

The Evaluation of the Physicochemical Quality of Ground Water in the Region of Sidi Taibi-Morocco

Naima Bentoutou^{1,2*}, Omar El Rhaouat¹, Fatima Raibi², Abdelaziz Chaouch¹

¹Laboratory of Biotechnology, Quality and Environment. Department of Chemistry, Faculty of Science, University Ibn Tofail PB 133 1400- Kénitra, Morocco.

²National Center of Energy, Science and Nuclear Techniques B.P.1382 R.P.10001-Rabat-Morocco.

Abstract -

Background: Groundwater pollution is becoming more and more important and concerns about its use for food represent a health hazard [1]. In view of this degradation of the quality of these waters, we proposed to conduct a study to evaluate the physico-chemical quality of the waters of twenty-one representative wells located in the Sidi Taibi region. The latter is known for its important agricultural potential exploiting these underground waters of the Maâmora aquifer.

Objectives: The objective of this study was to evaluate the physical and chemical quality of groundwater including twenty-one representative wells in the rural commune of Sidi Taibi (province of Kénitra) during a sampling campaign in 2015.

Methods: The physical parameters, in situ and laboratory measurements allowed to characterize the groundwater enveloping Sidi Taibi. SO, facts of pH, temperature, electrical conductivity by integrated mobile hardware measurements and analysis of non-type HANNA pH-meter (HI98150) thermometer and conductivity (HI9033), so that the parameters of other analyzes were carried out within the Radiation Laboratory of the National Center for Energy, Nuclear Measurement Science and Technology.

The statistical analysis of the results obtained is based on the comparison of the averages of the various parameters measured. We used maxima and minima to evaluate changes in these parameters for selected sites and for well-defined periods. We also carried out a principal component analysis of the different values obtained through the XLStat software (2014), in order to highlight the possible relationships between the evolution of the parameters.

Results: The results obtained show that most of the physicochemical parameters involved in determining the quality of these waters comply with the standards of Morocco [2] and those of the WHO [3]. However, we obtained non-conformance values for ammonium analysis, complete alkalimetric titer and turbidity. These parameters can be considered as indicators of the degree of pollution of this groundwater originating from the domestic and agricultural activities of the population of the region.

Conclusions: In the light of these results, as well as those described above, we advocate continuous monitoring of the parameters studied for wells with abnormal values, in particular P₁₆, until the competent authorities connect the villages Region of Sidi Taibi to the drinking water network and the sewerage network. Also, a campaign to sensitize the population on the basic means and techniques of treatment of water intended for human consumption.

Keywords: Groundwater, Quality, Physical Chemistry, ACP.

1. INTRODUCTION

In Morocco, groundwater is an important part of the hydraulic heritage of the country [4], due to its relatively easy operation. However, it is faced with quantity and quality problems. It became threatened by various sources of contamination (domestic, industrial, agricultural ...). In fact, the pollution of groundwater is one of the most disturbing aspects and the use of these waters for food is a danger against health [1]. Faced with this worrying situation of the quality of the water, a contribution was aimed to evaluate the physical and chemical quality of 21 representative wells in the rural commune of Sidi Taibi which is characterized by a significant agricultural potential nurseries by exploiting these underground water.

The groundwater in the region of Sidi Taibi is used for drinking and agriculture which induce a physicochemical health problem due to the ammonium ions and the full alkalinity and turbidity that has proven to be abnormal in almost all wells and could therefore affect the health of people who draw water from these wells.

Environmental Study

The rural commune of Sidi Taibi is part of the province of Kenitra. It is bounded by the Atlantic Ocean in the west, the urban agglomeration of Kenitra in the north, the rural commune of Haddada in the east and the rural commune of Bouknadel (prefecture Salé Al Jadida) in the south (Fig.1). It occupies, therefore, an intermediate space between two large cities particularly dynamic (Rabat-Sale and Kénitra). The area of this municipality covers 145 km², of which about 2/3 are covered by Maâmora forest. This area is part of the aquifer of the Maamora which represents a very important hydraulic potential across the country and contributes to the development of economic, industrial and agricultural activities. Similarly, the catchment area of Sidi Taibi contributes to the production of drinking water for the ASP Kenitra Mehdiya, Bouknadel and Salé [5]. The climate in Sidi Taibi is warm and temperate with a winter characterized by more precipitation in summer. This locality has an annual average temperature of 18.0°C and average annual rainfall of 558 mm.

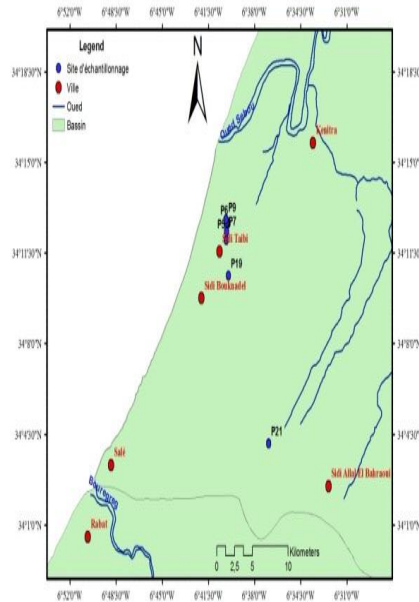


Figure 1: Location of study sites in Sidi Taïbi (Rabat-Sale and Kenitra)

2. MATERIAL AND METHODS

The study was conducted on water samples from some rural wells in the Sidi Taïbi region during a sampling campaign in 2015.

The physicochemical parameters measured in situ and in laboratory were used for the characterization of these waters. The collection, transportation and storage of water samples refer to the protocol defined by the French Agency for Standardization [6, 7]. The physicochemical analyzes were measured in situ (pH, temperature, electrical conductivity) by a type of portable analysing devices HANNA "pH meter (HI98150) and conductivity (HI9033)." Analyses of other parameters were performed in the laboratory of chemical monitoring unit of the environment within the National Centre of Energy, Science and Nuclear Techniques by using some techniques and the following apparatus: Salinity and Sediment dissolved rate were measured by conductivity meter laboratory inoLab Cond Level2. The material in to cellulosic suspension by filtration of 0.45 mm in diameter, the turbidity was measured by nephelometry by using a HACH turbidimeter-

type Model 2100AN, chlorides and alkalinity were determined by titration [8], the ammonium ions and the dissolved organic material were determined by using a V-530 spectrophotometer Jasco [6].

The statistical analysis of our results is based on the comparison of the average of the different parameters measured. We used the maxima and minima to evaluate the changes in these parameters to certain sites and for specific periods.

3. RESULTS

The physicochemical results represent the average values of 21 study sites in the rural commune of Sidi Taïbi, operated by a statistical principal component analysis (PCA) that we do explore the correlation between the different variables.

Table1: Overview of the physicochemical results of groundwater in Sidi Taibi, Morocco

Puits	pH	T	CE	Sal	TDS	Turb.	MES	TA	TAC	Cl ⁻	MO	NH ₄ ⁺
P1	6,96	18,60	763	0,20	755	3,63	0,40	0	655	92,30	0,003	0,0061
P2	7,10	18,80	700	0,10	694	4,42	0,40	0	571	99,40	0,003	0,0052
P3	7,00	18,80	748	0,20	741	3,38	0,40	0	555	85,20	0,007	0,0046
P4	7,11	18,60	660	0,10	655	1,02	0,80	0	555	99,40	0,006	0,0090
P5	6,99	17,80	1119	0,40	1109	1,05	0,80	0	655	134,90	0,014	0,0020
P6	6,72	17,50	867	0,20	860	5,97	0,40	0	703	106,50	0,012	0,0005
P7	7,00	11,00	859	0,20	854	2,02	0,80	0	255	106,50	0,010	0,0241
P8	6,98	10,40	894	0,30	886	4,96	1,60	0	315	99,40	0,016	0,0042
P9	6,94	10,20	817	0,20	809	9,02	2,00	0	655	78,10	0,017	0,0006
P10	6,88	10,20	1033	0,30	1023	6,68	0,40	0	855	113,60	0,026	0,0056
P11	6,95	10,40	906	0,30	898	12,9	1,60	0	715	106,50	0,011	0,0098
P12	6,90	10,10	1089	0,40	1080	5,03	1,20	0	735	120,70	0,017	0,0079
P13	6,96	10,50	1097	0,40	1088	12,00	1,20	0	795	131,30	0,031	0,0063
P14	6,90	10,90	1047	0,30	1038	4,90	1,20	0	675	113,60	0,002	0,0071
P15	6,93	11,70	1249	0,50	1238	13,30	0,80	0	835	156,20	0,028	0,0046
P16	6,90	11,80	939	0,30	931	1,80	1,60	0	1487	106,50	0,001	0,6540
P17	6,98	12,30	873	0,20	866	8,14	2,00	0	695	85,20	0,022	0,0078
P18	6,95	12,00	849	0,20	841	1,80	0,80	0	691	78,10	0,001	0,00105
P19	6,31	13,50	386	0,20	821	1,01	1,60	0	115	106,50	0,008	0,0063
P20	6,27	21,30	644	0,10	671	3,57	0,80	0	615	71,00	0,01	0,0196
P21	7,24	14,70	814	0,20	807	0,56	1,60	0	683	99,40	0,006	0,0019

T (° C):Temperature; pH: Hydrogen Potential ;EC (μS/cm): Electrical conductivity; TDS (mg / l): Levels of Dissolved Salts; Sal (%) Salinity; MES (mg/l): Suspended matter TA (mg / l): Titlealkaline; TAC (mg/l): FullTitlealkaline; Cl⁻(mg / l) Chloride; NH₄⁺ (mg/l): ammonium compounds; Turb: Turbidity (NTU); MO: organic matter(mg/l).

Descriptive statistics

The following table presents descriptive statistics characterized by the minima and maxima of the physicochemical parameters with standard deviations between study sites.

Table 2: Descriptive statistics of physical and chemical parameters of groundwater in Sidi Taibi,

Variables	Observations	Minimum	Maximum	Mean	SD
T	21	10,10	21,30	13,86	3,78
CE	21	386,00	1249,00	873,95	195,01
Sal	21	0,10	0,50	0,25	0,11
TDS	21	655,00	1238,00	888,81	156,70
Turb	21	0,56	13,30	5,10	3,96
MES	21	0,40	2,00	1,06	0,54
TA	21	0,00	0,00	0,00	0,00
TAC	21	115,00	1487,00	657,86	264,22
Cl ⁻	21	71,00	156,20	104,30	20,34
MO	21	0,001	0,03	0,01	0,01
NH ₄ ⁺	21	0,0005	0,65	0,04	0,14

4. DISCUSSION AND CONCLUSION

The average value of the temperatures of the order of 13.86°C oscillating between 10, 1°C and 21.3°C (Table.1). These values remain acceptable according to the current French regulations retaining the value of 25°C [9], and the average value of pH is about 6.9, which complies with the study done by [10].

Similarly the average values of electrical conductivity (873.95µS /cm) and chloride (104.3 mg /l) are respectively conform to Moroccan standards to 2700 µS / cm and 750 mg/l [11].The suspended matter contents recorded ranged from 0.4 mg / l and 2.0 mg / l with an average value of about 1.07 mg / l which conforms to the standard of 1000 mg/l[12].The organic matter concentration is negligible of average value of 0.01 mg / l. Likewise, the TDS has a variation in concentration between 655 and 1238 mg / l with an average value of about 888.81 mg / l with a salinity of 0.25 %.On average, the values of turbidity wells (P₆, P₉, P₁₀, P₁₁, P₁₂, P₁₃, P₁₅ and P₁₇) are above the norm for human consumption that is 5 NTU which is set by the [13] with the exception of the remaining wells. Then the values of ammonium ions, oscillating between 0.0005 mg / l and 0.65 mg / l, are lower than the Moroccan standards with 0.5 mg / l of ammonianitrogen [12] and those of the WHO [3] with the exception of wellP₁₆ (0.5 <0.65 mg / l).The alkalimetric contents are zero in all the treated water wells while the values in full alkalinity range from 115 mg /l to 1,487 mg /l exceeding the Moroccan standard for drinking water 200 mg /l[12],which makes these groundwater of poor quality.

Application of principal component analysis

Table 3: proper values

	F1	F2
proper values	4,84	1,8 3
Variability (%)	48,42	18,26
Cumulative%	48,42	66,69

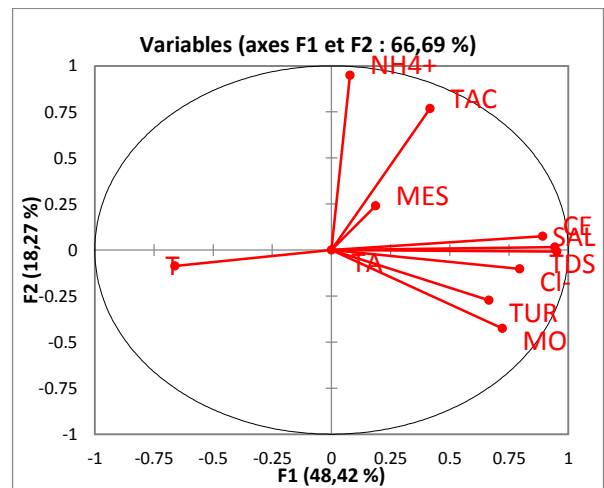


Figure 2: Projection of variables on the factorial plane F1 x F2 (61.22%)

This projection shows that the following variables: salinity, chlorides, TDS, turbidity, electrical conductivity and the organic material are positively correlated to the axis F1, but the opposite temperature is negatively correlated to this axis. However, both TAC and NH₄⁺ are positively correlated variables on the axis F2.

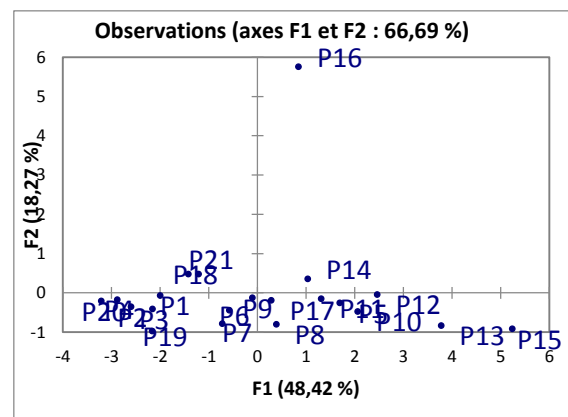


Figure3.Projection of individuals on the factorial plane F1 x F2 (61.22%)

