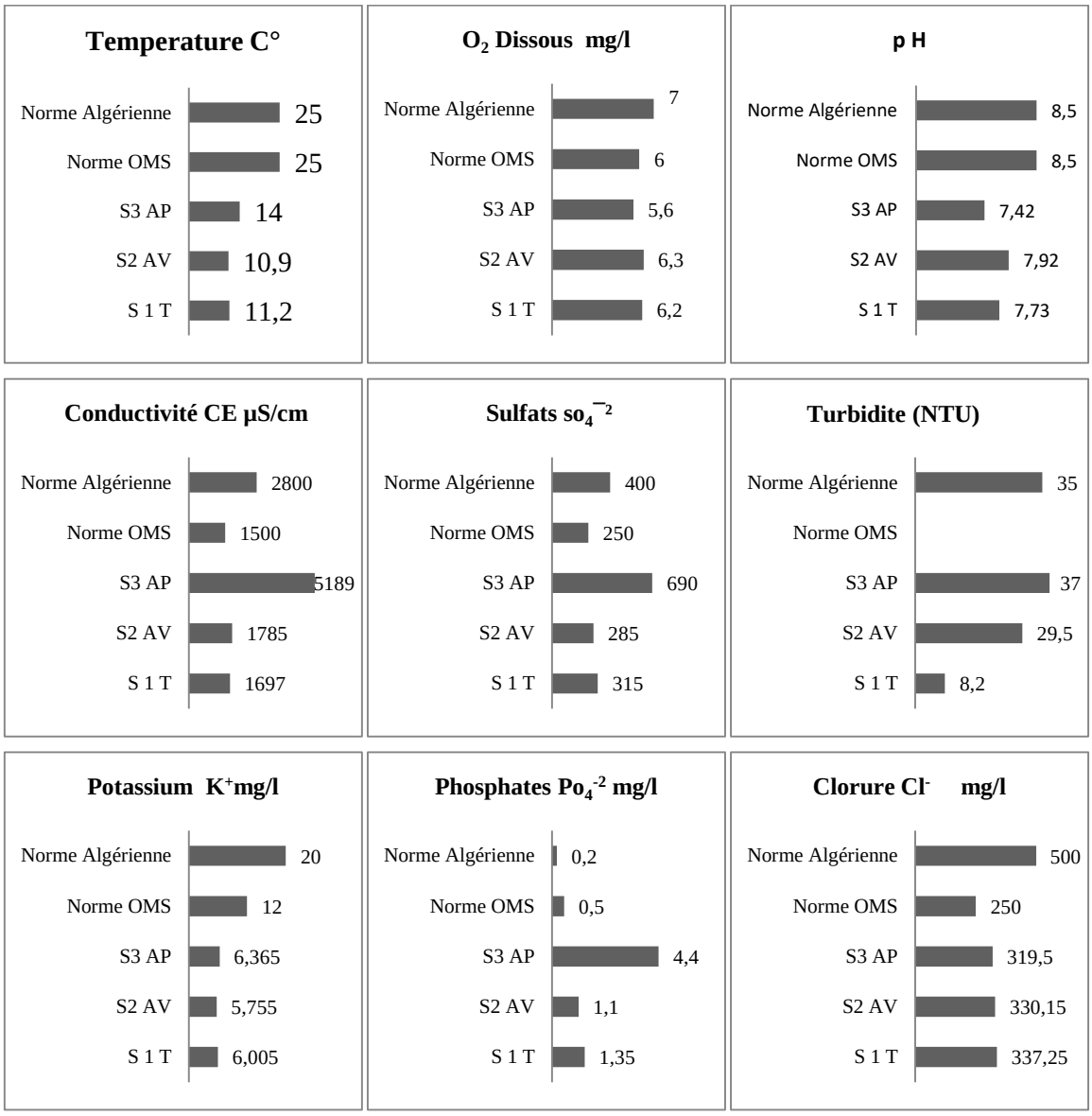

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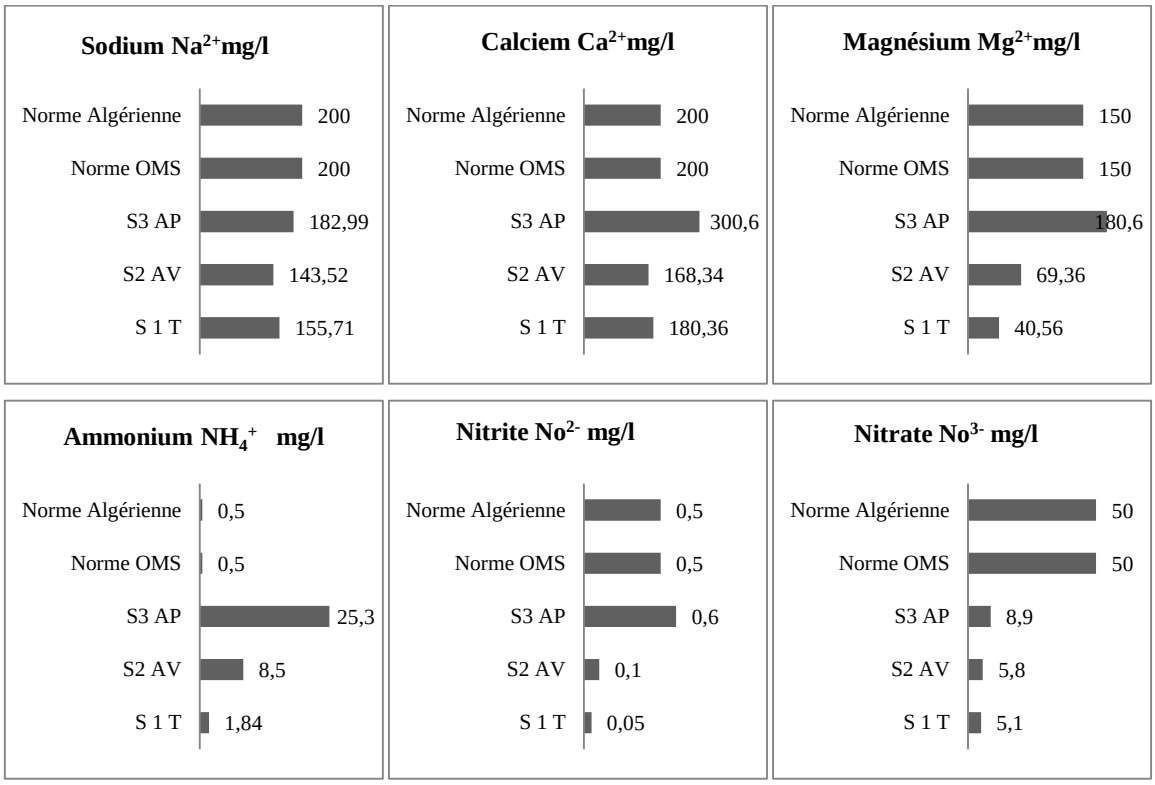

Figure 3: Results of the physicochemical analyses of the water of Meskiana Oued intended for irrigation.

The examination of the physico-chemical composition of water of the three sites shows that for the 2 sites of the upstream part (S1T and S2AV) the most of parameters have a low concentrations and do not exceeding the standards of surface water and the standards of the reuse of waste waters in agriculture. This is valid for: pH, temperature, turbidity, EC, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO^{-}_{3}, No_{2}^{-}, So_{4}^{2-}, and dissolved oxygen. Put except for Cl^{-} which differs between Algerian and international standard.

Phosphates can have organic or mineral origin, generally their presences in natural water result from their use in agriculture as chemical fertilizers or pesticides [17]. The NH_{4}^{+}on the level of the site (S2 AV), which probably comes from the nitrogenized organic matter due to the free access of the sheep and the bovine, and also from the gaseous exchange between water and the atmosphere [18].

For the third site concerned with the discharge (S3AP), measurements have reveals values which exceed the minimal allowed ones, and that for the most parameters (EC, turbidity, Ca^{2+},Mg^{2+}, No_{2}^{-}, NH_{4}^{+}, So_{4}^{2-},Po_{4}^{-}, Cl^{-}).The presence of ammoniac nitrogen constitutes a good indicator of pollution of water flaws by the urban effluents [18] .without moves away, the chlorides which would come from the

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dissolution of the chlorinated products due to the detergent products were finding in waste waters poured in the downstream part of the river[13].

[19] noted that an infinite quantity of nitrates in the surface water is related either to the increased growth of algal, or with the joint phenomenon of denitrifications which transforms nitrateNO_3^- to N_2 because of the presence of organic matter. The concentrations obtained nitrites agree with those of [20] for Algerian North-East surface waters and those of [21]. The presence of phosphates with high concentrations is surely due to the domestic ejections; they take part in the first line of the process of eutrophication, phenomenon which has environmental (algae developments) and medical (toxin alga release) consequences. The recorded values of phosphates are similar to those described by [21] from the river of Beni Aza (Blida, Algeria) in April. Concerning electric conductivity, the recorded values were largely exceeded the limits.

Salinity of water and their aptitudes for the irrigation

The dissolved salts contained in water have an impact on the soil and the plants, because that the sodium exerts a harmful action on the vegetation, in an indirect way, by degrading physical properties of the soil [22]. A salt water charged can caused this effect. The aptitude of water for irrigation cannot be only judged from the total concentration of salts, but also from the type of salts and the ions which it constitutes [23]. The risk is defined from the value of absorbable sodium "Sodium Absorption Ratio: SAR". In order to classify water of irrigation, the diagram of Richard [24] was adopted in which classes are defined on the basis of rate of absorption of sodium (SAR), according to electric conductivity. For the same conductivity, if the coefficient is higher the risk will be so great. The diagram's application gives us the results represented on fig.4 which were interpreted according to the same reference like the following:

C3S1: Water of acceptable quality for irrigation of cultures which are tolerant to salts with condition that the soil must be well drained and has a good permeability in which salinity must be controlled and that for the two sites of the upstream part (S1T, S2AV).

C4S1: Indicates poor water highly mineralized, likely to be appropriate for the irrigation of certain quite tolerant species to salts and on well drained and washed soil, this class was detected on the level of the site of the downstream part (S3AP) which is polluted by discharge of waste waters.

$SAR = (Na^+ + K^+) / \sqrt{(Ca_2^+ + Mg_2^+)} / 2$

All the cations are expressed in mill equivalent/l.

According to the classification of the water samples of Wilcox diagram who proposed 5 water classes

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for agriculture, 3 elements must be carried out: conductivity, sodium expressed as a percentage and boron (Figure 5), because the plants hold badly in soils saturated with sodium [7].

In our study boron hasn't been measured, so that we are only focused on conductivity and percentage of sodium

$\%Na^+ = ((Na^+ + K^{+)} / (Ca_2^+ + Mg_2^+ + Na^+ + K^+) *100.$

This classification emphasizes that the water of a good quality is the one of the two sites of the upstream art (pilot and before discharge) and the one of the downstream rough discharge has a poor quality. So we notice that water of the downstream part undergoes a degradation following the discharge of waters of the city.

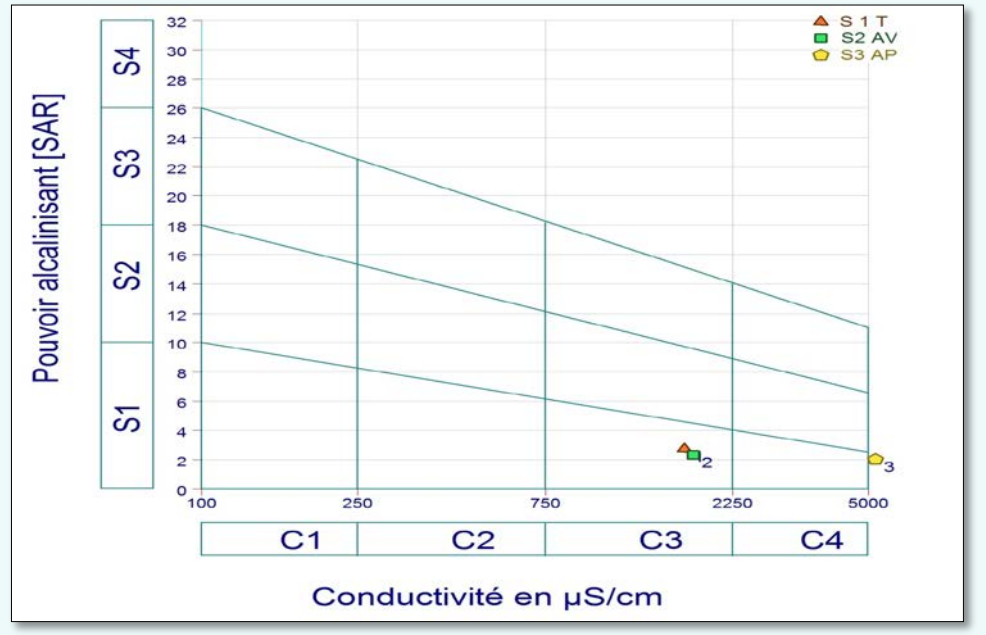

Figure 4: Diagram of Riverside for the classification of water of Meskiana River.

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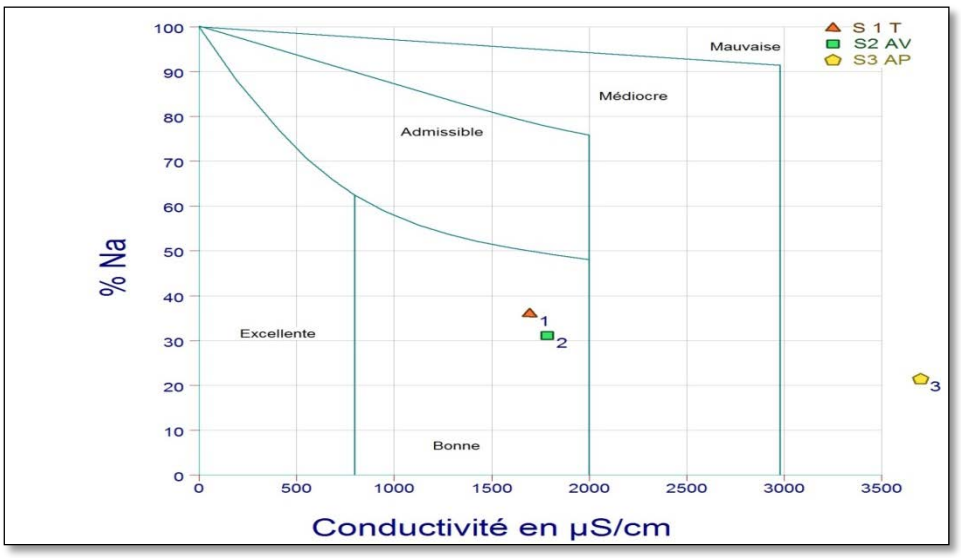

Figure 5: Diagram of Wilcox for the classification of water of Meskiana River.

Conclusion

At the end of this work, we tried to evaluate the quality of the water of Meskiana River which is used in irrigation in the plain of Meskiana. From the results, we notice that the total aptitude for the irrigation varies from the upstream to the downstream. Generally, the taking samples revealed high contents of polluted elements in the downstream part as well as a very important salinity; so that we classify water of this part according to Wilcox and Riverside to the poor quality and the bad for the irrigation and the ecosystem's health especially the irrigated soil. The origin of the contamination can be related to various contributions: natural such as the organic matter of animal for the upstream sites of the river and anthropic such as the domestic waste water rejections for the downstream part, also the use of fertilizers rich in phosphate and nitrogen in agriculture for the three sites which revealed a content that exceed the standards. Following the use of the water course to reject wastes, the physicochemical quality of this water system is gradually degraded. Lastly, the deterioration of the quality of the soil following the irrigation constitutes a serious danger to the durability of the operating system of the soil. The best answer to fight against salinization of the soil the appealto a reasoned irrigatigation in which the cours of water is of a good quality and don't exceed the needs of the plants.in prospects, we hope, the minimization of the use of the water of the river because that can influence the aspect and the ecology of thrse habitats, namely, the proliferation of the pathogenic micro-organismes,

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the accumulation of the chemical elements supporting the microbial development which caused manypublic health problems and animpoverishment of the soil. Also, the installation of a station of treatment of waste waters before discharge in natural environment.

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