J. Mater. Environ. Sci. 5 (3) (2014) 705-710 *Chemaou el Fehri et al.*
ISSN : 2028-2508
CODEN: JMESCN

Level of contamination by trace metals in groundwater in the agricultural area of Sidi abdelrrazak (Province of Khémisset, Morocco)

Imane Chemaou El Fehri[1], Abdellah El Abidi[2], Mohammed Fekhaoui[1], Abdelkbir Bellaouchou[3] , Rachid Benakan[2], Rachid El Jaoudi[4]

1. Laboratory of Zoology. Unite of Toxicology and Pollution. Scientific Institute. University Mohammed V, Rabat. Morocco
2, laboratoire d'hydrologie et de toxicologie, Institut National d'Hygiène. Ministère de la Santé, Morocco
3- laboratoire d'électrochimie et corosion, faculté des sciences, University Mohammed V Agdal. Rabat. Morocco
4 Laboratoire de Toxicologie Pharmacologie, Faculté de médecine et de pharmacie –Rabat, Morocco

Received 9 Oct 2013, Revised 9 Jan 2014, Accepted 9 Jan 2014
* *Corresponding Author : E-mail : imanechemaou@gmail.com ; Tel :0624532490*

Abstract
The objective of this study is to assess the quality of groundwater in the agricultural zone of Sidi Abdelrrazak (province of Khemisset), as well as the monitoring and analysis of some metallic trace elements. This study allowed us to identify the outline of the interaction between agriculture and water quality in the region where the ecotoxicological risks represented by the various uses are present. The analysis of metallic trace elements in the groundwater showed a lack of groundwater contamination by these elements, with the exception of Copper at a well which indicates the presence of a possible impact of agriculture on quality of these waters. However, the measured value for Fluor in this area suggested a possible local contamination of the deep layers of the region and opens the way for future investigations.

Keywords: groundwater, trace metals, toxicity, impact, contamination level.

1. Introduction
For several years, the increasing scarcity of national water resources and the deterioration of their quality have prompted officials (managers, researchers...) to pay attention and make efforts in the development and management of water resources [1] of particular interest Particularly, water savings, mainly for irrigation and control of pollutants in the Green Morocco Plan. A project that aims to improve the agricultural areas and production taking into account the current climate and water changes.
Nevertheless, to achieve this goal an important amount of fertilizers and chemical substances (herbicides, insecticides, fungicides) to prevent and fight pests are needed.
This process is not without risk of groundwater contamination by these substances if proper agricultural practices are not followed [2].
Morocco has more than 30 million inhabitants of which more than 50% live in rural areas. The majority of them don't have access to drinking water and sewage treatment. Thus, populations often use groundwater (wells, springs, boreholes) for different purposes (drinking water supply, livestock, irrigation ...).
One of the current issues that marks the degradation of groundwater [3] and threatens the health of populations especially in rural areas as well as and the environment is the presence of traces of heavy metals such as cadmium, copper, mercury elements, lead, etc, [4-5] which affects the overall quality of the water [6]and becomes a public health threat [7-8]
If some elements are necessary for life in low dose such as copper or iron, most of them though can be harmful in excessive amounts, which is the case for cadmium, chromium and lead. Because of their bioaccumulator effects in different ecosystems (water, sediment) and in living organisms [9] as well as fluorine which can lead to dental fluorosis (mottling of teeth) or bones and joints pains with deformations [10].
The objective of this study is to assess the quality of groundwater in the agricultural zone of Sidi Abdelrrazak (province of Khémisset) by monitoring of the metallic trace elements in these waters.

2. Materials and methods
The rural town of Sidi Abdelrrazak is in the province of Khémisset in Rabat-Salé-Zemmour-Zaer region. It is located 18 km from the city of Tiflet and 70 km from Rabat. In this region, groundwater is an important resource for drinking water.

ISSN : 2028-2508
CODEN: JMESCN

For the study of trace metals, 20 wells (P1 to P20) were selected (Figure 1). The geographical coordinates of the different sampling points and depths identified in these sites are listed in the table below (table 1).

Table 1- Geographic coordinates and depths (m) of the identified wells.

WELLS	latitude	longitude	depth (m)
1	34°00’20’’	06°07’57’’	17
2	34°00’26’’	006°07’50’’	28
3	34°01’04’’	006°07’28’’	26
4	34°01’16’’	006°07’28’’	20
5	34°00’48’’	006°07’35’’	24
6	34°01’12’’	006°07’39’’	30
7	34°03’23’’	006°06’07’’	30
8	34°01’13’’	006°07’29’’	26
9	34°01’18’’	006°07’17’’	22
10	34°03’17’’	006°06’24’’	3,5
11	34°00’21’’	006°08’06’’	26
12	33°59’47’’	006°06’39’’	28
13	33°58’44 ‘’	006°07’55’’	20
14	33°58’40’’	006°09’54’’	28
15	34°03’06’’	006°06’45’’	38
16	34°02’58’’	006°06’35’’	24
17	34°01’19’’	006°06’55’’	27
18	34°00’34’’	006°07’10’’	28
19	33°58’11’’	006°10’00’’	22
20	34°00’24’’	006°07’27’’	28

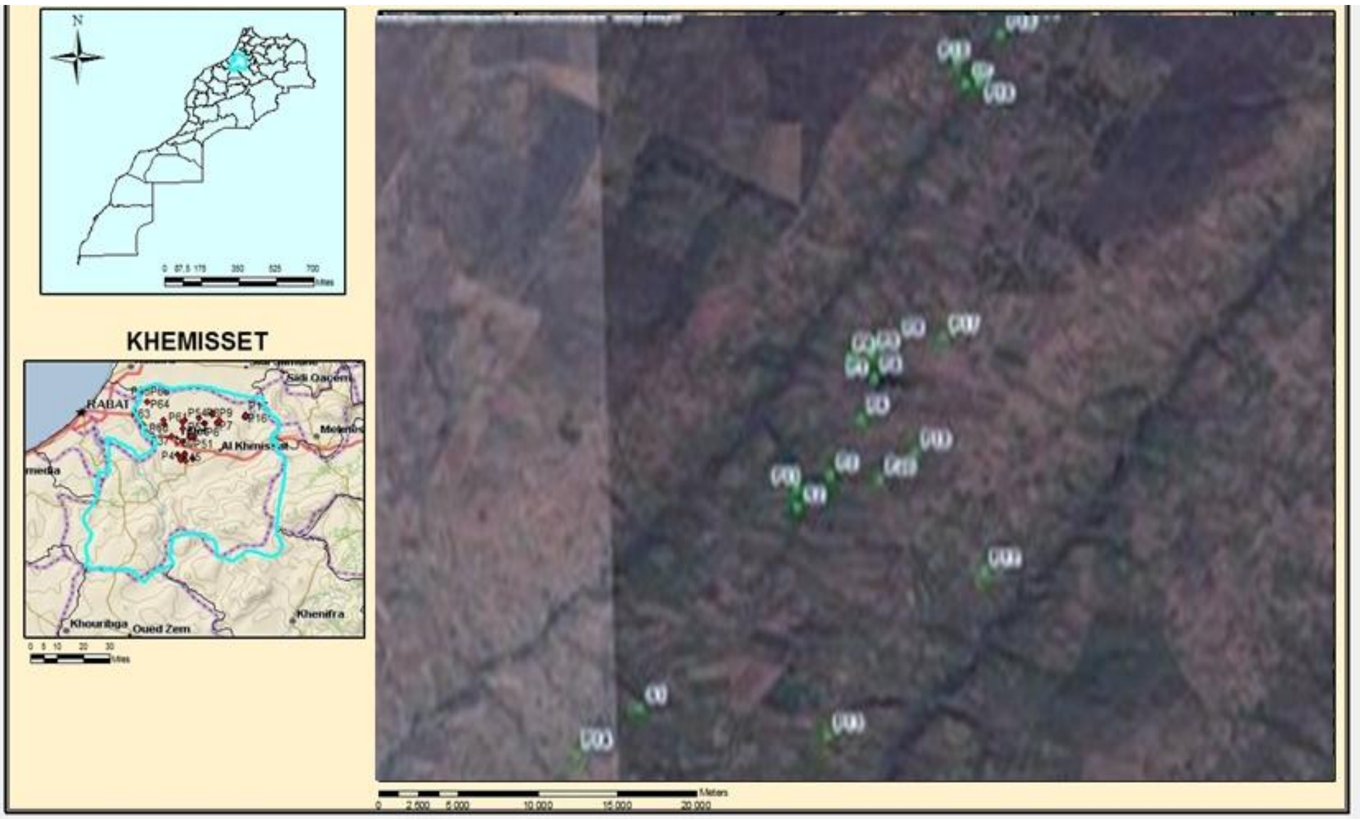

Figure1. Location of the study area “SIDI ABDELRAZAK”

Sampling for the analysis of metallic trace elements are made directly to the wells using a non-metallic container, in polyethylene tubes containing 50 ml of nitric acid (Merck, 65%) of high purity for attaching metallic trace elements [11].The samples are transported at low temperature (4°C) in portable coolers to the Department of Hydrology and Toxicology at the National Institute of Hygiene for analysis.

The contents of trace metals such as lead, copper, chromium and cadmium are determined directly without treatment by a near Atomic Absorption Spectrophotometer with Graphite Furnace (GF-AAS) Type VARIAN, 240 Zeeman. Fluorides were measured by electrochemical method with a specific fluoride electrode brand ORION SA520.

3. Results and discussion

The results are shown in Table 2 below, as well as figures 1 through 4:

Table 2: Values of trace elements analyzed in groundwater

wells	Cr (µg/l)	Cu(µg/l)	Pb(µg/l)	Cd(µg/l)	F- -(µg/l)
P1	0.54	0.02	0.12	0.01	0.50
P2	0.05	0.02	0.007	0.01	0.36
P3	0.77	0.02	0.007	0.15	0.43
P4	0.85	0.02	1.11	0.01	0.29
P5	0.51	0.02	0.007	0.01	0.31
P6	0.88	0.05	0.007	0.01	0.35
P7	0.62	0.02	0.007	0.01	0.34
P8	0.07	0.02	0.007	0.01	0.36
P9	1.54	0.02	0.007	0.01	0.35
P10	0.63	0.02	0.36	0.07	0.29
P11	0.40	0.04	0.45	0.10	0.37
P12	0.58	0.02	0.92	0.13	0.29
P13	0.44	0.02	0.40	0.04	0.29
P 14	0.25	0.06	0.21	0.02	0.70
P15	0.18	0.01	0.007	0.01	0.64
P16	0.63	0.02	0.007	0.01	0.71
P17	0.47	0.02	0.30	0.06	0.27
P18	0.32	0.16	0.18	0.01	0.36
P19	0.01	0.02	0.007	0.01	0.45
P20	0.22	0.02	0.32	0.05	0.37

The contents observed for chromium in different wells are highly variable (Fig. 2). They vary between 0.01 µg/l (P19) and 1.54 µg/l (P9). However, all values are lower than the tolerated Moroccan standards (50 µg/l).

Copper is absent in groundwater samplings, the values obtained are lower than the Moroccan standards (2 mg / l) and denotes the absence of a possible impact of agriculture on groundwater quality.

Despite the presence of some peaks (P4 and P12) values obtained for iron are lower than the Moroccan standards which is 10 µg/l and rank these waters in the good category.

For cadmium , the values obtained are between the minimum value of 0.01 and the maximum value of 0.13 µg/l at the P12 and 0.15 µg/l at the P3. Despite this presence, all these values are less than the value of 3 µg/l which is the maximum value according to the Moroccan standards and classifies the water in the right category.

All values recorded for fluorides show a presence of this element in these waters, but which remain below the maximum value (1.5 µg/l) and rank these waters in the excellent category. Moreover, the value of 0.7 µg/l identified at the wells P14, 15 and 16 suggests to us a natural origin (soil geochemistry) [12].

Despite the presence of some peaks of Lead especially at the well (P4 and P12) values obtained are lower than the Moroccan standard which is 10 µg/l and rank these waters in the category: good quality.

Thus, the presence of metallic trace elements is due to their bioaccumulative power may accumulate even at low doses in different organs and therefore reach the toxic threshold that can lead to disturbances in populations that consume these waters [13].

To generate a spatial typology of this presence, we performed a multivariate analysis (Principal Component Analysis). The CPA [14] is used to classify and process information on the physico-chemical parameters [15] made during the study period by establishing correlations between all the variables [16]. On the data matrix consists of 20 samples in which the 5 variables (Cr, Cd, Cu, Pb and F) were measured. The results are shown in Tables 3 and 4.

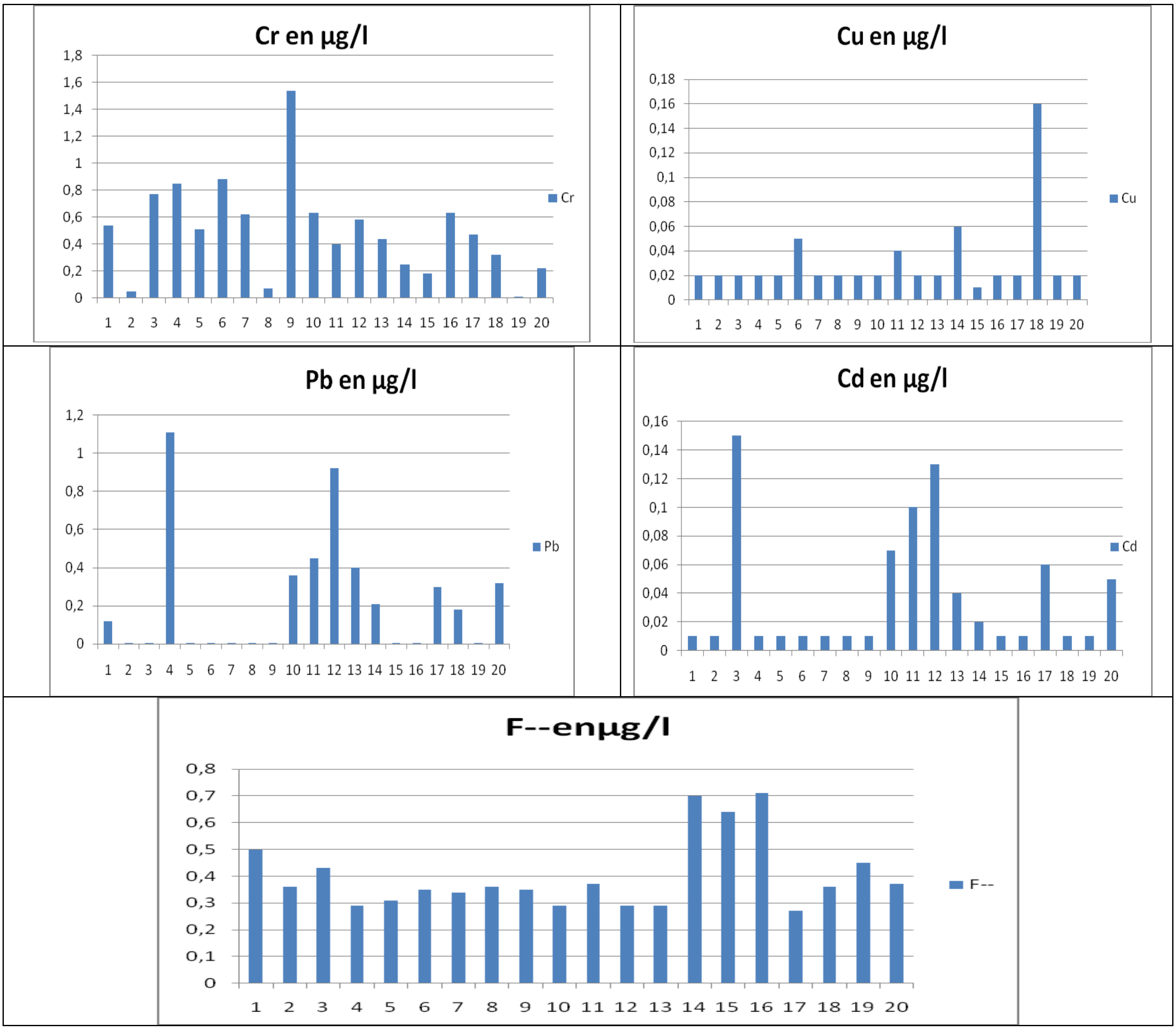

Figure. 2 - Spatial evolution of content (µg/l) of trace elements analyzed in groundwater

The Eigen values of the two components C1 and C2 and their contribution to the total inertia are shown in Table 3.

Table 3: Distribution of inertia of the three axes of the analysis (F1XF2)

	F1	F2	F3
Eigen values	1.720	1.007	0.902
Variability (%)	34.407	20.147	18.031
% Cumulative	4.407	54.554	72.585

Table 4: Correlations between variables and factors.

	F1	F2	F3
Cr µg/l	0.468	-0.087	0.857
Cu µg/l	-0.186	0.958	0.091
Pb µg/l	0.767	0.231	-0.170
Cd µg/l	0.699	-0.076	-0.361
F-- mg/l	-0.624	-0.153	0.001

In correlation circle (Figure 3), the 1st component (axis 1) defined by metals Pb (0.7) Cd (0.7), contributes with 34.4% of inertia. With inertia of 20.1% in the second component (axis 2) is defined by a single metal, Cu (0.958).

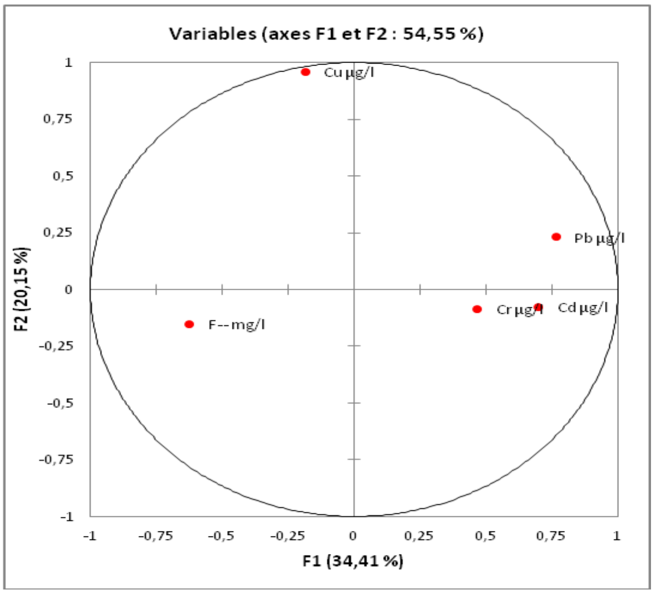

Figure 3: Circle of correlation of the analysis variables.

The analysis of the different approaches shows that the component (F1) defines a gradient notable presence of Pb and Cd elements on one side and average overload fluorine on the opposite side.

The factorial axis (F2): Axis 2 defines a gradient presence of copper only.

The typological structure generated by the F1XF2 plane (Figure 4) shows the organization wells of average presence of metallic trace elements [17, 18] analyzed. Indeed, the wells are organized along the axis 1 of the pole the least loaded in Cd and Pb (well 14) to wells most highly charged (wells 4 and 12).In the same gradient wells 14, 15 and 16 come off by the significant presence of fluoride in their water.

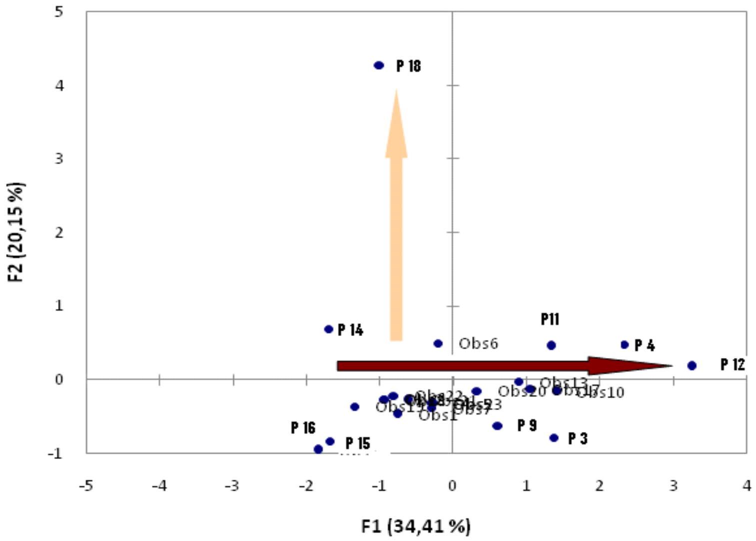

Figure 4: Graphical representation of factorial plan 1X2 of the analysis.

According to the second Gradient, only the well 18 seems most loaded of copper relatively to the set of points and however seems under the influence of local effects of agriculture.

Conclusion

Metallic trace elements analysis of those groundwaters shows an absence of contamination of these waters by these elements except for Copper at the well 18 and indicates the presence of a potential local impact of agriculture on groundwater quality.

However, the value of 0.7 µg/l for Fluor found in the area, suggests a possibility of local contamination by the deep layers of the region and opens the way for future investigations.
The study performed on the waters wells, on the assessment of the levels of metallic trace elements in groundwaters designed for the drinking water supply allowed us to highlight a weak presence in the region (below the standard value) with the exception for copper and fluorides which is present and confirm the natural origin of this element in this area.
This has shown the interest to take into account the structure on which the groundwater flow into the programs of the drinking water supply for the population and therefore the health risk associated with this natural occurrence

Acknowledgments-The authors thank the agricultural cooperative of Attakadom

References

1. Bzioui M., (2012) p63 Environnement et Changement Climatique au Maroc Diagnostic et perspectives (2012), Konrad-Adenauer-Stiftung E.V., Bureau au Maroc 87p.
2. Hani K., Narcisse A., Traoré S. K., Koné M.., Dembelé A., Houenou P., (1997) Recueil des travaux scientifiques des 3èmes Journées annuelles de la SOACHIM, Lomé.
3.Aoun Sebaiti B.,Thèse de doctorat (2010) Lille 1 ,211p ,Gestion optimisée des ressources en eau d‟une nappe côtière : application à la plaine d‟Annaba (Nord-est Algérien)
4. Gibons S. M., Hoss V. G., Laseter L. J., Rea W. J. Physician‟s Clinical Guide - A clinical guide to toxic chemicales ; enviro-health information center, Richardson, Texas, (1987) 87-89.
5. Fournier M. P., Brousseau, Bernier J., Cyr D., Pillet S., Rooney A., (2000). Les perturbateurs endocriniens, Université du Québec, INRS, Institut Armand-Frappier – Santé humaine, 171 p.
6. Amit Kumar, Sharma ., *J. Mater. Environ. Sci.* 5 (1) (2014) 95-100
7. Edmund J K., Uiso F C., Mbwambo H Z., Mahunnah R L., Moshi J M., Mgonda Y., *Journal d'ethnobiologie et ethnomédecine* 3 (2007) 6.
8. World Health Organization, (2006) - Guidelines for drinking-water quality: incorporating first addendum. Vol.1, Recommendations. 3rd ed. 595p.
9. Bidar G., Pruvot C., Garçon G., Verdin A., Shirali P., Douay F., *Environmental Sciences and Pollution Research.*16(1) (2009) 42-53.
10. Lachouri A; (2009) Thèse de Magister, Université de Ouargla. 75p.
11. Rodier J. (1976) L'analyse de l'eau : eaux naturelles, eaux résiduaires, eau de marée. 5e éd. T. II. Paris : Bordas, 364 p.
12. Bliefert Claus and Robert Perraud (2001) Environment Chemistry : Air, Water, sgarba De Boeck University edts., 447p
13. Adams S.M; (2002) In Editor. Biological indicators of aquatic ecosystem stress Bethesda. MD, American fisheries society.
14. Abdoulaye Demba N‟diaye, Khadijettou Mint Mohamed Salem, Mohamed Brahim El Kory, Mohamed Ould Sid‟ Ahmed Ould Kankou, Michel Baudu, *J. Mater. Environ. Sci.* 5 (1) (2014) 320-329
15. El fadeli S., Bouhouch R,. El abbassi A,. Chaik M,. Aboussad A,. Chabaa L, Lekouch N,. Hurrell R.F., Zimmermann M.B., Sedki A., *J. Mater. Environ. Sci.* 5 (Y) (2014) 225-230
16. El Morhit M., Fekhaoui M., El Morhit A., Élie P., Yahyaoui A., *J. Mater. Environ. Sci.* 4 (6) (2013) 893-904.
17. Sterckeman T., Douay F., Baize D., Fourrier H., Proix N., et Schvartz C., *Etude et Gestion des Sols*, 14(2) (2007) 153-168.
18. Taouil H., Ibn Ahmed S., El Assyry A., Hajjaji N., SrhiriA., *J. Mater. Environ. Sci.* 5 (1) (2014) 177-182