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Physico-chemical pollution of Sebou river by wastewaters in Mechraa BelKsiri, Kenitra-Morocco

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Abstract.
Pollution of groundwater and surfaces is a major problem around the world. In Morocco due to population growth, industrial, agricultural and climate change the country is currently experiencing water stress and is expected to experience a water shortage in 2025 (less than 500 m^3 / inhabitant / year). In addition, according to the WHO, around 30,000 people per day, approximately 10 million per year, die due to insufficient or poor quality water supply and deplorable hygienic conditions (WHO, 1977).

The Sebou river is located in the western region of Morocco, which is a very important agricultural area and therefore experiences high pollution. The purpose of this study is to carry out an updated forecast on its pollution by Urban, Agricultural and Industrial activities. To achieve this objective, several series of samples of the Sebou waters and physicochemical analyzes were carried out (pH, Ca++, Na+, Mg++, Cl-, SO_4--, NO_3-,…).

To verify the hypothesis of pollution of the Sebou river by domestic and industrial wastewaters and by its tributaries, we compared its physico-chemistry with those of Moroccan standards and of the two main rivers in the region, namely the Beht river and the Ouergha river. The results show that Sebou is very loaded with salts (10581 µs / cm; 11g / L). On the other hand, the waters of Beht are less polluted by nitrates (14.34 mg / L) and sulphates (51.51 mg / L) but more loaded with Potassium (55.87 mg / L) and Magnesium. (107.62 mg / L). Finally, the waters of Oued Ouergha are even cleaner than other rivers.

Keywords: Sebou, River, Waters, Pollution, Mechraa Bel Ksiri, Kenitra, Morocco.

1 . Introduction

Water quality is defined by physical, chemical and biological parameters, but also by its use. Thus, water unfit for human consumption can be adapted to irrigation, fish farming or to cool industrial circuits [1, 2, 3]. The rational management of water resources in the Kenitra Gharb region has become the main issue for local decision-makers to adopt a fair policy and which takes into consideration the importance of this resource and the challenge of increasing water resources. his request.

The Oued Sebou and its tributaries drain an area of 34000 km^2. It extends for more than 600 km starting in the Middle Atlas under the name of Oued Guigou. It opens in the Atlantic to Mehdia, through its estuary 35 km in length. The rise of marine waters being stopped at the level of the guard dam, immediately downstream of Sidi Allal Tazi [4].

In addition, the Sebou River is home to many pollutant spills from a variety of sources. The Sebou watershed, an extremely important area from a socio-economic point of view, is one of the most affected areas in Morocco. The existence of two of the main agricultural plains of the country as well as the multitude and diversity of industrial units and urban wastewater effluents in the major cities of the basin (Fez, Meknes, Mechraa Bel Ksiri, Dar Gueddari, Kenitra), not to mention the uncontrolled dumping of household waste, which are the main causes of the deterioration of the quality of Sebou waters.

In our present study it is proposed to examine the physicochemical surface water of the Lower Sebou sub-basin between Mechraa Bel Ksiri and Kenitra. This characterization of the levels and concentrations of the organic and mineral loads of Sebou raw water consists of a monitoring of the pH, EC electrical conductivity, sodium, chloride, sulphate, calcium, magnesium, potassium, bicarbonate, ammonium and nitrates.

1. Materials and Methods

2.1 Study area

The Gharb region is bordered on the west by the Atlantic Ocean, bordered to the north by the pre-Rif hills and to the south by the Maâmora plateau (Figure 1). It is composed of a coastal zone (dune cordon, flooded depressions, interior dunes), continental borders and the central alluvial plain of the lower Sebou which is the main wadi. The Sebou Basin forms a basin between the Rif in the North, the Middle Atlas and the Meseta in the South, the Fez-Taza corridor in the East and the Atlantic Ocean in the West. With an area of approximately 38380 km^2. It is the most

important basin of the kingdom and currently contains a total population of about 5.73 million inhabitants, of which 49% in urban and 51% in rural areas. It is characterized by an agricultural and industrial economy that contributes significantly to the national economy (Figure 2).

The climate prevailing on the whole basin is of Mediterranean type with oceanic influence and inside the basin the climate becomes more continental. The Sebou basin has a very developed industrial activity. Large units at the basin scale are: sugar mills, paper mills, oil mills, tanneries, cement plants, the textile industry and the oil refinery.

The taking of a water sample is a delicate operation to which the greatest care must be taken, it determines the analytical results and the interpretation that will be given. In general, the sample must be homogeneous and representative, and not modify the physicochemical characteristics of the water (dissolved gas, suspended matter, etc.) [5].

Sampling equipment should be given special attention. The washing of the flasks will depend on the desired analyzes on the sample. The most frequently used sampling method is instant sampling. The vials are filled without shaking the water and sometimes without contact with the air [6, 7].

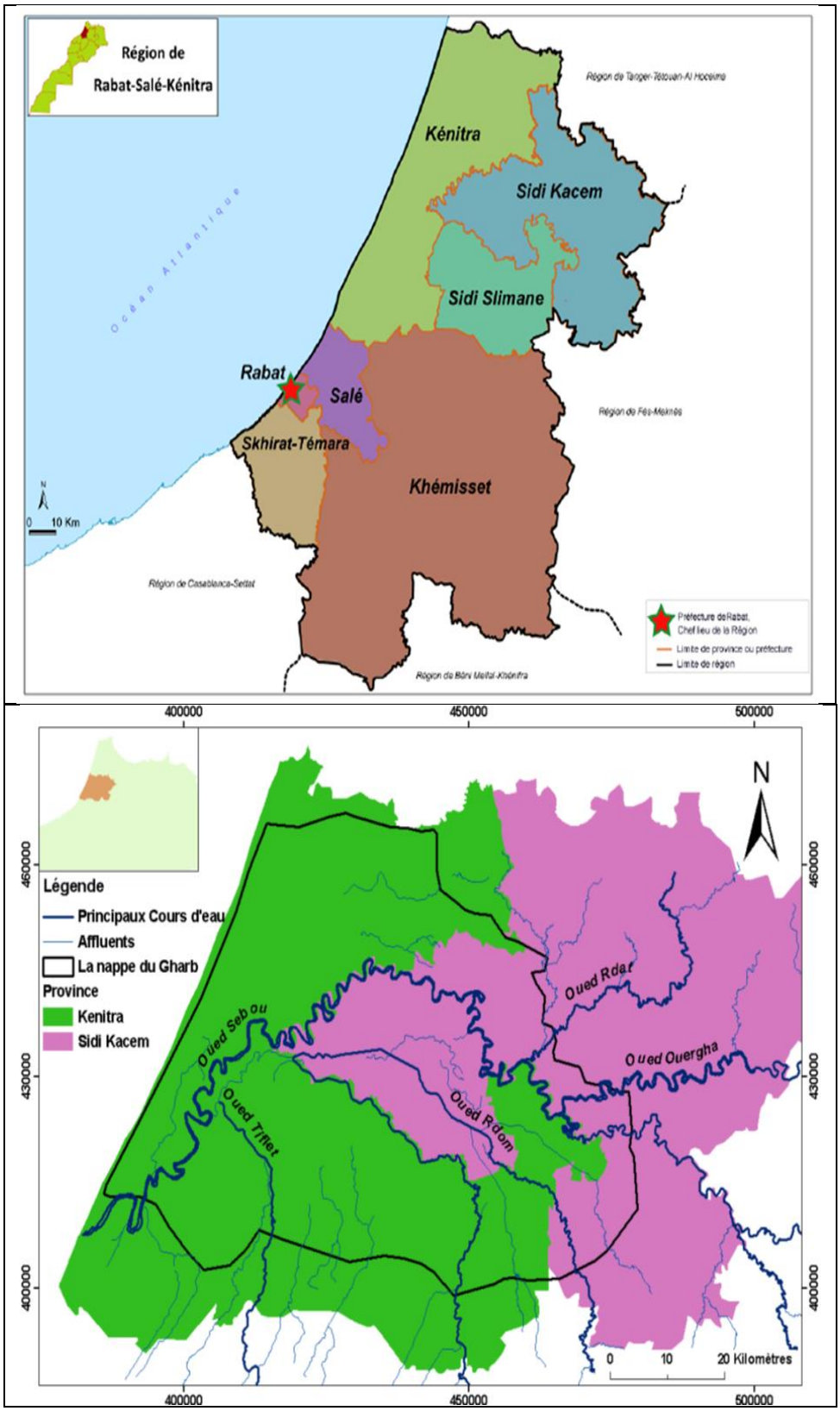

Figure 1: Localization of Sebou River and Gharb Basin

Figure 2: Sebou river and sampling area.

2. Study method

2.1 Sampling waters

1000 ml polyethylene bottles were previously rinsed with distilled water and then with the sample water in the field. Sampling was done in areas where the water is not stagnant and in the direction of flow. It is carried out in total immersion, so that the bottles are filled flush without air bubbles, in order to minimize the contamination on the one hand, and the evolution of the samples on the other. The water samples taken for analysis were transported at low temperature (4 ° C) in portable coolers to the laboratory where the analyzes were carried out.

In addition, from one company to another, the samples were taken at approximately the same time and place for the same station.

In the present study the parameters that were analyzed are: pH, electrical conductivity (EC), calcium (Ca ++), magnesium (Mg ++), sodium (Na +), potassium (K +), carbonate and bicarbonate (CO3-- HCO3-), chlorides (Cl-), sulphates (SO4-), ammonium (NH4 +) and nitrate (NO3-). Assays C831, Jenway flame photometer, NOVASPEC II pharmacy-type spectrophotometer, UV-Visible spectrophotometer [8, 9, 10, 11].

* Calcium and magnesium are determined by complexometry with EDTA in the presence of Eriochrome black T.

* Determination of carbonates and bicarbonates by a solution of 0.02N sulfuric acid in the presence of phenophthalein and bromocresol green as a colored indicator.

* Determination of the combined chloride in the chloride state by silver nitrate, in the presence of a solution of potassium chromate.

* Determination of sulfates by colorimetry by precipitation of sulphate ions in the presence of barium chloride in a hydrochloric acid medium in the form of barium sulphate.

* Determination of nitrates and ammoniums by distillation in the presence of a catalyst respectively magnesium oxide and alloy DEVARDA. NH4 + and NO_3- are collected in a boric acid solution and finally assay with H_2SO_4.

3. Results and Discussion

The evaluation of raw water pollution of the lower Sebou was made according to the determination of a certain number of physicochemical parameters characterizing the waters. In the light of this work which contributes to enriching the bases of the data accumulated on the Sebou basin, and to make it possible to clarify the degree of its pollution thanks to the results obtained during the period of our internship within the Regional Office of implementation. agricultural value of Kenitra.

It can be deduced from Tables 1 and 2 that the sub basin of the lower Oued Sebou is subject to different types of pollution of natural origin which are mainly mineral (by dissolution of the natural substrate, Atlantic tides) and anthropogenic (agricultural, industrial and urban).

The thermal regime of the Sebou hydrographic network follows that of the Mediterranean climate, cold in November and warmer in summer.

The pH does not show any significant variations and the waters are generally alkaline ranging between 8.0 and 8.77 (Table 1 and 3) following their crossing of limestone and marl-limestone soils characterizing the basin.

Mineralization accurately follows dissolved salt, salinity, chloride, sodium and potassium levels (Tables 1, 2 and 3). It results essentially from the leaching of the karstic limestone and kelp-like terrain and ocean spray. Indeed, the electrical conductivity that reflects salinity varies from 629 to 22760 µs / cm and far exceeds the Moroccan irrigation standard (> 2700 µs / cm) [12, 13, 14].

Table 1: Caractéristiques physico-chimiques des eaux de l'oued Sebou

Stations	T°C	pH	CE µs/cm	COD mg/L	NTU	Cl^- mg/L	Salinity g/L	TH °F	TAC
Sebou 1	13	------	----------	197,3	7,215	-------	4,98	--------	18,8
Sebou 2	16	7,65	2489	112,58	15,595	1140	2,68	73,45	14,51
Sebou 3	18	7,38	12570,71	195,2	6,62	5315	8,53	245,82	11,95
Sebou 4	18,5	7,615	3263,1	181,77	4,71	1430	2,37	88,3	14,83
Sebou 5	22	7,33	10434,17	185,62	7,46	4145	5,26	186,5	18,06
Sebou 6	25,5	7,2	11950	254,55	6,48	3965	8,96	235,75	19,14
Sebou 7	27	7,37	20171,43	363,64	15,38	6900	17,42	324,93	25,55
Sebou 8	27	7,075	1401,11	211,27	12,7	560	10,88	48,33	14,73
Sebou 9	27	7,36	15652,7	102,11	17,76	5760	8,48	218,55	12,29
Sebou10	27	7,46	12898,57	--------	--------	4920	---------	200,57	39
Sebou11	12	------	----------	9,6	3,89	-------	0,93	--------	25
Sebou12	13	8,05	7380	9,6	4,27	2800	0,74	284	15
Sebou13	15	7,92	29600	19,2	4,67	12780	1,75	536	22,5
Sebou14	15	7,89	16900	9,6	2,17	7740	0,58	328	25
Sebou15	20	7,79	17600	9,6	4,08	7040	1,4	304	39
Sebou16	22	7,45	21400	28,8	3,79	6810	1,99	380	30
Sebou17	23	7,95	26300	19,2	7	9940	10,06	490	25
Sebou18	24	7,5	2490	38,4	8,45	1140	5,85	75	15
Sebou19	26	8,03	26800	19,2	8,2	10720	2,11	376	13
Sebou20	25	7,94	24000	--------	--------	9790	-------	334	9
Sebou21	14	------	----------	691,2	15	-------	13,45	--------	10
Sebou22	19	6,55	1150	278,4	66	420	4,6	40	9
Sebou23	19	6,98	2000	576	22,5	890	21,06	60	12
Sebou24	22	7,07	797	604,8	6,1	350	7,27	48	10
Sebou25	24	7,06	2900	499,2	16	1060	11,7	72	20
Sebou26	28	6,93	2500	662,4	16,2	1210	13,33	84	9
Sebou27	31	7,05	5220	940,8	28,3	2130	121,17	125	11
Sebou28	30	4,42	1100	624	26,4	350	18,37	35	----------
Sebou29	28	6,92	4450	230,4	42	1280	17,67	76	----------
Sebou30	28	6,9	2280	--------	--------	850	--------	66	----------

Table 2: Statistique descriptive de la physico-chimie des eaux de l'oued Sebou

Variable	Observations	Minimum	Maximum	Mean	Standard Deviation
T°C	30	12	31	21,97	5,60
pH	30	4,42	8,05	7,29	0,67
CE µs/cm	30	797	29600	10581,41	8854,86
DCO mg/L	30	9,60	940,80	262,02	251,05
NTU	30	2,17	66	14,04	13,18
Cl^- mg/L	30	350	12780	4127,22	3515,80
Salinité g/L	30	0,58	121,17	11,98	21,44
TH °F	30	35	536	197,60	139,38
TAC	30	9	39	18,09	8,01

Concerning the nitrate contents (Figure 6), the values oscillate between 0.24 mg/L and 2692 mg / L and clearly translate the pollution of agricultural origin by the nitrogenous fertilizers, the waste water and leachates of the wild discharges [15, 16, 17, 18, 19, 20, 21].

The Piper diagram shows that globally the waters of the lower Sebou are hyper-chlorinated calcium, hyper-sulphated calcium, chlorinated sulphated calcium and magnesium or chlorinated sodium and potassium or sulphated sodium [22, 23].

Table 3: Physicochemical data (Anions) of the raw waters of the lower Sebou.

Stations	pH	NO_3- mg/L	CL – mg/L	SO_4-- mg/L	HCO_3- mg/L	CO_3- mg/L
S1	8,62	9,3	213	314,64	233,02	12
S2	8,65	10,42	161,88	159,18	214,72	18
S3	8,39	0,24	202,35	150,25	213,5	6
S4	8,46	17,11	154,78	141,18	275,72	0
S5	8	63,36	243,53	181,94	246,44	0
S6	8,12	20,58	202,35	151,62	362,34	0
S7	8,69	86,92	248,5	183,59	241,56	21,6
S8	8,33	188,6	385,53	258,32	323,3	13,2
S9	8,49	827,9	230,4	106,7	75,64	0
S10	8,24	2692	860,27	113,1	122	0
S11	8,4	260,8	269,09	37,62	100,04	0
S12	8,31	886,9	476,41	276,57	84,18	0
SD13	8,77	94,6	461,31	359,29	246,44	49,2
SD14	8,21	162,2	397,7	441,4	178,12	42
SD15	8,73	59,9	304,59	248,5	241,56	18
SD16	8,33	693,8	145,55	54,04	108,58	0

Table 4: Physicochemical data (Cations) of the raw waters of the lower Sebou.

Stations	Ca2+ mg/L	Mg2+ mg/L	K+ mg/L	Na+ mg/L	NH4+ mg/L	TH mg/L	CE µS/cm
S1	97,6	89,04	6,44	1240	0,18	6,15	1190
S2	118	46,56	6,24	1270	0,43	4,89	1120
S3	126,4	59,52	2,54	1560	0,04	5,72	1240
S4	166,4	17,76	5,27	1360	0,68	4,9	1160
S5	150,8	44,4	4,29	1820	0,22	5,62	1430
S6	169,2	68,64	9,56	1330	0,18	7,09	1400
S7	148,4	51,36	4,68	1470	0,68	5,85	1490
S8	220,4	111,6	12,48	1840	0,5	10,16	2370
S9	217,6	17,28	3,71	51	0,68	6,16	629

S10	914,4	631,2	5,07	140	1,76	49,16	15820
S11	148,4	26,64	6,63	190	15,34	4,82	11960
S12	314,8	39,36	17,55	390	0,54	9,51	22760
S13	170,8	124,08	9,75	2530	2,66	9,44	2200
S14	1072,8	74,88	15,99	150	1,26	57,94	16700
S15	144,8	94,08	7,41	400	1,29	7,54	1660
S16	174	99,36	2,73	120	1,51	8,49	880

Moreover, the projection of physicochemical data in the Wilcox diagram and Wilcox Log, shows that the quality of the waters of the lower Sebou varies between mediocre and bad and rarely excellent and especially have a degraded quality because the alkalizing power of sodium (SAR). The waters of the lower Sebou are classified in the group C3S3 and C4S4 and are unfit for irrigation [24, 25].

Table 5: Physicochemical data (Cations) of the raw waters of the lower Sebou.

Statistics	pH	CE µS/cm	NH_4+ mg/L	NO_3- mg/L	CL – mg/L	SO_{4--} mg/L	HCO_3- mg/L
Nb. Observations	16	16	16	16	16	16	16
Minimum	8,00	629	0,04	0,24	145,55	37,62	75,64
Maximum	8,77	22760	15,3	2692,0	860,27	441,40	362,34
1st Quartile	8,29	1182	0,3	19,71	202,35	134,16	118,64
Median	8,39	1460	0,6	90,76	246,01	170,56	223,87
3rd Quartile	8,63	4767	1,3	369,05	388,57	262,88	246,44
Mean	8,42	5250	1,7	379,66	309,83	198,62	204,19
Variance (n-1)	0,05	5168589	13,6	469921	32578	12189	7337
Standard deviation (n-1)	0,22	7189	3,6	685	180	110	85,65

Table 6: Physicochemical data (Cations) of the raw waters of the lower Sebou.

Statistics	CO_3- mg/L	Ca2+ mg/L	Mg 2+ mg/L	K+ mg/L	Na+ mg/L	TH mg/L
Nb. Observations	16	16	16	16	16	16
Minimum	0,00	97,60	17,28	2,54	51,00	4,82
Maximum	49,20	1072,80	631,20	17,55	2530,00	57,94
1st Quartile	0,00	147,50	43,14	4,58	180,00	5,69
Median	3,00	167,80	64,08	6,34	1255,00	6,62

3rd Quartile	18,00	218,30	95,40	9,61	1492,50	9,45
Mean	11,25	272,17	99,73	7,52	991,33	12,71
Variance (n-1)	241	82648	21151	20	609766	259,62
Standard Deviation (n-1)	15,55	287,48	145,43	4,48	780,87	16,11

4. Conclusion

In Morocco, hydraulic and hydrological studies of rivers are scare. In the present study, it is proposed to characterize the physico-chemical surface water of the sub basin of the lower Sebou of Kenitra. The physicochemical characterization of the raw waters of the Sebou revealed that this Oued is very loaded with mineral and organic matters. For the electrical conductivity (EC), a wide variation in the chemical composition of the water varies between a minimum of 629 µS/cm and a maximum of 2370 µS/cm. The average pH is between 8 and 8.77. The pH is slightly basic but remains acceptable according to irrigation standards.

The ammonium concentration varies between 0.04 and 2.66 mg/L, for surface water quality 65% of the water is of medium quality and 35% of poor quality. Concentrations of nitrates NO_3- have a maximum value of 196.9 mg/L and a minimum value of 0.24 mg/L. It has also been found that the concentration of ion Cl- has a maximum value of 385.53 mg/L and a minimum value of 145.55 mg/L.

For SO4 - sulfate ion concentrations, the maximum value is 359.29 mg / l and the minimum value is 37.62 mg / l. The maximum and minimum bicarbonate ion concentrations are 362.34 mg / l and 75.64 mg / l and are consistent with the irrigation standard. Calcium Ca2 + ion contents range from 220.4 to 97.6 mg / L. For magnesium ion concentrations Mg2 + the maximum value is 124.08 mg / L and the minimum value is 17.28 mg / l and these values are in line with the irrigation standard. Na + ion concentrations in water range from 2530 mg / L to 51 mg / L. K + ion concentrations in surface waters range from 17.55 mg / L to 2.54 mg / L.

In conclusion, this study shows that the waters of the lower Sebou have a high mineral load but remain within the limits of the Moroccan irrigation standard. The waters of the Sebou are too polluted and we recommend that all domestic and industrial wastewater be treated appropriately to reduce the nuisance to the receiving environment and to compensate for the loss of this coveted and prized water resource.

Adjacent agricultural activities occur well in the waters of the Lower Sebou sub-basin by significant concentrations of nitrates and sulphates which enter the water stream by runoff and leaching of nitrogenous and phosphorus fertilizer and phytosanitary products [26], [26] 27]. The upstream-downstream distribution of physicochemical parameters, reflects deteriorated situations of water quality in salts and chlorides in relation to the rise of marine saline waters.

The present work has revealed the poor quality of the waters of the lower Sebou but remains incomplete and needs to be deepened by analyzes of trace heavy metals and pesticides to provide the scientific and technical bases for decision-makers [28, 29, 30].

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