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By

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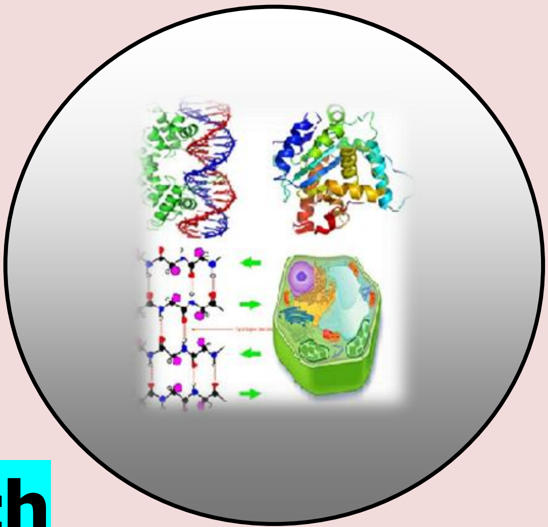
ISSN 2319-3077 Online/Electronic
ISSN 0970-4973 Print

UGC Approved Journal No. 62923
MCI Validated Journal
Index Copernicus International Value
IC Value of Journal 82.43 Poland, Europe (2016)
Journal Impact Factor: 4.275
Global Impact factor of Journal: 0.876
Scientific Journals Impact Factor: 3.285
InfoBase Impact Factor: 3.66

J. Biol. Chem. Research
Volume 36 (1) 2019 Pages No. 164-172



Journal of Biological and Chemical Research

An International Peer Reviewed / Referred Journal of Life Sciences and Chemistry

Indexed, Abstracted and Cited in various International and National Scientific Databases

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 36, No. 1: 164-172, 2019
(An International Peer Reviewed / Refereed Journal of Life Sciences and Chemistry)
Ms 35/01/4002/2018

ISSN 2319-3077 (Online/Electronic)
ISSN 0970-4973 (Print)

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REVIEW ARTICLE

Received: 28/04/2018 Revised: 21/01/2019 Accepted: 24/01/2019

Groundwater of the Shoul water table in the Region of Rabat-Sale-Kenitra

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ABSTRACT

The objective of this study is to evaluate the water quality of the wells from its physicochemical characteristics in the shoul layer.
The study carried oaut between 2016 and 2017 made it possible to measure at the level of ten wells the physical parameters such as the temperature (T), pH, the oxidation, the electrical conductivity (EC) of the water and the following chemical parameters: chlorides (Cl -), nitrites (NO2-), Ammonium (NH4+), Alcanity, and SAR. The annual average values are compared to the standards for the quality of drinking water.
Well water is slightly neutral with an average pH of 7,29 ± 0.6. It is weakly mineralized and slightly hard with an average conductivity of 690.4 µS /cm. Chloride pollution is a major indicator of the water quality of the studied wells. This pollution results in high levels of nitrates and ammonium in more than 50% of the wells.
Well wateris subjected to an in organic pollution in the shoul ply. This pollution of in origin be related to the infiltration of waste water and chemical fertilizers. The high levels of nitrates show that this water is chemically not suitable for human consumption and requires in the majority of wells a prior treatment.
Keywords : Physical chemistry, well, pollutionand Shoul.

INTRODUCTION

Water is an indispensable natural resource in the lives of humans, animals and plants. To have it available in sufficient quantity and quality contributes to the maintenance of health.

But it can also be a source of disease because of its pollution by industrial discharges, wastewater, household or agricultural waste, excreta and various organic waste [Scanlon et al., 2005, El-Naqa et al., 2007, Eblin et al., 2005].

Ccording to the World Health Organization, about 1.1 billion people lack access to safe drinking water and 2.4 billion lack access to adequate sanitation. More than 2 million people, mostly children under five in developing countries where hygiene and sanitation are inadequate, die each year from diarrheal diseases [OMS, 2011].

But worldwide, nearly 90% of diarrheal disease is attributed to the poor quality of drinking water and inadequate wastewater treatment. Water has become today a strategic global issue whose management must imperatively integrate into a political perspective of sustainable development [Servais et al., 1992].

Thus, the supply of drinking water to populations in sufficient quantity in all seasons remains one of the major concerns of the various governments . Drinking water is a vital element whose sources of supply are very diverse.The study aims to highlight the level of water pollution of the web of shoul through the identification of pollutants, and the main factors involved.

Middle-II, Method study

Field of study

The commune of Shoul constitutes the oldest of all the communes of the prefecture of Salé. Its creation goes back to the first years of independence. In an urban environment, it continues to form with the municipality of Bouknadel the two rural communal entities of the prefecture of Salé.

In terms of the environment, the municipality is characterized by a dissected plateaus with altitudes around 250 m and evolving in the form of rather homogeneous geomorphological environments, but containing differentiations of detail at the surface of the plateaux, valley, and slopes. It is also characterized by the diversity of soil types, but with the predominance of fersiallitic soils.

Thus, the exposure of the area to oceanic influences contributes to the distinction between two bioclimatic stages, one sub-humid concentrated in the North and the other semi-arid extends to the South.

On the human level, the commune is characterized by a low population density, with 50 inhabitants / km^2, and by a recently established agropastoral society, associating livestock and agriculture in a production system closely linked to the natural environment in which it lives. unfolds.

The tablecloth of Shoul East c onsidérée as a natural extension of the Maâmora ply, it covers an area of 200 km^2. It is located in the area between the road connecting Sala Al Jadida to the Center of Sidi Allal El Bahraoui , and the Oued Bouregreg . Its potential contribution is 7.5 m^3 /year, the depth of water varies between 20 and 60 m.

Method of study

Sampling and water analysis: Sampling was conducted between February 2016 and January 2017. Four samples were taken per well and per season.

Samples were taken at each well using a small bucket, weighted and stored for 72 hours in 1.5 L mineral water plastics for analysis. However, pH, conductivity and temperature were measured in the field using a portable multimeter (HANNA, HI 991300).

The other parameters were determined by a spectrophotometer (HACH, DR 2400) according to the methods recommended by Rodier (2009) at the ONEP laboratory.

Physicochemical parameters

Temperature

Temperature drilling water can vary by several degrees during transport, for this it was measured in situ so that there is no change in the latter, a high temperature can promote unpleasant tastes or odors.

In addition, it accelerates most physicochemical and biological reactions, influences bacterial growth, dissipates the effect of residual disinfectant by acting on the equilibrium constants, the increase in temperature is often accompanied by a reduction viscosity, and a decrease in the solubility of gases, particularly that of oxygen.

From the results obtained, the well water temperature of the Shoul aquifer varies between 20°C and 21.2°C (Figure 1).

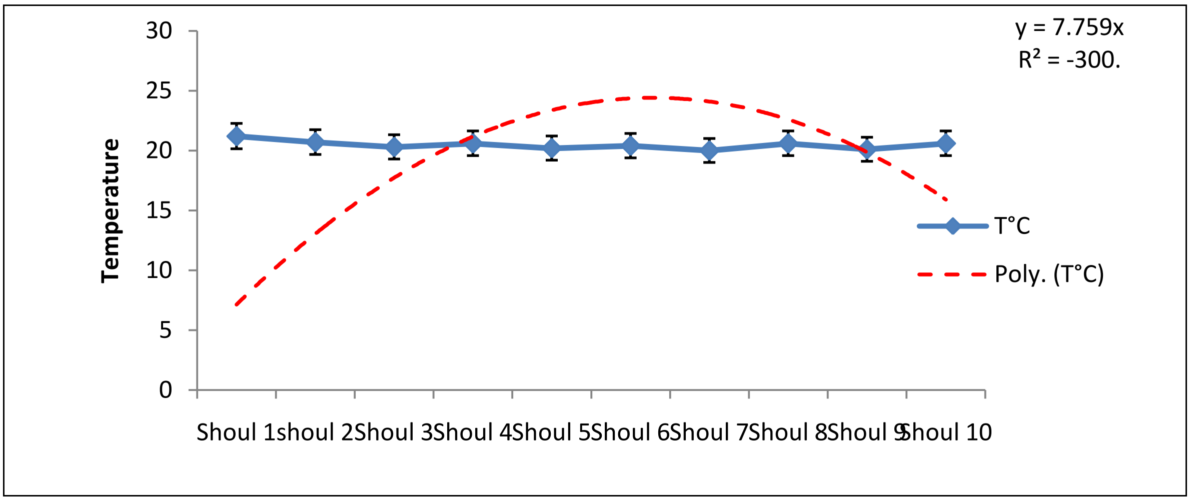

Figure 1. Spatial variations of changes in température ranges of the Shoul aquifer.

From the results shown in Figure 1 we note that the temperature of the studied water with an average of 20.47°C, then there is a compliance with Moroccan standards of human food water, of the order of ≤25°C.

Potential hydrogen

PH is the degree of acidity or alkalinity of the aquatic environment. It depends mainly on the origin of the waters, the petrographic nature of the crossed lands [Bennasseraet al., 1997,Dussart et al., 1993]. It is very sensitive to temperature, salinity, and respiration of organisms [Alexander, and Wood, 2005].

Regarding our results (Figure 2), the average pH values shown at the water level are all slightly neutral with mean extreme values ranging between 6.65 and 8.

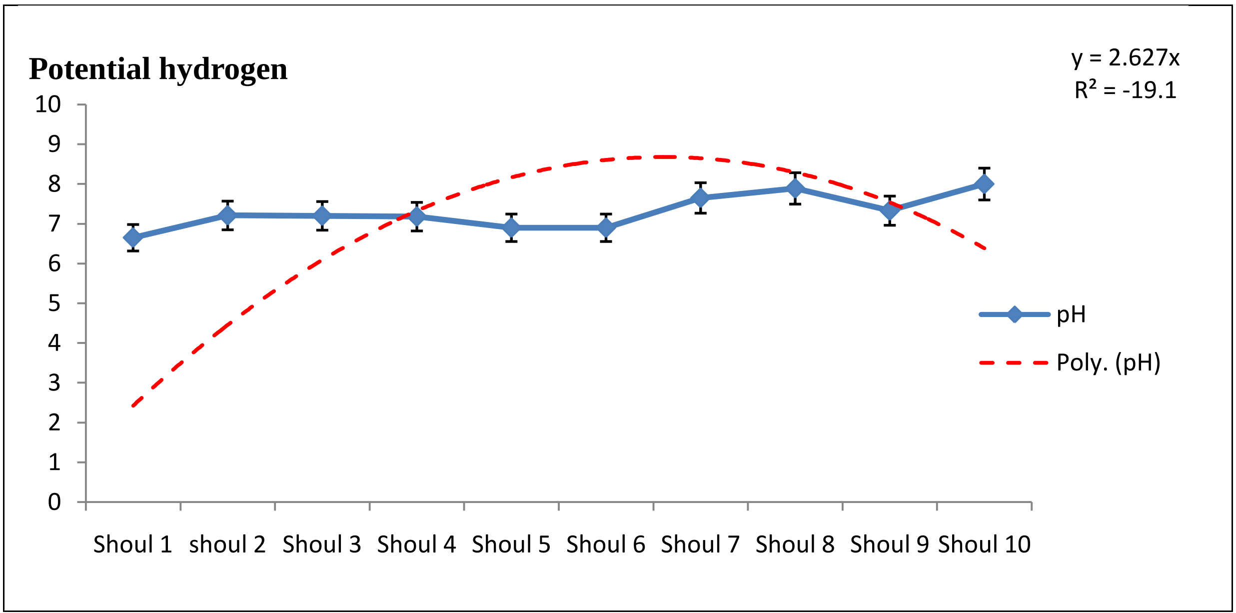

Figure 2. Spatial variations of the evolution of the pH ranges of the Shoul water table.

The measured pH values are acceptable according to Moroccan standards for the quality of surface water which are generally between 4 and 10**.**

For irrigation water, generally the recommended pH is between 6.5 and 8.5 [9]**,** because a lower pH favors the growth of filamentous fungi and other organisms responsible for floating sludge [Metcalf et Eddy, INC. 1991]**.**

PH values change from Shoul's water table with an average of 7.27 (Figure 2). By aillor s, the pH of the water surface, typically between 4 and 10; However, the neutral waters have a high pH and those coming from the limestone or siliceous soils have a pH close to 7 and, sometimes, less. In the same way, pHs between 6 and 9 allow a correct development of fauna and flora. Its influence is felt by the role it exerts on the ionic balances of the other elements. In addition, most organisms can not tolerate a pH greater than 10 or less than 4.

Oxydability

The permanganate index of a water corresponds to the quantity of oxygen expressed in mg/l, yielded by the permanganate ion and consumed by the oxidizable materials contained in one liter of water.

It is a conventional measure of the contamination of a water sample with organic matter.Its determination is mainly used to judge the quality of water intended for human consumption and groundwater because organic matter acts as a nutrient for bacteria, and the property of this material makes organic compounds susceptible to decrease the concentration of dissolved oxygen.

Examination of the results allows us to observe that the minimum value of the oxidability is of the order 0.73 observed at the level of the well 10, and the maximum value is of the order 6.5 recorded at the level of the wells. (Figure 3).

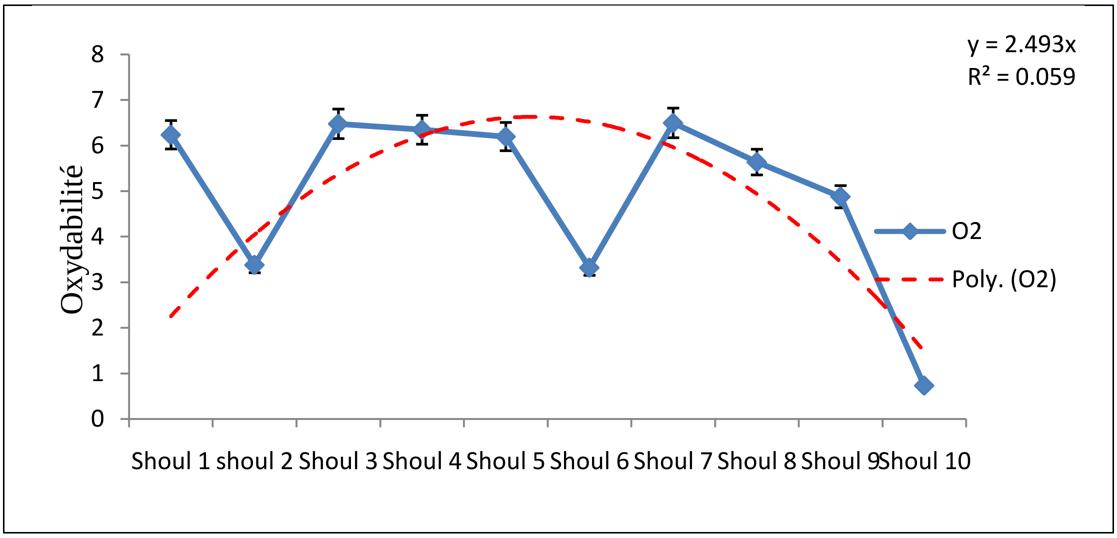

Figure 3. Spatial variations of oxidative evolution of the Shoul aquifer.

These results are higher than the maximum allowable value set by the Moroccan standard for the quality of human food water (VMA ≤ 5 mg / lO $_2$).

Electrical conductivity

Conductivity is the ability of a solution to conduct electrical current. This ability depends on several factors such as the presence of ions, and their total concentrations. It gives an idea about the salinity, allows a good appreciation of the materials in solution (especially mineral) in a natural water and makes it possible to detect the variations of the chemical composition of the water. High conductivity means either an abnormal pH or, most often, high salinity of natural or anthropogenic origin [Rodier, 2009, Rodier, 2005]

Regarding ourresults (Table 4) show that conductivities illustration Rees in waters ply Shoul, the average values vary between 206 µS/cm and 879 µS/cm with an average of 879 µS/cm.

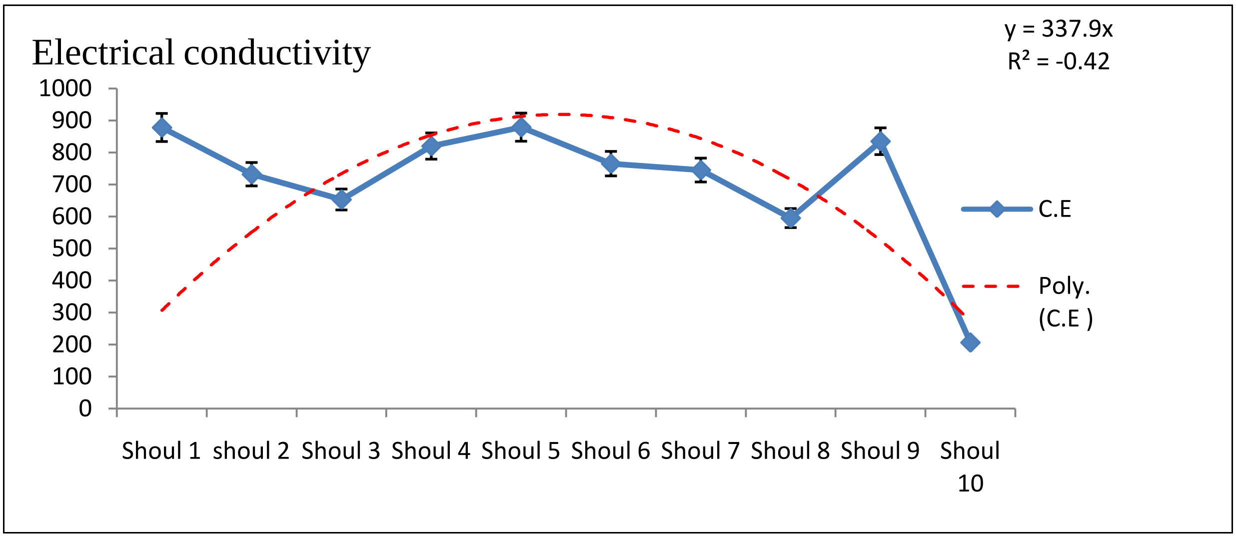

Figure 4. Mean spatial variations in electrical conductivity of the Shoul aquifer.

Electrical conductivity (EC) is a numerical expression of the ability of a solution to conduct electrical current. Most mineral salts in solution are good conductors. On the other hand, organic compounds are bad conductors. The standard electrical conductivity s' expr ime typically milliseconds per meter (mS/m) at 20°C. The conduct ivit é a natural water compr ise between 50 and 1500 µS / cm.

The estimation of the total quantity of dissolved solids can be obtained by multiplying the value of conductivity by an empirical factor depending on the nature of the dissolved salts and the temperature of thewater. Knowledge of dissolved salts cont enu e is important since each gold ganisme The Aquatic System has specific requirements for this per meter. Aquatic species do not support not generally import ant are variations of dissolved salts which may ar e observed for example in case wastewater discharges, values are normal. Moreover, many factors can locally influence the conductivity of the water table of a water such as the quantity of mineral or organic matter in suspension, the physicochemical quality of urban, agricultural or industrial discharges, the hydrodynamics of the masses. of marine water, etc. In aquatic environments, salinity is an important factor that acts directly on the absorption and concentration of metals at the tissue level. In fact, the salinity of the ambient water decreases the rate of absorption of the chemical elements.

Chlorures

Chlorides are widespread in nature, usually in the form of sodium (NaCl) and potassium (KCl) salts; they represent approximately 0.05% of the lithosphere. These are the oceans that contain by far the largest amount of chlorides in the environment.

Chloride ions are important inorganic anions found at varying concentrations in natural waters. The chloride ion is the main element. Knowing that its concentration in freshwater reaches several milligrams, it is a parameter that tells us about the salinity of the environment.

The major disadvantage of chlorides is the unpleasant taste they impart to water, especially when it comes to sodium chloride. They are also likely to cause corrosion in pipes and tanks,

Regarding the results (figure 5), the range of variation of the chloride content is significant in the waters of the Shoul water table . Similarly, we note that chlorine levels and values of electrical conductivity evolve in parallel in the study areas.

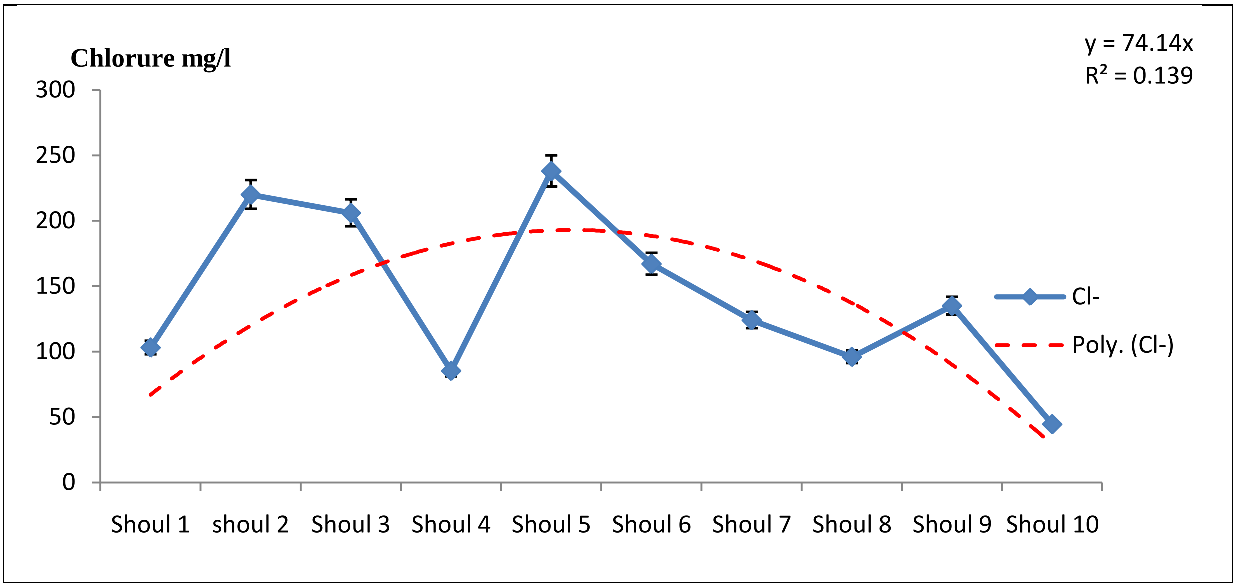

Figure 5. Mean Spatial Variations of chlorure and Shoul Tablecloth.

Mean values of chloride show well the existence of a strong mineralization , chloride quality standard in the fixed drinking at 50 mg/l.

The chlorides and salinity contents of the treated effluent are very high compared to the tolerable limit which is of the order of 350 mg / l in chlorides for water intended for the irrigation of crops according to the Ministry of the Environment., 2002.

Nitrites

Nitrites are very sensitive indicators of the beginning of nitrification. They are an important step in the metabolism of nitrogen compounds that fit into the nitrogen cycle between nitrates and ammonia, they are very unstable and their presence due to bacterial oxidation of the ion ammonia either to the reduction of nitrates.

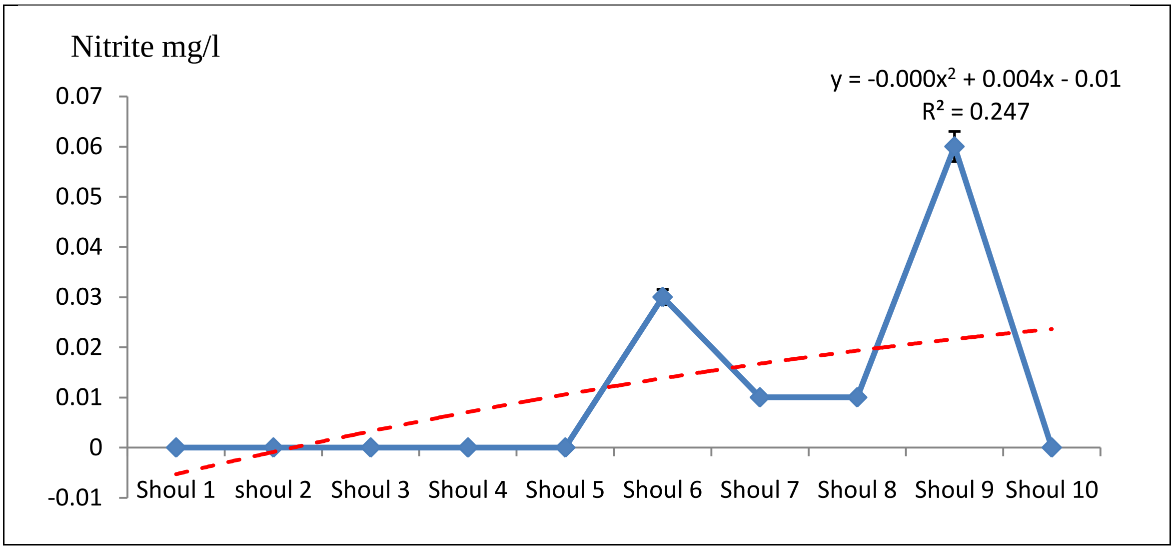

Figure 6. Mean Spatial Variations of Nitrite in Shoul Waters.

The results obtained (Figure 6) show that the value of the nitrite is the same at the level of the Shoul 1, Shoul 2, Shoul 3, Shoul 4 and Shoul 5 wells and it does not exceed the Moroccan standard for water quality. human nutrition (≤ 0.5 mg / l).

AmmoniumNH_4^+

The different forms of a zote are NH_4NO_3, NO_2, NH_3 and N_2O. Among the sources of nitrogen ; ammonium NH_4^+ and nitrates NO_3^-.At the water level of the Shoul, the ammonium concentration between 0, 01 and 0,19 mg/l.The ion, NH_4^+, is the reduced form of nitrogen. It comes mainly from the decomposition of natural proteins contained in phytoplankton and microorganisms. They are found in natural waters at concentrations that can range from 0.1 to 10 mg/l. Well water from the Shoul water table remained in the range of 0.1 to 10 mg/l (Figure 7).

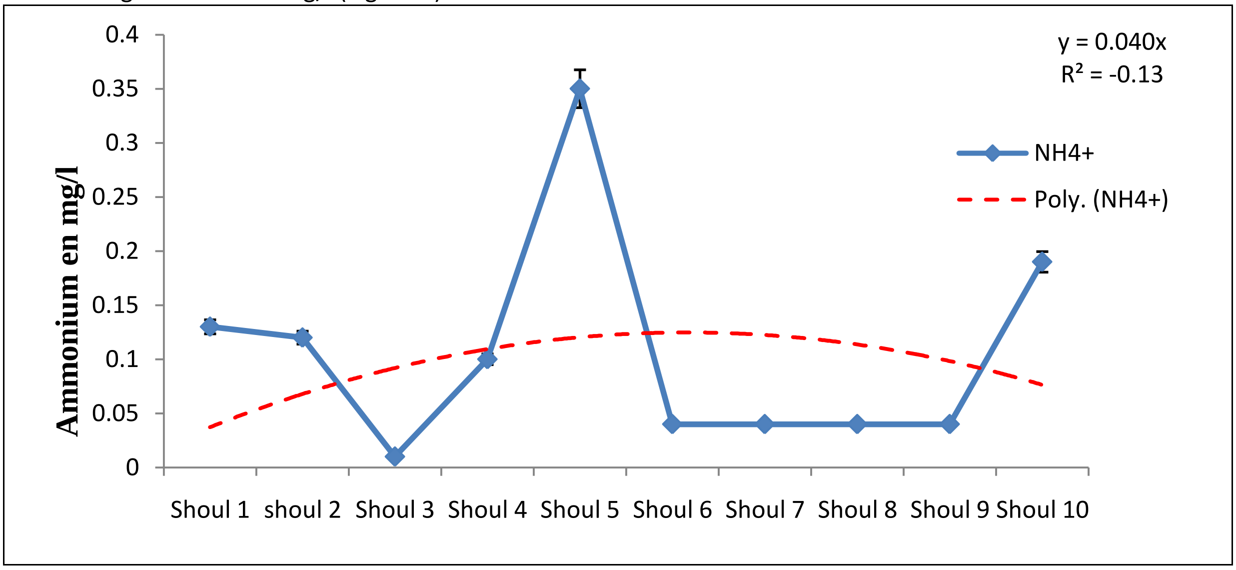

Figure 7. Mean Spatial Variations of Ammonium in Shoul Waters.

The ammonium ion is not harmful to health, but it is a food for many bacteria, which can proliferate in the wells. It should therefore be removed from water intended for human consumption .There is always the possibility of conversion of ammonia to nitrates by bacteria according to the following reaction:

$2\ NH_4^+ + 3O_2 = 2NO_3^- + 8H^+$
It is an acidifying reaction that releases H + ions ; which leads to a decrease in soil pH. Indeed
$PH = -\text{Log}(H_3O^+)$
Ammonium NH_4^+, a positive ion, is not very mobile in the soil. As the soil is negatively charged (organic materials and clays), NH_4^+ is well retained by these negative charges while NO_3^-, is not retained by these negative charges of the soil. They are easily leached and transported to the groundwater table. Moreover, they never leave alone, they are lost with the cations (K^+, Ca^{++} and Mg^{++}) to preserve the neutrality of the charges .

Alkalinity
Alkalinity of irrigation water is assessed using SAR. The greater the SAR, the more water there is a risk of soil hardness because of the exchange that will occur at the equilibrium between Na^+ of the soil solution and Ca^{2+} / Mg^{2+} of the absorbing complex. .The SAR is defined by the following equation:

$$SAR = \frac{CNa^+}{\sqrt{\frac{CCa^{2+} + C\,Mg^{2+}}{2}}}$$

(C): ion concentration in mol / m^3
Na: Sodium
Ca: Calcium
Mg: Magnesium
A large amount of sodium ions in the water affects the permeability of the soil and poses infiltration problems. This is because the sodium present in the soil in exchangeable form replaces the calcium andmagnesium adsorbed on soil clays and causes dispersion of particles in the soil, the soil tends to be easily cultivated and has a permeable and granular structure).
This dispersion results in the alteration of soil aggregates. The soil then becomes hard and compact (when it is dry) thus reducing the infiltration rates of the water.

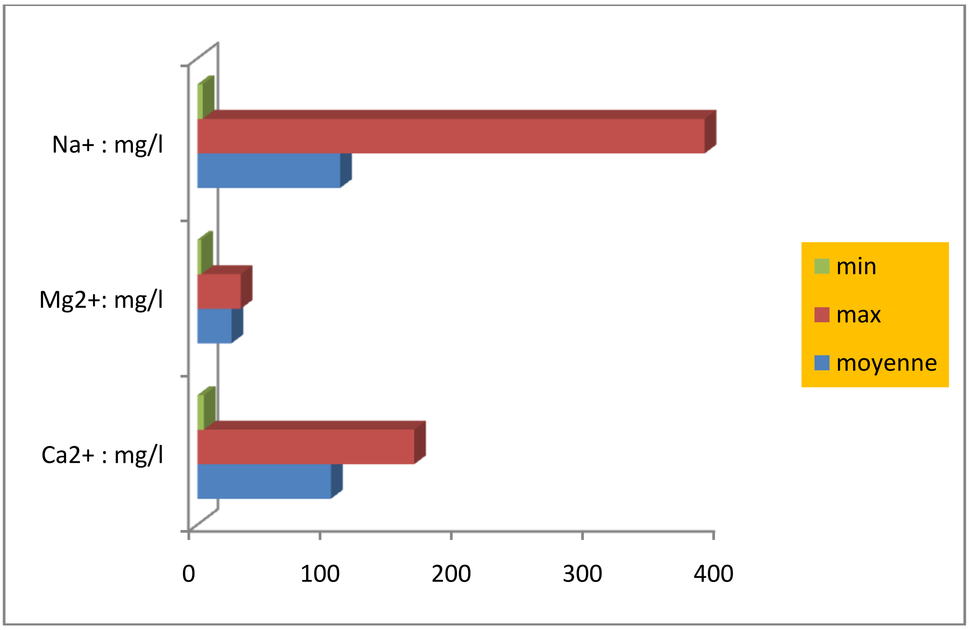

Figure 8. Evolution of the means of Calcium, Magnesium and Sodium in the studied samples.

We see from the figure 8 that the tablecloth area of Shoul is present a higher Na + level compared to Ca^{2+} and mg $^{2+}$.

Table 1. **Evolution of Calcium, Magnesium and Sodium means in the studied samples.**

	Ca^{2+} mg /l	Mg 2 +: mg /l	Na + mg / l
average	101.602	25.942	108.66
max	165	33	386
min	5.02	2.92	4.1

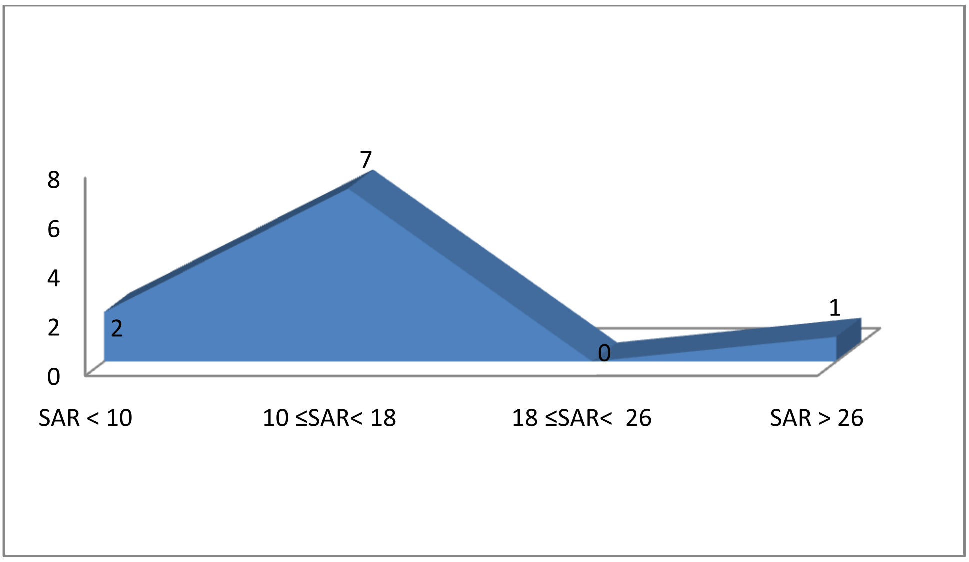

Figure 9. **Evolution of SAR averages in Shoul water.**

From Figure 9 and the comparison with the c lasses risks (Table 1) it can be seen that for the tablecloth region from Shoul about 0% of the studied wells are in the value or high risk and 10% in the value 0 or less likely high. So from these results we conclude that the risk of using water x from the Shoul aquifer is the best for irrigation.

Table 2. **Risk values of irrigation water.**

classes	R isques
SAR 10	low risk
10 <SAR 18	average risk
18 <SAR 26	high risk
SAR> 26	very high risk

If good quality water is used for irrigation.

CONCLUSION

At the end of this study, the physicochemical characteristics of well water were determined in the S houl aquifer of Rabat-Sal- Kenitra region of the 8 parameters measured concentrations nitr i respect your and ammonium are the standards for the quality of water boi sson in most wells but the chloride content does not comply with WHO standards. Pollution is believed to be related to anthropogenic activities including the infiltration of wastewater and the use of chemical fertilizers in agriculture. It is a health risk for people who depend on well water for their needs.

Conflict of interests

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS
We thanks go to all those who have actively contribute to conduct this study in particular: Laboratory of Agro-Physiology, Biotechnology, Environment and Quality.

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