International Journal of Agriculture, Environment and Bioresearch

Vol. 3, No. 03; 2018

ISSN: 2456-8643

EVALUATION OF THE PHYSICOCHEMICAL QUALITY OF WATERS SURFACE OF THE RICE PLANTATIONS OF THE PLAIN OF GHARB-MOROCCO

El amrani Btissam[1*], Rahmouni Thami[1], Belghyti Driss[1], El kharrim Khadija[1].

[1]Department of Biology, Laboratory Agro-physiology, Biotechnology, Environment and Quality, Kenitra Faculty of Sciences / Ibn Tofail University. B.P .: 133/14000 Kenitra (Morocco)

ABSTRACT

Rice is the only cereal that can survive in conditions of flood, this is enough to explain the complex relations which exist between rice and water. In Morocco, rice growing locates in the area of Gharb and Larache (North-West of Morocco).the location of these rice plantations is due to the presence of three factors : a warm climate and not very wet, proximity of the Sebou wadi where the pumping the water of irrigation is carried out, and the propitious nature of the ground. The objective of our work is to evaluate the physicochemical quality of surface waters of five clos of the rice plantations of the area of Gharb in Morocco (town of Sidi Allal Tazi and Bil Ksiri).The analysis focused to 13 physicochemical parameters of water such as the temperature, the hydrogen potential, electric conductivity, salinity, and the ions major (Cl-, SO42-, NO3-, HCO3-, Ca2+, Mg2+, 〖K〗^+ Na+ et 〖〖NH〗_4〗^+).The got results showed a strong alkalinity, which could be explained on the one hand by the biological activity of the macro vegetation immersed with in the pieces, and on the other hand by the nature of the grounds of the rice plantations and an appreciable mineralisation..

Keywords: Rice plantations, physicochemical, mineralisation, irrigation

INTRODUCTION

The Rice fields are agro-ecosystems that remain flooded almost permanently during cultural period (at the end of May to middle of Octobe), and are dried out the rest of the year. The culture of rice in Morocco is practiced only on a restricted scale and remains very localized in the plain of Gharb and this rice growing requires during all the vegetative cycle a quantity of water necessary for its development [12]The irrigation of this culture that is located in the plain of Gharb is insured by pumping in the oued Sebou and its tributary of oued Beht. The objective of the present study is the description of the physico-chemical parameters of the aquatic phase of the rice ecosystem, and the understanding of the fundamental characteristics.

To solve this problem, we carried out a follow-up of the physical and chemical parameters (temperature, pH and electrical conductivity, calcium, magnesium, salinity, sulphates, chloride, sodium, ammonium, bicarbonate, nitrate, potassium) during the campaigns 2014, 2015 and 2016.

MATERIAL AND METHODS

STUDY ZONE

Vol. 3, No. 03; 2018

ISSN: 2456-8643

The Gharb plain is located in the Atlantic littoral zone between latitudes 34 ° and 34 ° 45'N. It constitutes the northern half of a well-defined hydro geological unit called the Gharb-Maamora basin, the Maamora constitutes the southern half of the basin.

Climatic context :

The climate of our zone of study is hot and moderated. The winter is characterized by precipitation more important than in summer. The average of annual temperature recorded in this region is approximately 19.2 °C. The annual average precipitation are 570 mm,July is the driest month, with only 0 mm. In December, the precipitation are the most important of the year with an average of 114 mm. 26.7 °C make of the hottest August of the year, January is the coldest month of the year and the average temperature in this period is 12.4 °C.

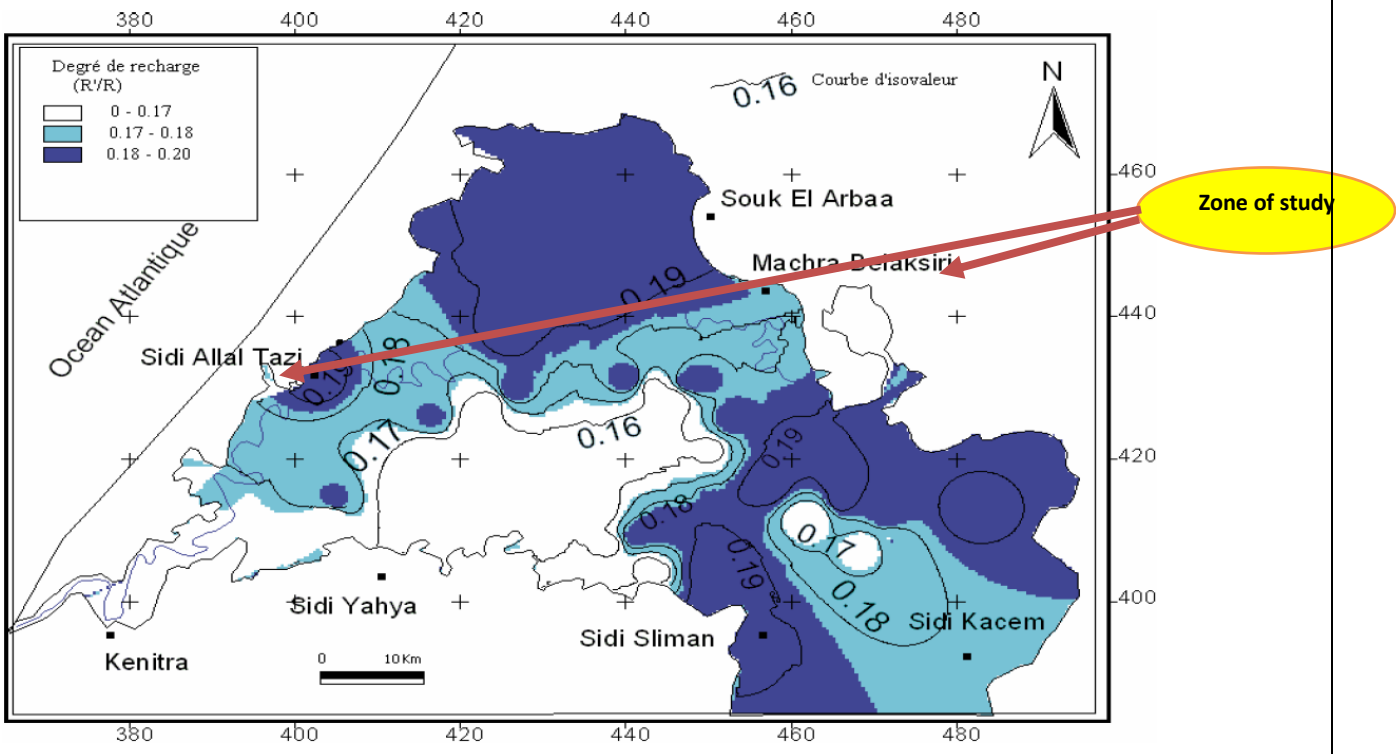


Figure 1 : the geographical map of the Gharb plain[4]

Geologic and hydro geologic context

geologic Context

The persistence during all quaternary of the collapse movement of the South Rifain furrow was at the origin of the creation of the vast plain of Gharb [1].

It corresponds to a vast alluvial triangle, marshy, born of the Sebou and the Beht, defended at the edge of the ocean by a rise dunes of ancient and which is between Rabat, Dar Bel Amri and Arbaoua. The Neogene rarely shows itself, despite it being very thick, above of socle old collapsed more than 2000m deep [3].

Vol. 3, No. 03; 2018

ISSN: 2456-8643

The pre-rifal zone is represented by marginal formations of the external furrow ;
The upper Cretaceous is characterized by a marly predominance. The lias and the Dogger are limestone, the upper Jurassic is schisto-sandstone, the upper Cretaceous is marly and marl-limestone [10].

Hydrogeological context

The area of the Gharb-Maamora hydrogeological basin is 7500 square kilometres; These limits are constituted by the ocean altantic the hills of Lalla Zohra in the North, those of Ksiri, Bou-Draa, Outita in the East and the reliefs between Khemisset and Tiflet in the South [10].

Sampling and analysis :

The area of our study is localized in Sidi Allal Tazi's region and Bel Ksiri. These paddy fields are installed on grey Tris , grounds of alluvionnaire origin, clayey, poor in humus, in phosphoric acid, very often in nitrogen.
The samples of water were taken during three rice cycles 2014, 2015 and 2016, and be made approximately at the same hours in five resorts.
These samples of water are put in flasks in polyethylene of beforehand washed in the distilled water then rinsed 3 times with the water of rice fields to be analyzed.
The parameters, the pH, the electric conductivity, the temperature were determined by a typical pH-meter CONSORT C831 provided with a probe measuring the on-the-spot temperature (in situ). Other parameters was analyzed on samples of water transported at low temperature (4°C)in the laboratory :
The Bicarbonates, chlorides, calcium, magnesium were measured by titrimétrie, whereas nitrates, sulfates, potassium, ammonium, sodium have been determined by means of the methods recommended by Rodier [5].

DATA PROCESSING

The results of the physico-chemical analyses were handled by methods of multivariated statistical analysis coupled with the hydrochemical methods.
The hydrochemical method required the use of the diagram of Piper realized under software Diagrams and the methods of Riverside and Wilcox, for the hydrochemical classification of surface waters.
These statistical methods are fluently used in the field of the Sciences of the water. Analyses focused the following 13 variables : the Salinity, T°C, CE, pH,Ca^{2+},Mg^{2+},Cl^{-},K^{+},Na^{+},SO_4^{2-},HCO_3^{-},NO_3^{-}, NH_4^{+}.

RESULTS AND DISCUSSION

The results of the physico-chemical analyses waters rice fields Bel Ksiri and Allal Tazi was recorded in Table 1 and Figures 2 and 3. For the reliability of the results of analyses, we applied the method of the Ionic balance. It is necessary to call back that in theory, a natural water is electrically neutral. Thereby, the sum (in chemical equivalents) of cations should be equal in that of the anions (in chemical equivalents). In reality, this equality is rarely obtained. In a general

Vol. 3, No. 03; 2018

ISSN: 2456-8643

way, the difference is attributed to the uncertainties, to the presence of certain not dosed ions or to the possible errors of analysis. So, a certain margin of imbalance enters anions and cations is admitted. it is expressed in the form of a relative gap by the formula :

$$BI = \frac{\sum(cations) - \sum(anions)}{\sum(cations) + \sum(anions)} * 100$$

With BI : the Ionic balance

In our study the calculation of BI gives a value lower than 5 % that is 0.02 %. Then the reliability of analyses is excellent.

Tableau1: statistical variability's of the physico-chemical parameters.

	PH	T°C	CE	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	NH_4^{+}	Cl^{-}	SO_4^{2-}	NO_3^{-}	salinité
C1(2014)	7,53	12,10	552,00	4,75	2,89	6,21	0,13	4,44	0,15	6,69	1,51	0,32	0,60
C2(2014)	7,64	11,80	632,80	5,25	2,95	7,15	0,11	5,24	0,14	7,69	1,39	0,14	0,20
C3(2014)	8,59	12,60	576,00	5,15	2,60	6,02	0,11	4,33	0,18	6,34	1,03	0,24	0,30
C4(2014)	7,61	12,10	557,60	4,64	2,72	6,13	0,11	4,46	0,15	6,37	1,31	0,17	0,30
C5(2014)	9,80	11,20	872,80	6,28	3,48	9,80	0,16	6,33	0,12	9,95	2,02	0,13	0,40
MOY	8,23	11,96	638,24	5,21	2,93	7,06	0,12	4,96	0,15	7,41	1,45	0,20	0,36
MAX	9,80	12,60	872,80	6,28	3,48	9,80	0,16	6,33	0,18	9,95	2,02	0,32	0,60
MIN	7,53	11,20	552,00	4,64	2,60	6,02	0,11	4,33	0,12	6,34	1,03	0,13	0,20
C1(2015)	8,00	11,10	388,00	3,06	2,53	4,66	0,11	4,01	0,11	4,73	1,14	0,19	0,20
C2(2015)	5,86	12,30	455,60	3,80	2,68	5,48	0,12	4,33	0,12	5,28	1,58	0,19	0,30
C3(2015)	6,04	11,80	392,00	3,09	2,58	4,45	0,12	3,98	0,11	4,79	1,25	0,20	0,80
C4(2015)	7,84	12,10	384,80	3,05	2,98	4,39	0,11	3,94	0,12	4,71	1,10	0,19	0,20
C5(2015)	7,16	11,40	560,00	4,23	2,74	6,49	0,13	4,31	0,17	6,72	2,23	0,32	0,20
MOY	6,98	11,74	436,08	3,45	2,70	5,09	0,12	4,11	0,13	5,25	1,46	0,22	0,34
MAX	8,00	12,30	560,00	4,23	2,98	6,49	0,13	4,33	0,17	6,72	2,23	0,32	0,80
MIN	5,86	11,10	384,80	3,05	2,53	4,39	0,11	3,94	0,11	4,71	1,10	0,19	0,20
C1(2016)	8,04	12,20	573,60	4,61	3,36	6,44	0,12	4,78	0,12	7,36	2,26	0,18	0,30
C2(2016)	7,08	12,10	612,80	5,17	3,04	7,59	0,12	5,27	0,11	7,88	2,34	0,19	0,60
C3(2016)	7,12	11,90	543,20	4,56	3,00	6,25	0,12	5,17	0,12	6,79	2,43	0,18	0,20
C4(2016)	7,14	11,60	546,40	4,48	3,01	6,47	0,12	5,33	0,12	6,97	2,72	0,18	0,40
C5(2016)	7,86	12,30	1356,60	10,93	7,16	25,12	0,24	10,40	0,14	25,77	6,95	0,17	0,10
MOY	7,45	12,02	726,52	5,95	3,91	10,37	0,14	6,19	0,12	10,95	3,34	0,18	0,32
MAX	8,04	12,30	1356,60	10,93	7,16	25,12	0,24	10,40	0,14	25,77	6,95	0,19	0,60
MIN	7,08	11,60	543,20	4,48	3,00	6,25	0,12	4,78	0,11	6,79	2,26	0,17	0,10

Temperature

Temperature is a factor directly related to the development of rice. Overall, the evolution of the superfice water temperature varies according to the atmospheric temperature during the first months of cultivation, in relation to the nature of the rice fields fully open during this period. The thermal average recorded in the middle of the day is 11.90 ° C.

PH

Vol. 3, No. 03; 2018

ISSN: 2456-8643

The values of this parameter are relatively high during the campaign 2014, and are situated between 7.5 and 9.8. This slight alkalinity could be explained on one hand by the nature soil installed rice fields on Dihs or the Tris known for the alkaline pH and on the other hand by the supply of irrigation water by Oued Sebou (salty charged waters the year alkaline).
During campaigns 2015 and 2016 ; the values have relatively low ; they are situated between 5.8 and 8 for year 2015 and between 7.08 and 8.04 for 2016. This interannual difference could be explained by the use of manure in the form of a mixture of acidic reactions.

Electrical conductivity

During the three rice cycles 2014, 2015 and 2016 ; the recorded values of the electrical conductivity show an inter annual variation. In the 2014 campaign the values are between 552 µS / cm and 872.8 µS / cm, while the values recorded during the year 2016 are a little high, and are between 543.2 µS / cm and 1356.6 µS / cm.
This mineralization could find its origin in the Sebou water irrigation at high tide (Sebou waters being known for its high load of dissolved salts).
The values obtained the electrical conductivity are high comparatively to the value recorded in the paddy fields of the Camague (392 and 449 µS / cm). The highest of average recorded (580 µS / cm) was due to exceptional weather conditions [2].
Finally, an electrical conductivity of water greater than 1500 µS / cm makes irrigation water unusable for crops [6].

Chloride

During the three rice campaigns 2014, 2015 and 2016 ; the Chloride valuesvary between 6.34 meq / l to 9.95 meq / l (2014 campaign) from 4.71 to 6.72 meq / l (2015 campaign) and from 6.79 to 25.77 meq / l (2016 campaign).
This recorded concentration greatly exceeds the limiting content of Moroccan standards for water intended for irrigation and can damage semi- tolerant crops.

Calcium and magnesian hardness

During the three rice campaigns 2014, 2105 and 2016 ; the concentration of calcium is low it varies between 3.05 and 10.93 meq / l.
The low calcium concentration could be explained by its use according to biological processes and / or by its precipitation of by the biais oxidation-reduction reactions within this closed ecosystem.
Unlike the Gharb ricefields, in those of the Camargue ; the concentrations in calcium recorded are of the order of 168 mg / l. These strong concentrations coincide with the growth of characeae, known to fix to their surface of important quantities of carbonate of calcium [2].

The Sulphates

The values obtained in sulphates in surface water vary between 1.45 Meq / l and 3.34 Meq / l. This element can arise from of also the water of irrigation rich in sulphates taked in the Sebou at high tide. [11].

Vol. 3, No. 03; 2018

ISSN: 2456-8643

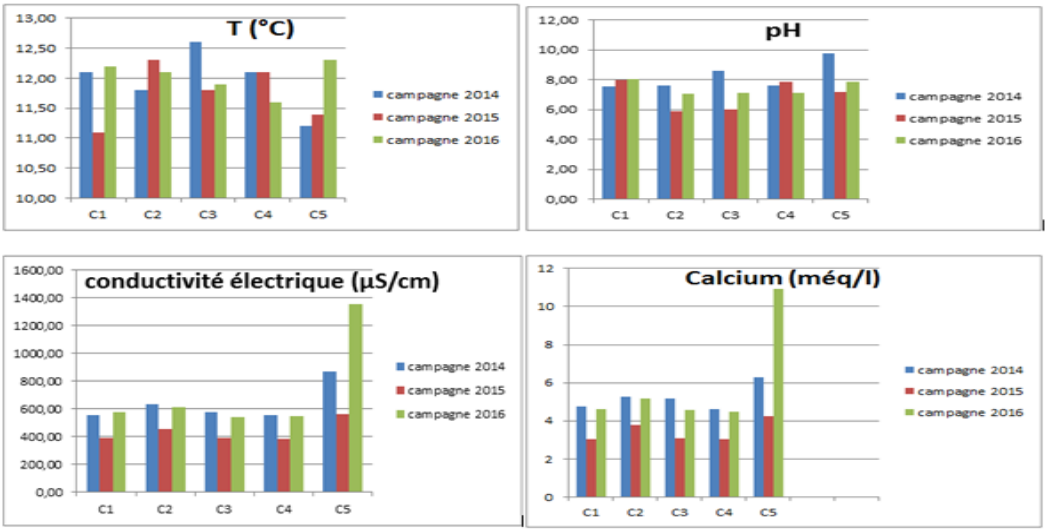
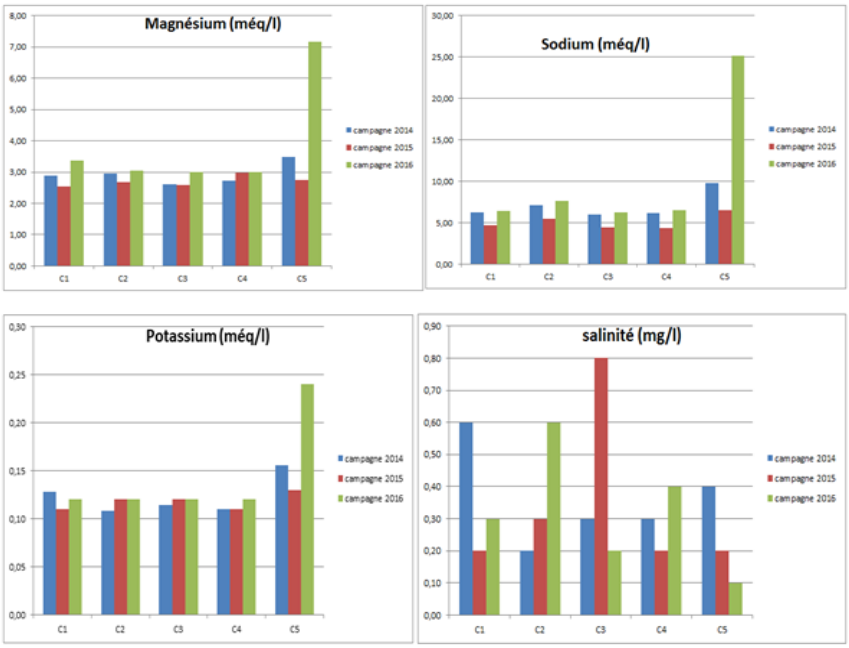


Figure2 : concentrations of the following parameters : °(T C), pH, CE (µS / cm), Calcium (méq / l) during three cycles rice fields (on 2014, 2015, 2016) of the zone of study.

Note :C1, C2, C3, C4, C5 are closed rice.



Vol. 3, No. 03; 2018

ISSN: 2456-8643

Figure 3: Concentrations of the following parameters: sodium (meq / l), potassium (meq / l), salinity (mg / l) and magnesium (meq / l) during the three rice cycles (2014, 2015, 2016) of the zone study.

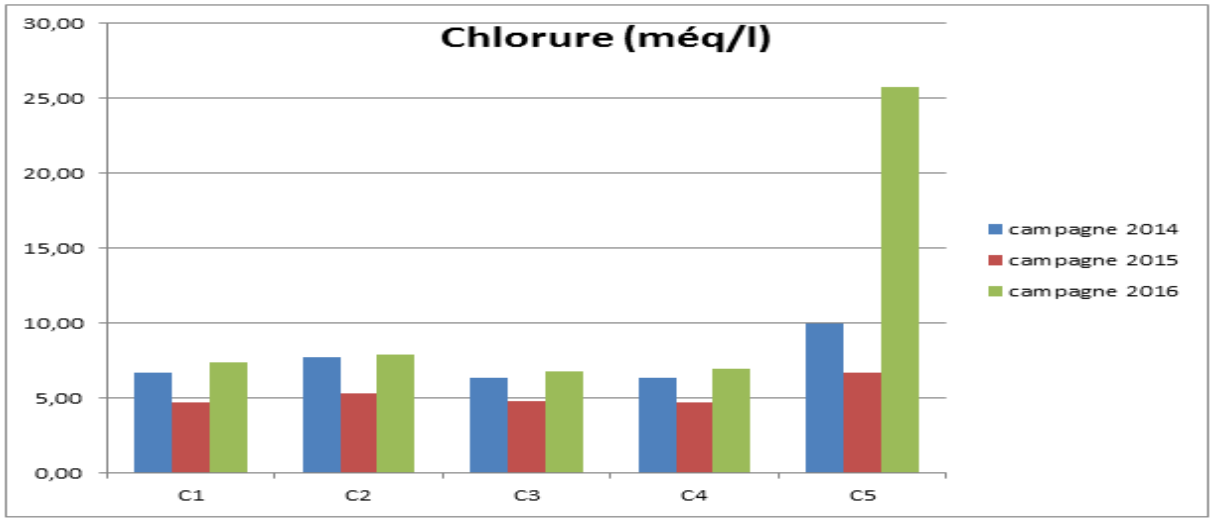


Figure 4: variations of chlorides during three campaigns 2014, 2015 and 2016 of the zone of study.

HYDROCHEMICAL DETERMINATION OF THE FACIES OF WATERS:

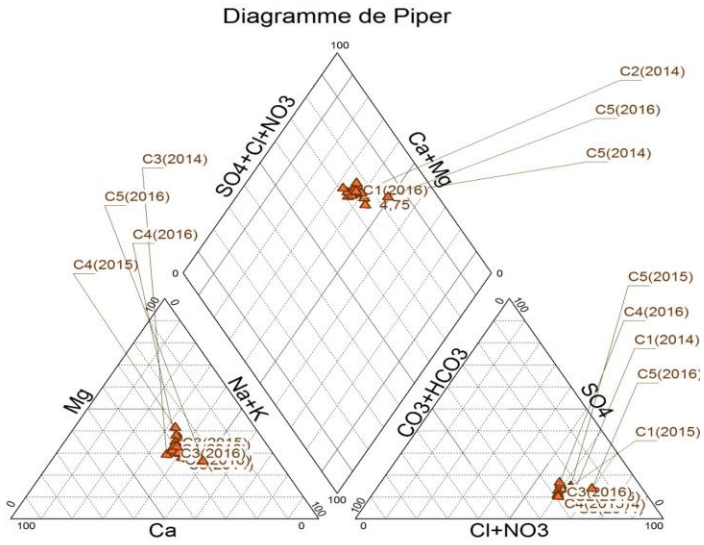


Figure 5: Piper diagram of surface waters.

Vol. 3, No. 03; 2018

ISSN: 2456-8643

The representation of the samples on the piper diagram (Figure 5) shows the existence of two chemical facies :
- A chloric bicarbonate water.
- sodium water.

Explained by the presence of alkaline charges which is in the water that comes from Oued Sebou (salt water).

STATE OF THE QUALITY OF WATERS USED IN THE RICE GROWING :

when the concentration of Na^+ ions in the soluble state in the soil is important, these ions most frequently replace the Ca^{2+} cations (base exchange) in the absorbing complex. Water loaded with salts can cause this action. The risk is determined using the value of Sodium absorbable (Sodium Absorption Ratio, SAR). For the same conductivity, the risk is even greater when the coefficient is higher [8].

The SAR is defined by the following relation :

$$\mathbf{SAR} = \frac{(\mathbf{Na^+ + K^+})}{\sqrt{\frac{\mathbf{Ca^{2+} + Mg^{2+}}}{\mathbf{2}}}}$$

All ions are expressed in meq / l

After plotting all the values of analyses on the diagram of Riverside [9](figure 6), according to the electrical conductivity and the value of SAR, were able to clear the presence of the following classes:

C2 S1: characterize a good quality water for the irrigation.

C3 S2 and C3 S3: indicating acceptable waters for the irrigation of the cultures of rices.

The classification of water the samples according to the diagram of Wilcox, who founded on the electrical conductivity and the content in sodium in the water expressed in percentage (formula 2)[8] :

$$\%Na^+ = \frac{(Na^+)}{(Ca^{2+}+Mg^{2+}+Na^+ +K^+)} * 100 \quad \textbf{(2)}$$

This approach has shown that the rice growing waters of Sidi Allal Tazi and Bel Ksiri, according to the Wilcox classification (Figure 7) belong to the following classes:

C2 S1: includes waters of excellent quality.

C3 S2 and C3 S3: designating eligible waters for irrigation of rice crops. Which are more mineralized than those of the previous classes.

From the results of these two methods (Riverside and Wilcox) it can be concluded that the irrigation waters of the paddy fields in the study area are almost of the same quality, except that the clos of the Bel Ksiri region are more mineralized.

Vol. 3, No. 03; 2018

ISSN: 2456-8643

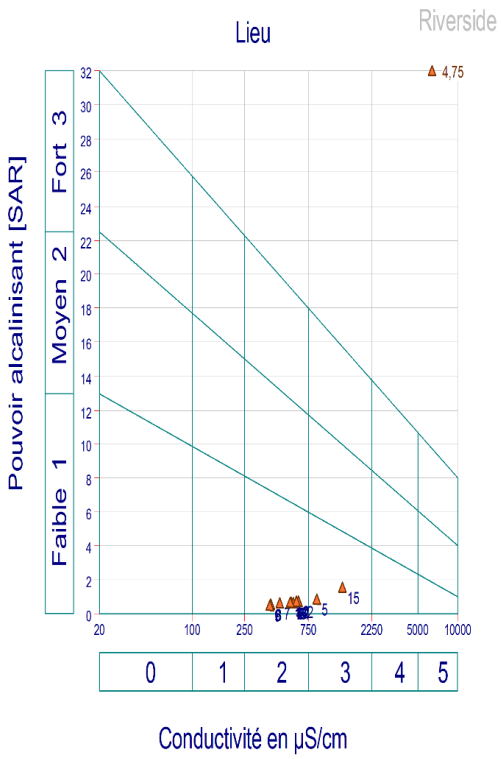


Figure 6: Riverside Diagram of the Waters surface of our study area

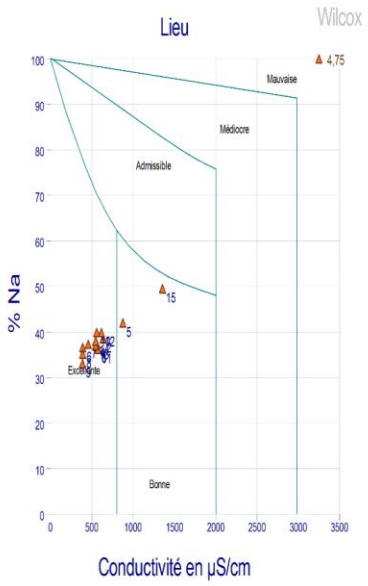


Figure 7: Wilcox Diagram of Waters surface of our study area

CONCLUSION

The characterization of the physico-chemical parameters of superficial waters of the clos of the paddy fields of the study area ; it is show that this water the irrigation is not ideal ; such as the temperature variations are accentuated by the shallow depth of the blade of water and intervenes in the solubility and the diffusion of gases particularly the dissolved oxygen and the carbon dioxide, in the processes of dissolved salts. The variations of the electrical conductivity, the salinity and the calcium and magnesian of waters of the paddy fieldsallowed on the one hand of shown the strong alkalinity and on the other hand to confirm of impact of the dynamics of the oued Sebou.

The alkaline pH of rice fields observed would be due to the alkaline pH of the rice ground of the plain of Gharb [7].

The alkalinity of the waters of the Gharb ricefields could be explained on the one hand by the biological activity of the macro-vegetation immersed in the plots and on the other hand by the

Vol. 3, No. 03; 2018

ISSN: 2456-8643

nature of the soils of rice fields known for their alkaline pH and a significant mineralization and by the supply of saline water loaded with free alkaline by the Sebou wadi during the high tide (salty waters laden with free alkaline) [12] .

An important mineralization of the organic matter and the atmospheric evapotranspiration could entrainer an increase of the Ionic concentration which would be compensated of partially only with the water of irrigation.

Chloride submersion water content can have a detrimental effect on the development of rice.

The strong conductivity translates a water mineralized well with contents $Ca^{2+}$and Cl^{-}high enough. In certain elements in the biological processes and their precipitation in this closed ecosystem, can explain, the very low rates.

Globally, The rice fields of Gharb are characterized by a strong mineralization, and show a certain similarity with lakes and ponds of shallow depth. Elements broadcasting from sediments are immediately included in the biological cycles.

REFERENCE

[1] A, MICHARD. Eléments de géologie Marocaine : Notes et Mémoires du Service Géologique, v. 252. *Rabat : Editions du Service Geologique du Maroc 1976*.

[2] A, VAQUERE .D, Pont. Influence des producteurs primaires sur la régulation ionique de l'eau de submersion des rizières de Camargue. *Ecologia mediterranea 1998*, 14**,** 5-16.

[3] E, ROCH. *Histoire stratigraphique de la plaine du Gharb au 1/100000 .Notes et Mém.Ser.Géo.Maroc 1950, 221 bis ,39p*

[4] https://www.erudit.org/en/journals/rseau/2007-v20-n2 rseau1725/015812ar/media/015812arf009n.png

[5] J, RODIER. B, LEGUBE. N, MERLET. L'analyse de l'eau. 9 e édition. Entièrement mise *à jour, Dunod, Paris 2009*.

[6] J, RODIER. L'analyse de l'eau, eaux naturelles, eaux résiduaires, eau de mer, J. Rodier 1996.

[7] K, Berrady. Recherches bio-écologiques sur le peuplement entomologique des rizières de la plaine du Gharb (Maroc) : Coléoptères, Hétéroptères, Odonates et Diptères Culicidae. Thèse 3e Cycle, Univ. Ibn Tofaïl, Fac. Sci. Kénitra, 1997, 161 p.

[8] L, GOUAIDIA. O, GUEFAIFIA. A, BOUDOUKHA. M, LAIDHEMILA. C, MARTIN. Évaluation de la salinité des eaux souterraines utilisées en irrigation et risques de dégradation des sols : exemple de la plaine de Meskiana (Nord-Est Algérien). *Physio-Géo. Géographie physique et environnement* 2012 (Volume 6)**,** 141-160.

Vol. 3, No. 03; 2018

ISSN: 2456-8643

[9] L, RICHARDS. Diagnosis and Improvement of Saline and Alkali Soils. *Science 1954,* 120**,**800

[10] M, Combe. Cartes hydrogéologiques de la plaine du Rharb au 1/100000. *Notes et mémoires du service géologique du Maroc* 1969 (221).

[11] M, FEKHAOUI. L, BENNASSER. Qualité physico-chimique des eaux superficielles et dynamiques marégraphique. *Actes rencontres sur l'hydrodynamique marine 1994*.

[12] S, EL Blidi. M, FEKHAOUI. A, SERGHINI. A, EL ABIDI.Rizières de la plaine du Gharb (Maroc) : qualité des eaux superficielles et profondes. *Bulletin de l'Institut Scientifique, Rabat, section Sciences de la Vie 2006,* 28**,** 55-60.