

# Groundwater of the Maamoura Water Table Morocco



**Hamdan Abderrahim, Chaouch Abdelaziz**

**Abstract:** This study was conducted to characterize the quality of groundwater. It was done in a design office. In this context, an illustration of the groundwater quality of the kenitra salted flats region, which constitutes, by five layers, the maamoura sheet. We sampled 2 3 wells.

These analyzes show that the temperature of these waters complies with the standards, the same for the potential of hydrogen against the level of chloride, total chlorine and free chlorine largely exceeds the Moroccan standards of drinking water.

So we see that it is necessary to make treatments before using this water so as not to have consequences on their health, especially for children, who are more sensitiv .

**Keyword:** In this context, an illustration of the groundwater quality of the kenitra salted flats region, which constitutes, by five layers, the maamoura sheet. We sampled 2 3 wells.

## I. INTRODUCTION

Morocco is facing environmental problems, sometimes quite serious. This situation is due to population growth, rapid urbanization and insufficiently proactive management of resources to meet the needs generated by economic development.

For this purpose, we have chosen physicochemical elements as an indicator of inorganic pollution in the groundwater of the maamoura nappe.

## II. MIDDLE-METHOD STUDY

### II-1-Field of study

The Maamoura water table covers an area of about 4000 square kilometers and is a free water table fed solely by the infiltration of precipitation in the subsurface . It constitutes a large reservoir of water (134 M m<sup>3</sup>/ year of renewable resources .

This study was conducted on 2 3 wells distributed at the level of the Maamoura water table, the Maamoura zone within the Rabat-Salénenitra region . The samples were taken over four periods during the year 2016-2017:

The first period : summer between June and August 2016.

The second period, autumn, between September and November 2016.

The third period : winter, December 2016 and February 2017.

The fourth period : the spring between March and May 2017 .

We will , at first, to characterize the physico-chemical water quality of 20 wells with a discussion in relation to the standards and previous studies.

### II-2-Method of study

Samples Were taken at Each well using a small bucket , weighed and Stored for 72 hours in 1.5 L mineral water plastic 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 .

## III. DESCRIPTIVE ANALYSIS

### III-1-Temperature

The results obtained show that the temperature varies widely from one source to another, ranging from 13 ° C in winter to 23 ° C in summer (Table 1 ). These values remain similar to those reported by Belghiti in 2015 [1] .

**Table 1: Spatial variations of the mean, minimum and maximum values of water temperature in the wells of the Maamoura aquifer .**

WELL	Average	Minimum	Maximum	Standard deviation
P1	15,00	13,10	17,00	1.83
P2	16.75	13.04	19,00	2.63
P3	17,00	13,11	20	3.16
P4	17.75	13,2	22,00	3.69
P5	20.58	20,21	21,30	0.68
P6	21.25	20	22,00	0.96
P7	17.5	13.02	21,00	3.32
P8	15.75	13,10	19,00	2.75

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P9	14.5	13.03	18,00	2.38
P10	15.5	13, 15	19,00	3
P11	16.98	14.91	19,00	1.86
P12	18.60	17,00	21,00	1.96
P13	17.45	15,00	22,00	3.12
P14	20.85	18,00	23,00	2.18
P15	20.30	19,70	21,00	0.57
P16	19.43	18,00	21,00	1.23
P17	17.75	14,00	20	2.63
P18	19.20	17,00	22,00	2.07
P19	20.6	19,00	21.4	1.08
P20	20.13	18,00	22,00	1.65
P21	18.75	16,00	20	1.89
P22	17.25	16,00	18,00	0.96
P23	20	17,00	22,00	2.16

Temperatures that exceed 25 ° C (Maamoura wells) could lead to the proliferation of biofilm and the proliferation of bacterial flora in the water pipes [2] .

These temperatures would induce a decrease in performance [3]. They are even the cause of under consumption in young chicks [4,5].

### II. 2 .Potential hydrogen ( pH )

At the Maamoura water table, values ranged from 6.67 at P14 in winter to 8.95 at P16 in fall (Table 2). Only wells 15 and 16 showed values greater than 8 . These results remain globally in the standards.Indeed, the European standards are between 5.5 and 7.5 [6] while Carter and Sneed [7] recommend a pH between 6.8 and 7.8 ; acidity could lead to digestion and corrosion of watering equipment [7, 8] and demineralization especially in laying hens [9] . However, the alkaline waters of wells 6, 11, 15, 17, 19 and 20 could favor the formation of the biofilm and subsequently lead to a significant drop in performance [2]. While there has been reported a significant decrease in food consumption in the case of acidic waters and gizzard ulcers in the case of very acidic waters (less than 5) [10, 11] .

**Table 28: Spatial Variations of Mean, Minimum and Maximum pH Values of Water in Maamoura Wells**

WELL	Average	Minimum	Maximum	Standard deviation
P1	7.37	7.10	7.80	0.31
P2	7.62	7.22	8.04	0.35
P3	7.37	7.07	7.70	0.26
P4	7.20	6.85	7.60	0.36
P5	7.40	7.13	7.60	0.20
P6	7.50	7.30	7.90	0.27
P7	7.46	7.11	7.90	0.34
P8	7.42	6.96	7.87	0.49
P9	7.41	6.90	7.70	0.36
P10	7.30	7.20	7.40	0.08
P11	7.34	6.89	7.70	0.42
P12	7.43	6.99	7.63	0.30
P13	7.43	6.95	7.75	0.35
P14	7.06	6.67	7.38	0.34
P15	7.76	7.16	8.86	0.79
P16	7.69	7.09	8.95	0.85
P17	7.21	6.80	7.70	0.41
P18	7.49	7.01	7.85	0.41
P19	7.34	6.90	7.85	0.42
P20	7.28	6.78	7.60	0.35
P21	7.30	6.95	7.90	0.42
P22	7.04	6.80	7.50	0.31
P23	7.18	6.80	7.80	0.43

These results are similar to those recorded during the work of Oueslati (in Tunisia) [12,13, 1] , On the other hand they are lower than those reported by Akchour in 2003 (Morocco) [14] and Balloy in 2001 (in France ) [ 15] .

**Table 3: Spatial Variations of Mean, Minimum and Maximum Values of Water Hardness in Maamoura Wells**

WELL	Average	Minimum	Maximum	Standard deviation
P1	32.75	20.50	47.50	11.48
P2	50.88	35.00	69.00	16.26
P3	49.63	41.00	65.00	10.64

### II-3- Total hardness

The values of the hardness vary between 14 ° F in the wells 13 and 15 in the spring and 76 ° F in the wells 11 and 18 fall ( Table 3 ) .

P4	49.75	46,00	53,00	2.99
P5	47.75	36,00	65,00	13.52
P6	59.88	55.50	62.50	3.09
P7	39.38	36.50	42,00	2.56

P8	39.75	30,00	52,00	9.18
P9	58,00	32,00	75,00	18.42
P10	45.88	30,00	62,00	13.52
P11	61.50	35.50	76,00	17.91
P12	45.88	43,00	49,00	2.84
P13	26.25	14,00	35,00	9.39
P14	33.25	20.00	48.50	13.49
P15	30.75	14,00	48,00	13.89
P16	55,00	43,00	66,50	11.07
P17	49.63	40.50	61,00	8.94
P18	53.75	31.50	76,00	22.26
P19	36,00	20.50	55.50	14.50
P20	55.75	43.50	69,00	13.63
P21	53.63	50,00	60,00	4.50
P22	42.88	31.50	66,00	15.97
P23	58.50	49,00	64,00	6.86

**II-4-Nitrates and nitrites**

The nitrate levels in the Maamoura aquifer range between 0.5 and 17 mg/L (Table 4) , the standards are below 50 mg / L , while the nitrite varies between 0.001 and 0.07 mg / L of water. , the normal rate nitrite is fixed at 0.1 mg / l (table 5). Belghiti in 2015 [1] reported values of 41 to 73 mg / L in nitrates while Abdelmoutalib reported 2.7to 140 mg /L and in

the maamoura region , while Coulibaly found 12 to 117 mg /L , Akchour reported 0 to 68 mg / L and Oueslati found 3 to 283mg / L.

These values lower than those reported from France by Balloy are between 46 and 315 mg/L. For nitrites Belghiti described 0 to 5 mg/L and Oueslati 0 to 1 mg/L while Balloy found 0 to 25 mg/L.

**Table 4: Spatial variations of average, minimum and maximum values of water nitrite in the wells of the Maamoura nappe .**

WELL	Average	Minimum	Maximum	Standard deviation
P1	0,009	0,005	0,018	0,006
P2	0,014	0,009	0,028	0,009
P3	0,017	0,008	0,030	0,010
P4	0,006	0,004	0,008	0,002
P5	0,006	0,004	0,011	0,003
P6	0,021	0,001	0,058	0,026
P7	0,043	0,001	0,060	0,028
P8	0,011	0,008	0,015	0,003
P9	0,004	0,003	0,005	0,001
P10	0,009	0,007	0,014	0,003
P11	0,005	0,003	0,007	0,002
P12	0,008	0,004	0,016	0,006
P13	0,009	0,005	0,017	0,005
P14	0,024	0,001	0,071	0,032
P15	0,006	0,002	0,014	0,006
P16	0,005	0,001	0,008	0,003
P17	0,009	0,001	0,016	0,006
P18	0,005	0,004	0,006	0,001
P19	0,012	0,003	0,039	0,018

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<b>P20</b>	<b>0,006</b>	<b>0,002</b>	<b>0,010</b>	<b>0,003</b>
<b>P21</b>	<b>0,008</b>	<b>0,003</b>	<b>0,016</b>	<b>0,006</b>
<b>P22</b>	<b>0,008</b>	<b>0,002</b>	<b>0,015</b>	<b>0,006</b>
<b>P23</b>	<b>0,005</b>	<b>0,002</b>	<b>0,007</b>	<b>0,002</b>

**Table 5: Spatial Variations of Mean, Minimum and Maximum Values of Water Nitrates in the Wells of the Maamoura Water Table**

<b>WELL</b>	<b>Average</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Standard deviation</b>
P1	1,350	0,900	2,000	0.465
P2	2,025	1,100	4,000	1,340
P3	2,425	1,300	4,600	1,480
P4	0,993	0,070	1,500	0.652
P5	2,400	1,700	3,400	0.744
P6	1,825	0,800	3,500	1,164
P7	1,725	1,200	2,400	0.512
P8	5,250	1,600	13,100	5,292
P9	1,250	0,700	1,600	0.404
P10	5,410	0,040	17,300	8.054
P11	4,600	2,700	9,000	2,952
P12	5,450	3,000	8,800	2,680
P13	1,325	0,900	2,100	0.532
P14	3,350	2,300	4,700	0,998
P15	1,600	1,200	2,000	0.337
P16	2,900	1,900	4,900	1,364
P17	5,325	3,300	7,500	1,823
P18	0,900	0,700	1,200	0,245
P19	4,100	3,000	5,700	1,225
P20	2,250	0,500	4,500	1,886
P21	3,075	1,800	4,000	1,063
P22	4,125	0,700	6,600	2,555
P23	3,975	3,700	4,200	0.222

### II. 5-chloride

At the Maamoura aquifer, chloride levels ranged from 1239 mg / L at well 8 in the fall to 21 mg / L at well 15 in winter (Table 6). The region of Sidi Slimane has wells with very high chloride concentrations . Wells 3, 4, 5, 6, 7, 8 and 10 have concentrations that exceed the standards .

But, according to Olkowski (2009), animals could tolerate up to 1000 mg / L while regulating their acid-base balance. However, salty water (> 500 mg / L), such as well 18, could affect its consumption and consequently the consumption of the food, which would lead to lower performance [16] . In addition, a water rich in chlorides induces a softening of the droppings and therefore the degradation of the litter which would lead to a not inconsiderable drop in performance [17]

**Table 5: Spatial Variations of Mean, Minimum and Maximum Values of Water Chlorides in the Wells of the Maamoura Water Table**

<b>WELL</b>	<b>Average</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Standard deviation</b>
P1	188.15	145.55	255,60	47.19
P2	209.45	170.40	241.40	34,05
P3	756.15	702.90	816.50	46.56
P4	554.69	454.40	599.95	68.92
P5	729.53	678.05	798.75	55.41
P6	580.88	442.00	923.00	229.22
P7	472.98	255,60	731.30	207.18
P8	557.74	256.00	1238.95	462.32
P9	269.34	97.70	584.00	215.03
P10	530.66	181.05	1223.00	490.35
P11	104.73	60.35	138.45	32.60
P12	104.73	85.20	138.45	24.34
P13	86.55	46.15	106.50	27.33
P14	103.84	63.90	152.65	36.71
P15	55.03	21,30	127.80	49.74
P16	91.41	46.15	173,93	57.33
P17	176.25	124.25	220.10	39.93
P18	139.34	81,65	198,80	48.19
P19	65.68	42.60	102.95	26.96
P20	165.08	142.00	209,45	31.82
P21	137.56	113.60	198,80	41.13

P22	92.48	42.60	131.35	38.08
P23	111.83	78.10	156.20	33.07

**II. 6 . Salinity**

According to the results of the analyzes obtained in Gharb and Saïss , the salinity contents are moderately concentrated ( Table 7 ). Well P8 showed a salinity of 2.3 ppt during the second and fourth periods. Wells 3 , 4.5 , 6.7, 8 and 10 have values averaging about 1.5 ppt over the four periods.

The water from these wells could lead to stagnation or even weight loss in chickens and in extreme cases high mortality [18] . In young people, the salinity of the water would result in diarrhea and mineral leakage that would have negative consequences on ossification, as well as the appearance of the phenomenon of dirty eggs and the weakening of the shell in laying hens and breeding hens ( 19 ; 20 , 21, 22 , 23).

**Table 7: Spatial Variations of Mean, Minimum and Maximum Values of Water Salinity in the Wells of the Maamoura Water Table**

WELL	Average	Minimum	Maximum	Standard deviation
P1	0.38	0.30	0.40	0.05
P2	0.38	0.20	0.50	0.15
P3	1.73	1.70	1.80	0.05
P4	1.33	1.10	1.60	0.22
P5	1.70	1.60	1.80	0.08
P6	1.40	1.00	1.90	0.46
P7	1.55	0.50	2.10	0.72
P8	1.83	0.60	2.30	0.82
P9	0.48	0.10	0.80	0.29
P10	2.05	0.50	3.60	1.79
P11	0.45	0.40	0.50	0.06
P12	0.48	0.40	0.50	0.05
P13	0.38	0.30	0.50	0.10
P14	0.43	0.40	0.50	0.05
P15	0.30	0.30	0.30	0.00
P16	0.40	0.40	0.40	0.00
P17	0.58	0.40	0.70	0.15
P18	0.40	0.30	0.50	0.08
P19	0.35	0.30	0.40	0.06
P20	0.50	0.40	0.70	0.14
P21	0.50	0.40	0.60	0.08
P22	0.33	0.20	0.50	0.13
P23	0.33	0.10	0.50	0.17

**II.7. Fe r**

In the Maamoura nappe, the total iron content varies between 0.01 mg / L and 0.3 mg / L ( Table 8 ), whereas the recommended iron-in-water concentration must be less than 0, 3 mg / L. The 're well 6 and 11 showed levels at the limit of acceptable threshold, this could lead to a decrease in water consumption [24] , increased risks of infections [25] and neoplasia compromising the first barrier

Immune defense ( Olkowski , 2009) .This water may be a significant risk factor for intestinal proliferation of *Clostridium botulinum* bacteria and the subsequent development of botulism [26,27]. In addition, iron affects the lifespan of live vaccines in drinking water and therefore affects the quality of vaccination .

**Table 8: Spatial variations of average, minimum and maximum values of water iron in the wells of the Maamoura aquifer .**

WELL	Average	Minimum	Maximum	Standard deviation
P1	0.053	0,020	0,100	0,036
P2	0,035	0,030	0,050	0,010
P3	0,095	0,050	0,200	0,070
P4	0.058	0,010	0,100	0,038
P5	0.048	0,010	0,120	0,052
P6	0.086	0,004	0,300	0.143
P7	0,021	0,004	0,030	0.012
P8	0,046	0.005	0,070	0,029

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P9	0,028	0,020	0,040	0,010
P10	0,045	0,030	0,070	0,017
P11	0.115	0,030	0,300	0.126
P12	0.068	0,020	0,170	0,071
P13	0,065	0,020	0,160	0.064
P14	0.088	0,020	0.210	0.090
P15	0,025	0,010	0,040	0,013
P16	0,038	0,010	0,070	0,025
P17	0.033	0,020	0,050	0,013
P18	0,023	0,000	0,040	0,017
P19	0,028	0,010	0,070	0,029
P20	0,030	0,010	0,060	0,022
P21	0,050	0,030	0,100	0,034
P22	0.068	0,030	0,150	0,056
P23	0,063	0,010	0,160	0.067

### II.8.Chlore free and total chlorine

The presence of chlorine in the water is generally beneficial for its disinfection, however highly chlorinated water is unsuitable for live vaccines in drinking water in poultry . It is decisive to know the rate of free and total chlorine before using this water. Byrd et al. 2003 reported that the effect of

chlorine can stay up to 72 hours in water pipes while standards should not exceed 1mg / L.

The recorded levels of free and total chlorine ( Tables 9 and 10 ) are normal at the Maamoura stations and hardly exceed 0.7 mg / L, so the waters of the Maamoura tablecloth meet the standards.

**Table 9: Spatial Variations of Mean, Minimum and Maximum Values of Free Chlorine Water in Maamoura Wells .**

WELL	Average	Minimum	Maximum	Standard deviation
P1	0.04	0.02	0.06	0.02
P2	0.04	0.01	0.05	0.02
P3	0.05	0.03	0.08	0.02
P4	0.05	0.04	0.06	0.01
P5	0.03	0.01	0.05	0.02
P6	1.09	0.03	4.25	2.11
P7	0.23	0.03	0.80	0.38
P8	0.05	0.01	0.08	0.03
P9	0.06	0.04	0.11	0.03
P10	0.10	0.05	0.25	0.10
P11	0.03	0.02	0.05	0.02
P12	0.03	0.01	0.05	0.02
P13	0.03	0.01	0.06	0.02
P14	0.05	0.03	0.06	0.02
P15	0.03	0.02	0.03	0.01
P16	0.02	0.01	0.03	0.01
P17	0.04	0.00	0.07	0.03
P18	0.02	0.01	0.02	0.01
P19	0.01	0.01	0.02	0.01
P20	0.02	0.01	0.03	0.01
P21	0.07	0.02	0.17	0.07
P22	0.02	0.01	0.03	0.01
P23	0.01	0.01	0.02	0.01

**Table 19: Spatial Variations of Mean, Minimum and Maximum Values of Total Chlorine Water in Maamoura Wells .**

WELL	Average	Minimum	Maximum	Standard deviation
P1	0.04	0.02	0.07	0.02
P2	0.05	0.02	0.10	0.04
P3	0.04	0.02	0.05	0.01
P4	0.04	0.02	0.07	0.02
P5	0.04	0.02	0.05	0.01



P6	0.87	0.01	3.38	1.67
P7	0.04	0.02	0.05	0.01
P8	0.06	0.01	0.09	0.03
P9	0.20	0.04	0.64	0.30
P10	0.02	0.00	0.04	0.02
P11	0.03	0.01	0.05	0.02
P12	0.04	0.01	0.09	0.04
P13	0.04	0.02	0.07	0.02
P14	0.04	0.03	0.07	0.02
P15	0.07	0.03	0.14	0.05
P16	0.02	0.01	0.03	0.01
P17	0.02	0.01	0.04	0.01
P18	0.03	0.01	0.04	0.01
P19	0.03	0.01	0.07	0.03
P20	0.03	0.01	0.07	0.03
P21	0.04	0.02	0.11	0.05
P22	0.02	0.01	0.04	0.02
P23	0.01	0.01	0.01	0.00

#### IV. CONCLUSION

This study will highlight the pollution of the maamoura nappe . It is necessary to seek averages for water treatment before use to avoid pose true public health problems .

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