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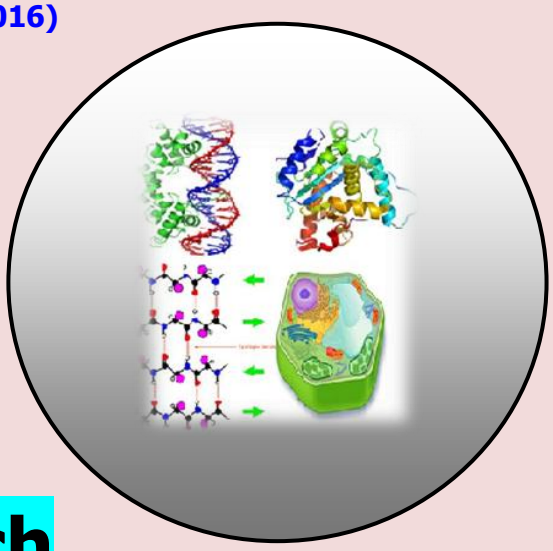

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Study of Ground Water Pollution from the Table Cloth Gharb, Sidi Kacem-Morocco

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ABSTRACT

The objective of our work is to determine the degree of pollution of the water table of the Gharb region (Morocco), we have chosen physicochemical and metallic elements as indicator of inorganic pollution. Samples were taken from 10 wells (S1 ..... S10) located in the town of Sidi Kacem, performing analysis for 12 physicochemical parameters in the ONEP laboratory. These parameters are pH, CE, Hardness, Ca^{2+}, Mg^{2+}, Na +, NH^{4+}, Cl-, NO_3, SO_4^{2-}, TH and TAC. Also, the results were compared with WHO standards. These results showed pollution high compared to WHO standards, which indicates to the presence of nitrogen pollution that can come from organic waste, fertilizers used excessively in agriculture and domestic or industrial discharges also corresponds to a strong mineralization which generally results from the nature of the crossed lands or the industrial or domestic pollution.

Keywords: Tablecloth Maamora; Microbiology, Physico-chemistry, Heavy metals, Quality and Gharb, Morocco.

INTRODUCTION

All the important chemical elements in the water have been measured ie major elements: chlorides, calcium, magnesium and sulfate.

Other elements such as iron, manganese, turbidity and conductivity of the water were also measured. The temperature, the pH, as well as the dry residue were also determined.

Sampling for the physico-chemical does not pose any particular problem. Plastic bottles are sufficient and the volume of the sample is one liter for a complete analysis. The sample can be kept for a few days, but it is better to assay the chemical elements as soon as possible. Elements such as nitrates may be modified during storage.

Middle, Method of Study
Material and Methods

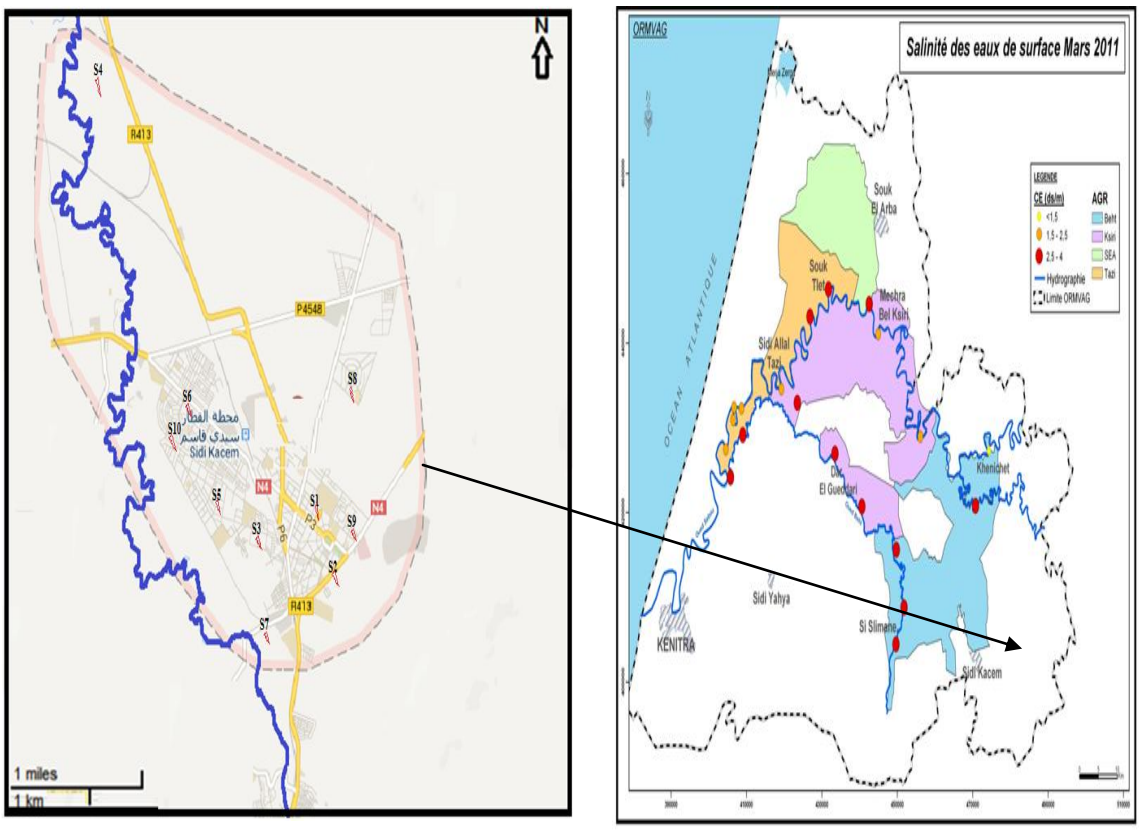

Figure 1. Situation géographique de la zone d'étude (ORMVAG 2002).

Sampling Frequency

A monthly sampling frequency was conducted at the wells for two study cohorts, summer 2015 (June, July and August 2013) and winter (November, December 2015 and January 2016).

Method of study

The samples collected in polyethylene bottles were transported as quickly as possible to the ONEP Kenitra laboratory to undertake the analyzes, where we studied the following parameters:

Wastewater samples for other physicochemical analyzes: Hydrogen potential (pH), electrical conductivity (EC), Turbidity (NTU).

And also the heavy metals were made in the laboratory: the National Office of Drinking Water, in Kenitra.

These samples have been stored according to the general guide for the preservation and handling of samples according to ISO 5667/3 (1994).

RESULTS AND DISCUSSIONS

Study of the spatial variation of physicochemical parameters of well water in the city of Sidi Kace

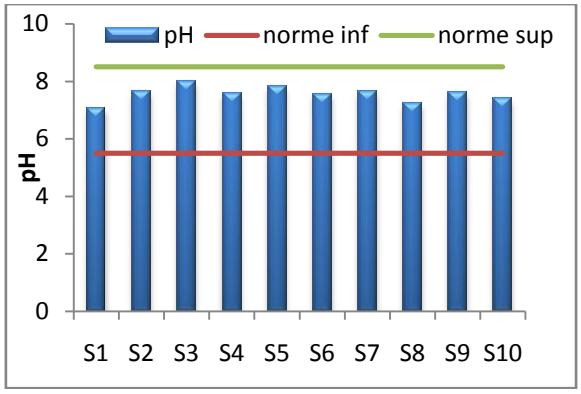

Figure 2. pH Variation.

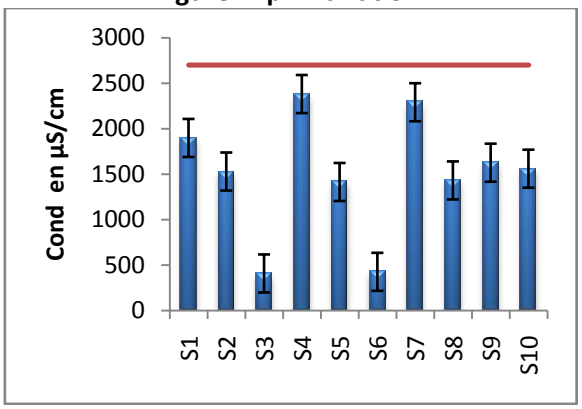

Figure 3. Variation in conductivity.

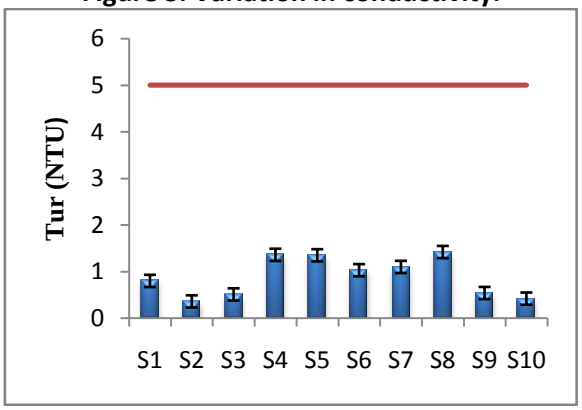

Figure 4. Variation of turbidity.

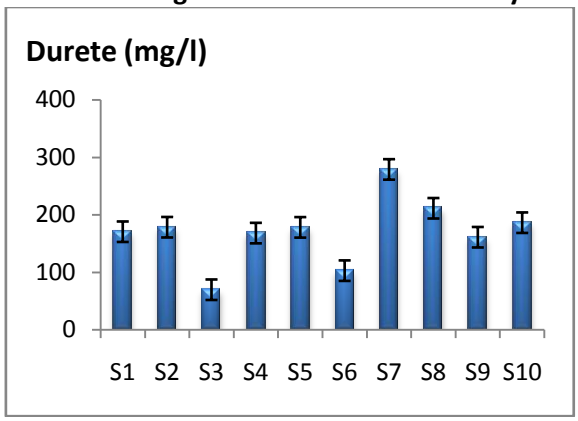

Figure 5. Variation in hardness.

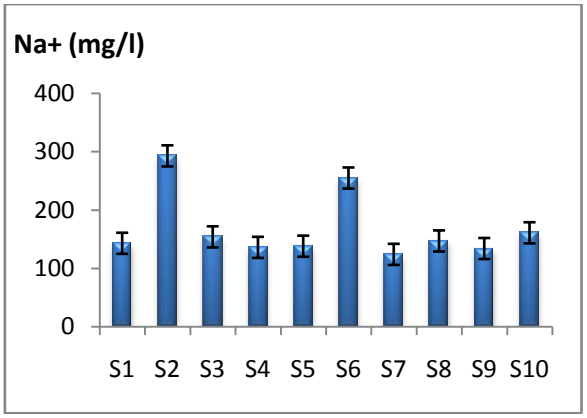

Figure 6. Sodium variation.

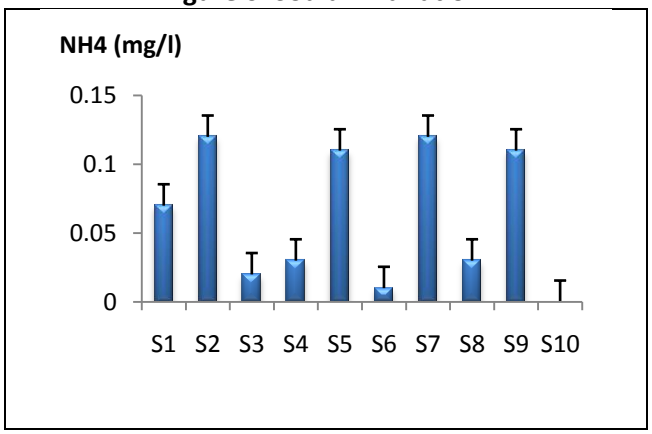

Figure 7. Ammonium variation.

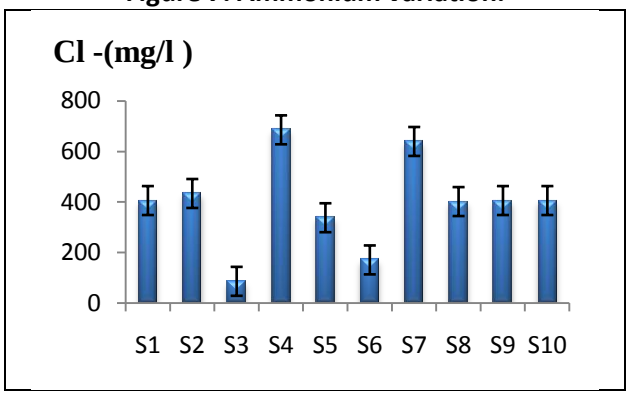

Figure 8. Variation of chlorides.

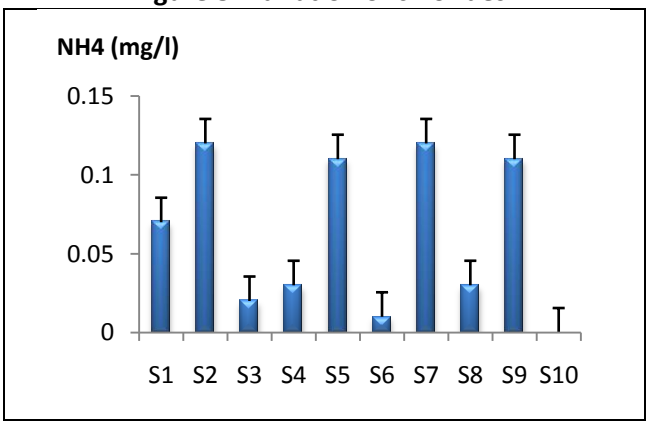

Figure 9. Variation des nitrates.

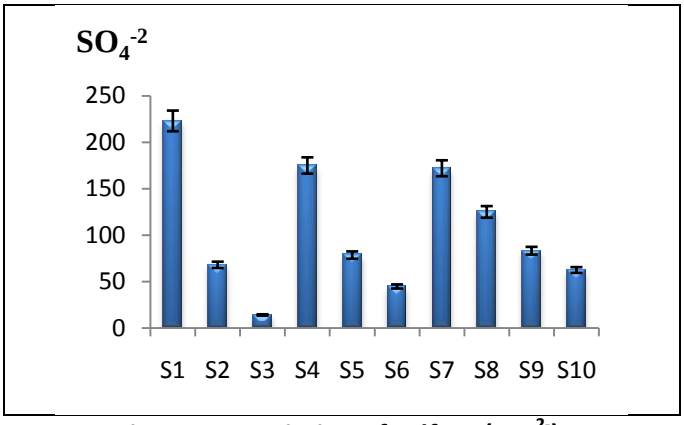

Figure 10. Variation of sulfate (SO_4^{2-}).

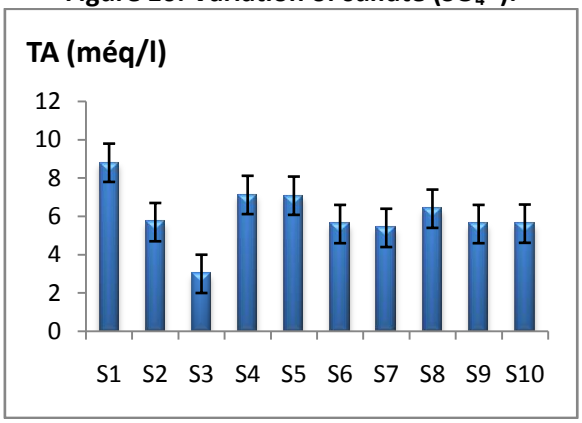

Figure 11. Variation of chlorides.

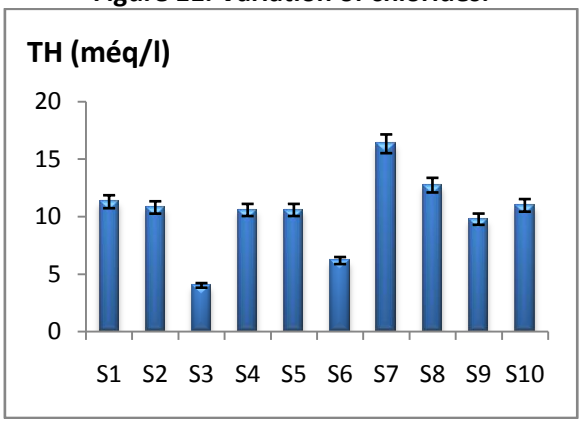

Figure 12. Variation of the Hydrotimetric.

DISCUSSIONS

The pH of the water varies during the study from 7.05 to 7.98. PH is a factor of investigation of the acidity or the alkalinity of a water (Figure: 2).

The values obtained are close to neutrality, so by referring to Moroccan standards (pH between 6.5 and 8.5) for drinking water, 100% of the analyzed water are recommended for human consumption.

In fact, the waters of the Sidi Kacem aquifer do not require a pH correction that could be overloaded. According to the NMES [SEEE (2007], all the stations studied have good to excellent water quality. The values obtained in the present study are comparable to those reported by Kadri [Kadri et al., 2012] at the wadi level in the Wadi Hassar, one of the three peri-urban streams of Greater Casablanca [Fouad et al., 2013].

The results obtained from the analyzes carried out are illustrated in fig. 3. During our study, the values of the conductivity oscillate between 407 µs /cm and 2380 µs /cm. Its normal rate is set at 2700 µs/cm according to the Moroccan standards of potability. values are still stable and lower than the maximum allowable value, however the high content of this parameter is explained by the high content of chloride ions (Cl-) due to the proximity of the water table of Sidi Kacem with Oued Rdam, as well as the strong mineralization due to contact of these groundwater with rock formations.

These results corroborate those of ABHB [ABHBC. (2004] and Zerouali [2001] which confirm the strong mineralization of the coastal chaouia aquifer. The average ECs also remain comparable to those reported by Benmoussa [2013] to oued khoumen and by [Kbibch et al., 2011] to oued Mda.

The results obtained from the turbidity analyzes carried out are illustrated in fig. 4 The turbidity varies during the study from 0.36 NTU to 1.42 NTU, its normal rate is set at 5 NTU according to the Moroccan standards of potability. We find that 100% of the analyzed waters have low turbidity levels and that conform to Moroccan standards.

The total hardness of a water is produced by the calcium and magnesium salts it contains. During our study the magnesian hardness values oscillate between 69,32 mg/l and 278,78 mg/l (Figure 5), this high content of Mg^{2+} can be justified also by the total hardness (TH) which is high.

The mean annual sodium value shown at the wells is 168.5 mg/l, the maximum concentration (293 mg/l) is recorded in the S2 wells (Figure 6). The sodium content in natural waters is mainly related to the geological nature of the lands crossed, the sodium values do not exceed 10 meq/l (limit value according to OMS) because the average value of the wells analyzes equals 7.32 meq/l.

The nuisance related to ammonia results mainly from its ability to promote the development of nitrifying bacteria, the growth of suspended solids and the increase of the rate of organic matter and the modification of the color of the water. The results obtained from the analyzes carried out are illustrated in fig. 7. During our study, the ammonium values oscillate between 0 mg/l and 0.17 mg/l, its normal rate is set at 0.5 mg/l according to Moroccan standards of potability, therefore these values always remain lower than the maximum admissible value, This can be justified by the presence of a sufficient quantity of oxygen which favors the operation of the nitrification (transformation of the ammonium in nitrites then in nitrates) .

Compared to other Moroccan rivers, the average levels obtained in the present work are higher than those reported by Bentouat [2012], at wadi Bousselam and El ouali-alami [1973] at the level of the river. Wadi Fez.

The chloride results obtained from the analyzes carried out are illustrated in fig. 8. During our study, the values of the concentration of the chloride ions oscillate between 85.2 mg /l and 685 mg/l, its normal level is set at 750 mg/l. according to the Moroccan standards of potability, these values always remain lower than the maximum admissible value, however the high content of this parameter is explained by the conductivity which is high and by the proximity of the tablecloth of Sidi kacem with Oued Rdam.

This is consistent with the findings of the other authors who have mentioned that chloride concentration increases continuously and proportionately under the effect of urbanization [Edwards and Thornes, 1973, Bontoux, 1993, Cun and Vilagines, 1997, Lamri and Belghyti, 2011] and according to the nature of the land crossed [14, 15, 16] but still under the effect of the contributions of the water table (superficial in M4) as testifies the works of Zerouali.

The results obtained from the analyzes carried out are illustrated in fig. 9. The nitrate content varies during the study from 0.01 mg/l to 0.12 mg/l, the normal level is set at 50 mg/l according to Moroccan standards of water potability.

Although nitrates have no direct toxic effects except in high doses, the fact that they can give birth to nitrites led to toxicity.

The nitrate levels remain low except in the well S8 case gets well and is in agricultural area, the average value anneals and conform to the standards, for the same reason as the nitrites.

These results, which corroborate those of the ABHBC (2004), highlight the degradation of the quality of the coastal chaouia aquifer by the high levels of nitrates. It should also be noted that in the sub-basin of the coastal chaouia, the development of pumping has led to the over-exploitation of the water table, its dewatering in places and consequently the advancement, at a very fast pace, of the salt wedge. Moreover, the results of this work are comparable to those reported by El ouali-alami, higher than those reported by Abouelouafa [2002], but lower than those recorded by Derwich [Derwich et al., 2008, Lamrani et al., 2012, Fawzi et al., 2001, El Addouli et al., 2009]

The results obtained from the analyzes carried out are illustrated in fig. 10. The results obtained for the sulphates vary between 14 mg/l and 223 mg/l. the concentrations remain below 100 mg/l SO_4 except in the well 223 mg/l; according to the NMES, the waters of this hydrosystem would therefore be of average quality.

These grades remain lower than those reported by El addouli [2009] to wadi Ouislane periurban of the city of Meknes. It should also be noted that the average sulphate content of the effluents from the Had Soualem industrial zone remains well below the limit value recommended by the NMRD and is equal to 250 mg SO_4/l.

The results of complete alkalimetric titre obtained from the analyzes carried out are illustrated in fig. 11. The TAC of the water varies during the study from 3 meq/l to 8.8 meq/l. The values obtained are generally stable, and based on the pH values which are always lower than 8.3 (TA= 0), then the TAC values represent only the concentrations of bicarbonates. Total hardness is the sum of calcium hardness and magnesian hardness.

The results obtained from the analyzes carried out are illustrated in fig. 12, according to which the TH values are varied between 4 meq/l and 16.32 meq/l. It is then found that the TH values obtained are generally high because these underground waters are close to Wadi Rdam.

Principal Component Analysis

water from the sidi kacem aquifer with a principal components analysis. And according to the correlation matrix of the physicochemical parameters we conclude that (Table: 1):

-Electric conductivity and strongly correlated with TA, TH, Mg^{2+}, Cl-, SO_4^{2-}.

-TH and strongly correlated with conductivity, TA, TH, Mg^{2+}, Ca^{2+}, Cl-, SO_4^{2-}.

Table 1. Correlation matrix of physicochemical parameters of well water in the city of Sidi Kacem.

Variables	pH	Tur	Cond	NH4	TA	TH	Mg 2+	Ca 2+	Cl -	SO4-2	NO3-
pH	**1**	-0,152	-0,462	0,161	**-0,690**	-0,647	**-0,782**	-0,318	-0,393	**-0,731**	-0,145
Tur	-0,152	**1**	0,208	-0,132	0,469	0,285	0,278	0,213	0,279	0,403	0,590
Cond	-0,462	0,208	**1**	0,304	**0,709**	**0,798**	**0,852**	0,515	**0,957**	**0,775**	0,365
NH4	0,161	-0,132	0,304	**1**	0,276	0,322	0,309	0,246	0,204	0,109	0,057
TA	**-0,690**	0,469	**0,709**	0,276	**1**	**0,726**	**0,894**	0,341	0,615	**0,874**	0,129
TH	-0,647	0,285	**0,798**	0,322	**0,726**	**1**	**0,878**	**0,853**	**0,758**	0,629	0,502
Mg 2+	**-0,782**	0,278	**0,852**	0,309	**0,894**	**0,878**	**1**	0,499	**0,764**	**0,905**	0,302
Ca 2+	-0,318	0,213	0,515	0,246	0,341	**0,853**	0,499	**1**	0,540	0,152	0,579
Cl -	-0,393	0,279	**0,957**	0,204	0,615	**0,758**	**0,764**	0,540	**1**	**0,681**	0,435
SO4-2	**-0,731**	0,403	**0,775**	0,109	**0,874**	0,629	**0,905**	0,152	**0,681**	**1**	0,229
NO3-	-0,145	0,590	0,365	0,057	0,129	0,502	0,302	0,579	0,435	0,229	**1**

The applied PCA shows that the factorial F1F2 contains 70.18% of the information and the rest is shared by the other plans (Tables 2).

Tableau 2. Eigenvalues of the Principal Components Analysis.

	F1	F2	F3	F4	F5	F6	F7	F8
Valeur propre	6,176	1,544	1,362	0,879	0,642	0,332	0,044	0,021
Variabilité (%)	56,147	14,039	12,385	7,987	5,837	3,020	0,399	0,187
% cumulé	56,147	70,186	82,571	90,558	96,394	99,414	99,813	100,000

The circle of correlations (Figure: 13) makes it possible to distinguish that TH, Cl^-, Conductivity, Mg^{2+}, TA, SO_4^{2-}.
However, the potential of hydrogen, turbidity, Ca^{2+}, NO_3^- are weakly correlated with the two axes F1 and F2.

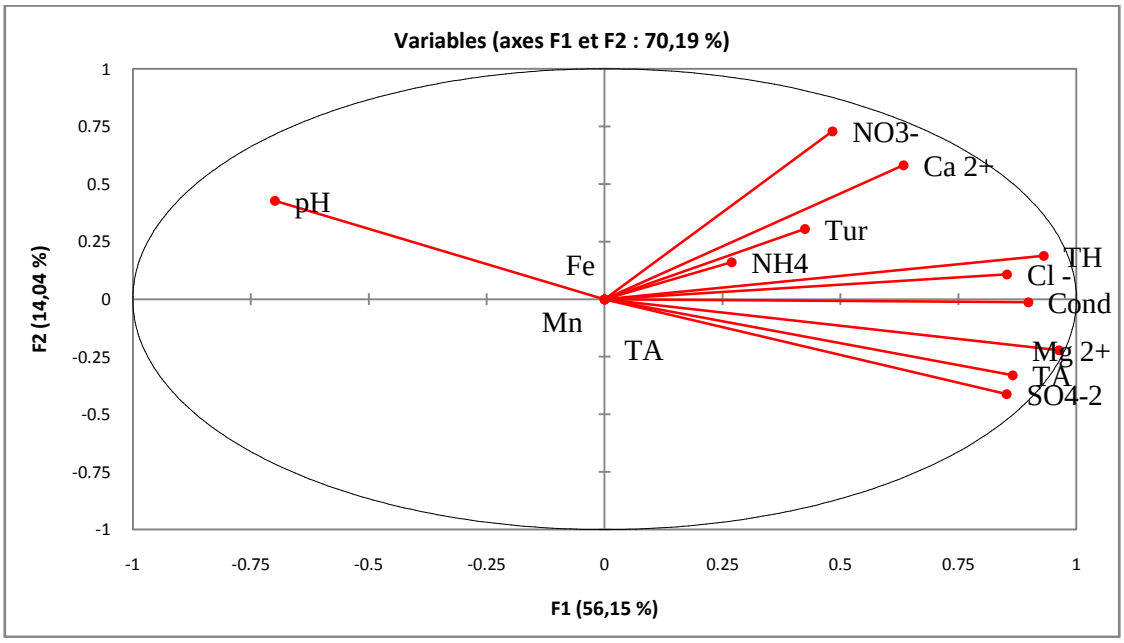

Figure 13. Circle of correlations of the physicochemical variables of the Sidi Kacem wells.

The typology of sampling stations or wells (Figure 14) shows a double gradient along the axis F1 and the axis F2 in the form of a circle. No grouping is visible only a progressive variation of the stations.

CONCLUSION

Water pollution affects the life of aquatic ecosystems, the food web and the health of the population. Among anthropogenic activities, agricultural activity is the main source of coupled water pollution and water pollution by hospital activities as well as surface water filtration. All these results show the acuity of the problem generated on the groundwater.

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