Physical and Chemical Diagnosis of Lower Sebou River for Agricultural Use (GHARB - Morocco)

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Abstract— *In the present study, it is proposed to characterize the physicochemical of the water of the Lower Sebou sub-basin in the Gharb region used mainly in irrigation. The physicochemical characterization of the raw waters of the Sebou revealed that this river is very loaded with mineral and organic matters and have a wide variation in the chemical composition:*

**the electrical conductivity (EC), varies between a minimum of 629µS/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 standard;*
**the ammonium concentration varies between 0.04 and 2.66 mg/L;*
**concentrations of nitrates NO_3- have a maximum value of 196.9 mg/L and a minimum value of 0.24 mg/L;*
**the concentration of ion Cl- has a maximum value of 385.53 mg/L and a minimum value of 145.55 mg/L;*
**for sulfate ion SO_4 --, the maximum concentrations 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;*
**calcium Ca^{2+} ion contents range from 220.4 to 97.6 mg /L;*
** for magnesium ion Mg^{2+} the maximum concentration is 124.08 mg / L and the minimum value is 17.28 mg/L;*
** 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 wastewaters should be treated appropriately to reduce the nuisance to the receiving environment and to compensate for the loss of this coveted and prized water resource.

Keywords— ***Sebou River, Waters, Hydrochemistry, Agricultural, Irrigation, Gharb, Morocco.***

I. 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 [1-3]. The rational management of water resources in the Kenitra Gharb area 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. The Sebou river 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 Guigou river. 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 city [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, Allal Tazi, 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. 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.

II. MATERIAL AND METHOD

2.1 Study area

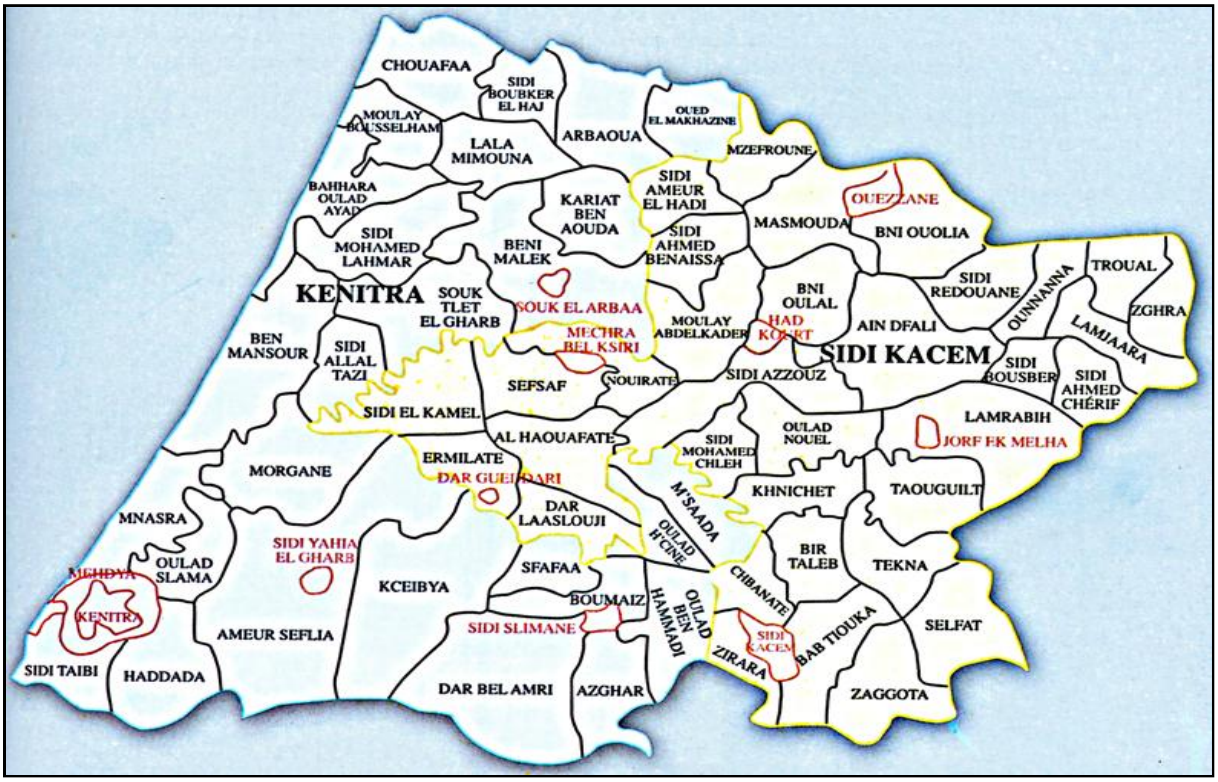
The Gharb region is bordered on the west by the Atlantic sea, bordered to the north by the pre-Rif hills and to the south by the Maâmora shelf (**Fig.1**). It is composed of a coastal zone (dune cord, flooded depressions, interior dunes), continental borders and the central alluvial plain of the lower Sebou which is the main river. The Sebou basin forms a basin between the Rif in the North, the Middle Atlas and the Meseta in the South, the Taza corridor in the East and the Atlantic sea in the West. It is the most important basin of the kingdom with approximately 38380 km^2 and currently contains a total population of 5.73 million inhabitants, of which 49% in urban and 51% in rural areas. It is characterized by an agricultural and industrial activity that contributes significantly to national economy.

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].

2.2 Study method

2.2.1 Water removal

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



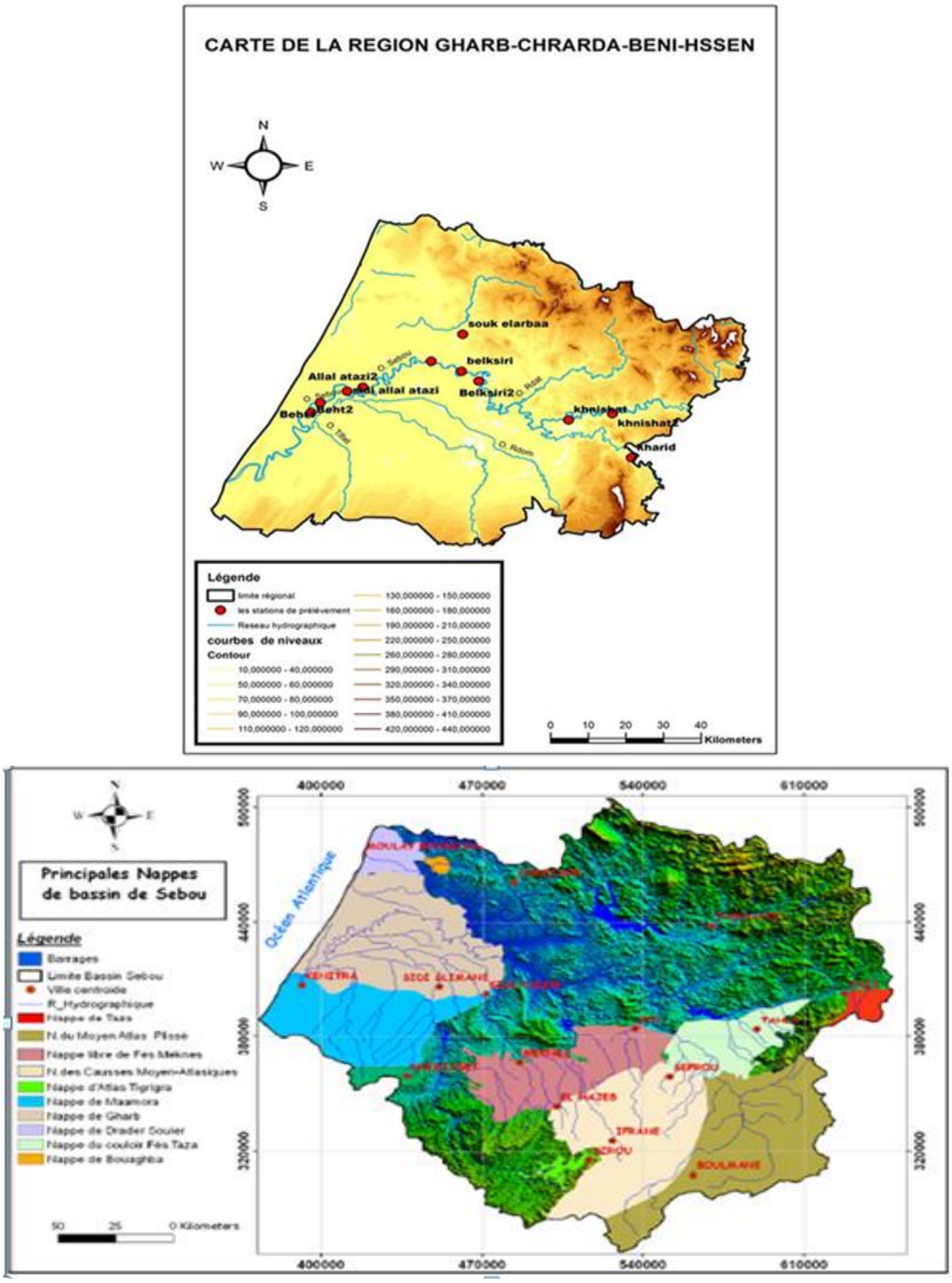


FIGURE 1: GEOGRAPHICAL LOCALIZATION OF SAMPLING AREA GHARB MOROCCO

2.2.2 Water analyzes

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 (CO_3-- HCO_3-), chlorides (Cl-), sulphates (SO_4--), ammonium ($NH_4{}^{+}$) and nitrate (NO_3-). The devices used are Assays C831, Jenway flame photometer, NOVASPEC II pharmacy-type spectrophotometer, UV-Visible spectrophotometer (**Fig. 2, 3**) [8-11].

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. $NH_4{}^{+}$ and NO_3- are collected in a boric acid solution and finally assay with H_2SO_4.

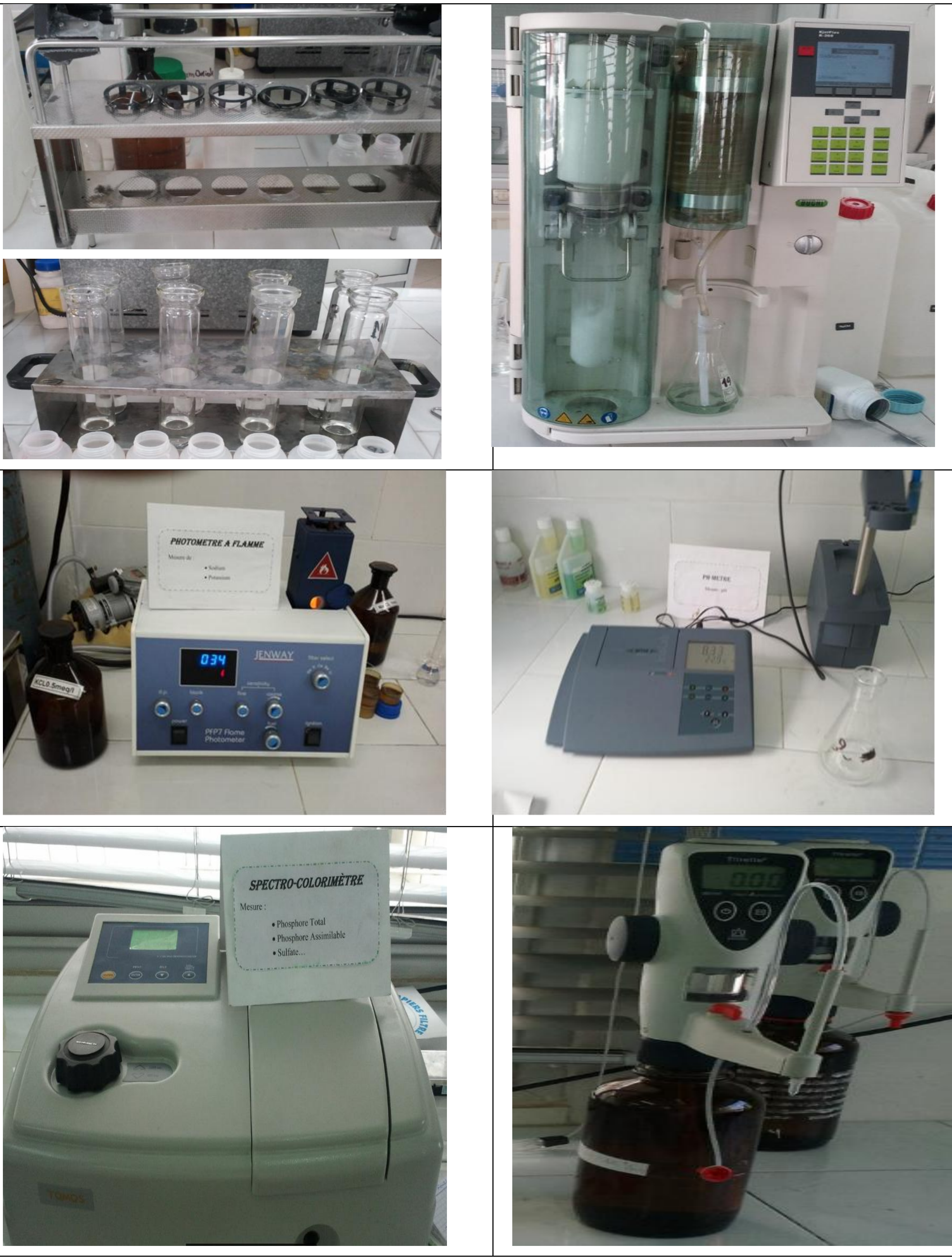


FIGURE 2: DEVICES FOR MEASURING WATER QUALITY IN THE TRAINING LABORATORY (ORMVAG-KENITRA)

FIGURE 3: METHODS OF ASSAYS AND TITRATIONS OF MINERAL ELEMENTS IN THE WATER OF THE LOWER SEBOU

III. 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, 2** and **Figures 4, 5** that the sub basin of the lower Sebou river 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 (**Tab.1**) following their crossing of limestone and marl-limestone soils characterizing the basin.

Mineralization accurately follows dissolved salt, salinity, chloride, sodium and potassium levels (**Tab. 1, 2** ; **Fig.4, 5**). It results essentially from the leaching of the karstic limestone and kelp-like terrain and ocean spray. Indeed, the electrical conductivity that reflects salinity (Tab.2) varies from 629 to 22760 µS / cm and far exceeds the Moroccan irrigation standard (> 2700 µS / cm) [12-14].

TABLE 1
PHYSICOCHEMICAL DATA (ANIONS) OF THE RAW WATERS OF THE LOWER SEBOU RIVER

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
SD5	8	63,36	243,53	181,94	246,44	0
SD6	8,12	20,58	202,35	151,62	362,34	0
SD7	8,69	86,92	248,5	183,59	241,56	21,6
SD8	8,33	188,6	385,53	258,32	323,3	13,2
SD9	8,49	827,9	230,4	106,7	75,64	0
SD10	8,24	2692	860,27	113,1	122	0
SD11	8,4	260,8	269,09	37,62	100,04	0
SD12	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 2
PHYSICOCHEMICAL DATA (CATIONS) OF THE RAW WATERS OF THE LOWER SEBOU RIVER

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
SD5	150,8	44,4	4,29	1820	0,22	5,62	1430
SD6	169,2	68,64	9,56	1330	0,18	7,09	1400
SD7	148,4	51,36	4,68	1470	0,68	5,85	1490
SD8	220,4	111,6	12,48	1840	0,5	10,16	2370
SD9	217,6	17,28	3,71	51	0,68	6,16	629
SD10	914,4	631,2	5,07	140	1,76	49,16	15820
SD11	148,4	26,64	6,63	190	15,34	4,82	11960
SD12	314,8	39,36	17,55	390	0,54	9,51	22760
SD13	170,8	124,08	9,75	2530	2,66	9,44	2200
SD14	1072,8	74,88	15,99	150	1,26	57,94	16700
SD15	144,8	94,08	7,41	400	1,29	7,54	1660
SD16	174	99,36	2,73	120	1,51	8,49	880

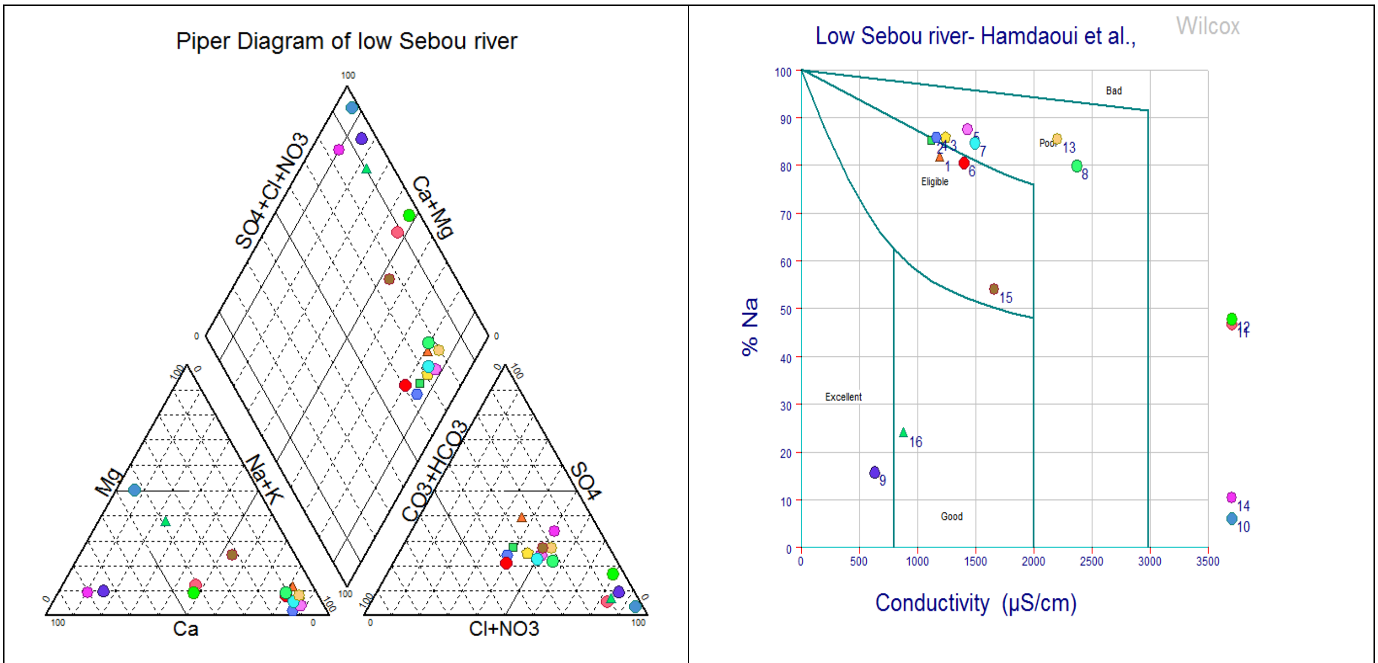


FIGURE 4: PIPER AND WILCOX DIAGRAMS OF WATER OF THE LOWER SEBOU

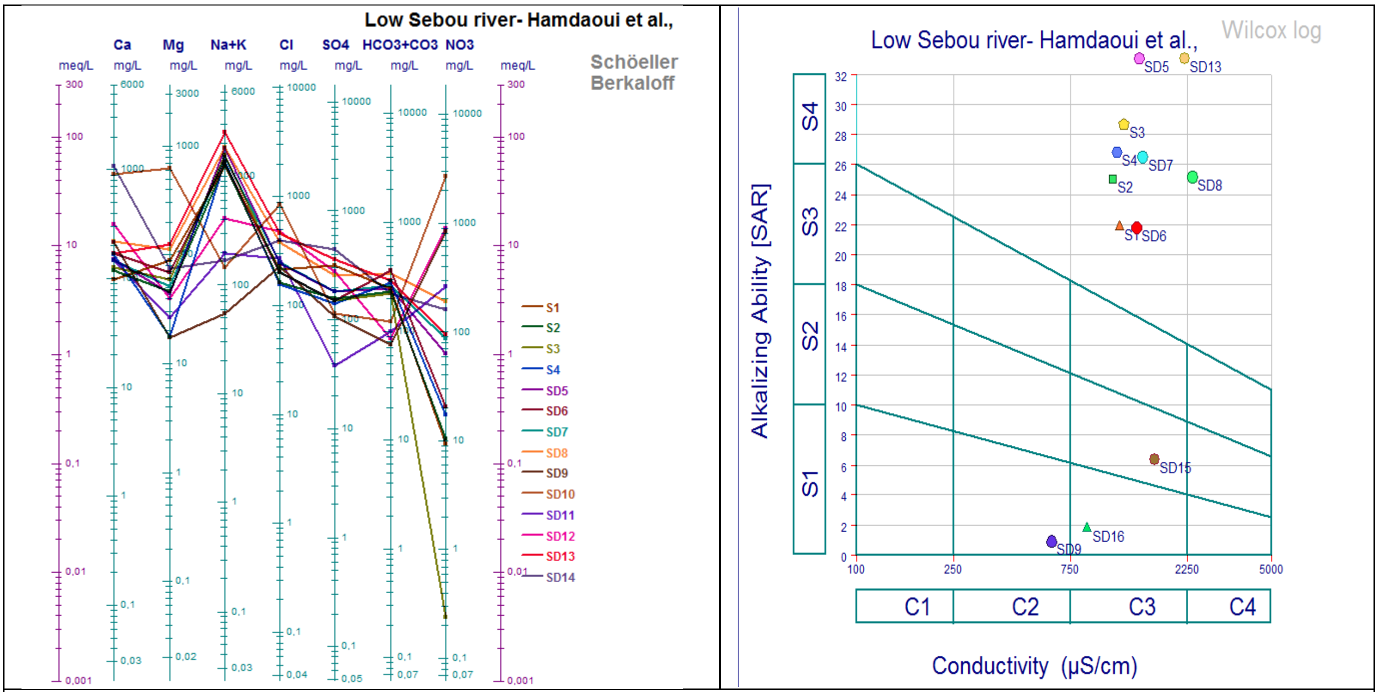


FIGURE 5: BERKALOFF AND WILCOX LOG DIAGRAMS OF WATER OF THE LOWER SEBOU

Concerning the nitrate contents (**Tab.1**), 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 wastewater and leachates of the wild discharges [15-21].

The Piper diagram (**Fig.4**) 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].

Moreover, the projection of physicochemical data in the Wilcox diagram (**Fig.4**) and Wilcox Log diagram (**Fig.5**), shows that the quality of the waters of the lower Sebou varies between Poor 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 C3S4 and C4S4 (**Fig.5**) and are unsuitable for irrigation [24-25].

IV. CONCLUSION

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 [26-27]. 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 [28-30].

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