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Study of the ammoniacal pollution of the M'nasra water table (Morocco)

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ABSTRACT

We have been interested in the study of the chemical pollution of M'nasra's water table. This one is located in the Gharb region in Morocco where 145 000 people live. We have carried out 49 campaigns of measurement in three different periods with a quite important time interval between these periods. This water table constitutes the unique non-available resource of groundwater for this region. Agricultural industries are highly represented in this region where nitrogen fertilizers and pesticides are used at a large scale. The general averages of ammonium concentration in 1993, 2007 and 2008 are respectively 1.3mg/L; 2.3mg/L and 3.3mg/L i.e. an increase of 2mg/L between 1993 and 2008. If in 1993, 02 wells over 49 prospected wells (4.08 %) were conformed to WHO (Word Health Organization) drinkability standards, in 2007 and in 2008 all the wells are polluted. Moreover, the spatial analysis has confirmed an area of 10 000 Ha where M'nasra water table has know an ammoniacal pollution between 1993 and 2008.

INTRODUCTION

One of the important problems for agriculture nowadays is nitric nitrogen N-NO3 pollution of groundwaters, especially due to the over use of nitrogen fertilizers in intensive crop areas[1]. Unfortunately, with demographic evolution and agriculture industrialization, the quantities of nitrogen used increase continuously. For example for the production of dry beans in the region of M'nasra, the spread rates of nitrogen fertilizers have reached 32-270 kilograms of N.ha-1 giving an average of 117kg N/ha[2]. Nitrogen can be formed by oxidation of gaseous nitrogen during a rainy weather (thunder), as it can come from the oxidation (nitrification) of ammonia or of nitrite in oxygenated milieu[3-6]. Ammonia nitrogen is often present in waters and it usually means that there is an uncompleted process of organic matter degradation. It constitutes one of the links of nitrogen cycle. Ammonia is a soluble gas in water, but in function of pH conditions, it can be transformed either in an uncombined compound or in an ionized form[7]. The presence of ammonia in the environment result from metabolic process, agricultural and industrial[8], intensive livestock breeding can produce much more important concentrations in surface waters[2].

The presence of ammonia nitrogen in relatively high quantities can be a sign of pollution by wastes from human or industrial origin (chemical industries, nitrogen

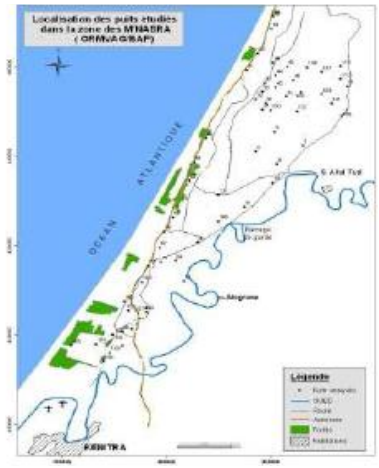

Figure 1 : Localization of the 49 studied wells in the zone of M'nasra

fertilizers, coking plants, ice cream factories, textile industries).

The impacts of agricultural practices on environment are closely and almost exclusively linked to surface and underground waters or to water used for transport and transformation mechanisms which can contaminate the environment.

The ammonium is not very toxic. Its direct effects on the health are still not known enough. The ammonium is most frequently found in the form of chloride of ammonium. This substance is not really dangerous for the health. Nevertheless its inhalation can provoke coughs, its contact with the skin or the eyes can cause red patches, its ingestion can cause nausea, throat pains and vomits. So in case of inhalation it's better to stay in the fresh air in the rest and to consult a doctor. In case of contact with the skin or the eyes it is necessary to rinse abundantly with some water. In case of inhalation it is necessary to drink some water abundantly and to consult a doctor[10].

The ammonia also has the disadvantage of decreasing the efficiency of the disinfection treatment because it reacts with available chlorine and produce organochlorinated compounds unwanted for the health. We practically need 10mg of chlorine by mg of nitrogen of ammonia origin to oxidize chloramines in gaseous nitrogen. The ammoniacal nitrogen can serve as nutrient for microorganisms, responsible for flavors and for unpleasant smells.

Generally speaking, problems posed by the exploitation of a coastal aquifer are complex[11-13]. The large scale use of nitrate fertilizers and pesticides. In the farming sector, the massive uses of chemical pesticides and fertilizers, as well as the very high concentration of the zones where the manure is spread have strongly contributed to the deterioration of the quality of waters. This is going to engender pollution of the water table by an increase of the concentration of the nitrogenous compounds in particular nitrates and ammonium[14-18]. It is in this context that the present work had as objective on one hand, the evaluation of the ammonia pollution of the water of M'nasra's water table. And on the other hand, the study of the spatial and temporal evolution of this nitrogenous pollution, for that purpose 49 wells were observed in three campaign periods 1993, 2007 and 2008.

MATERIAL AND METHODS

Zone of study

The zone M'nasra, object of the present study is the coastal strip of Gharb, covering a geographical surface of about 48 000 ha. More than 26 100 ha of grounds possess less than 6% of clay and more than 82% of sand. Half of the zone approximately 54% is occupied by sandy grounds with a strong permeability[19].

Sampling and measurement methodology

Choice of wells

The choice of these wells was essentially based on two criteria: the intensification of the crops and the depth of the water table.

Sampling

For the sampling, the water has been taken directly from the irrigation network used for wells which are equipped of pushback pumps. For wells that are not equipped, the samples are taken with a ballasted metallic container. All the samples have been put into flasks made of polyethylene or made of borosilicate glass. The samples are carefully marked and kept at +4°C, until their arrival at the laboratory.

Dosage of ammonium

The ammonium was measured by spectrophotometry (in indophenol blue or in Nessler reagent), in alka-

TABLE 1 : The average levels of the concentration in ammonium of waters coming from 49 wells of M'nasra in 1993, 2007 and in 2008

Class sel on Teneur (Ti) en ammonium en (mg/L)	1993		2007		2008		Qualite
	Nombre de puits	Concentration moyenen ammonium (mg/L)	Nombre de puits	Concentration moyenen ammonium (mg/L)	Nombre de puits	Concentration moyenen ammonium (mg/L)	
C_1 (Ti = 0.5)	02	0.18	0	-	0	-	Bonne
C_2 (0.5<Ti≤1)	15	0.86	02	0.83	17	0.78	Mauvaise
C_3 (1<Ti≤1.5)	20	1.25	08	1.33	21	1.26	
C_4 (Ti>1.5)	12	2.08	39	2.58	11	11.14	
Moyenne generale	49	1.3	49	2.3	49	3.3	

line milieu (pH = 10.8 and 11.4) the ammonia reacts quantitatively with the hypochlorite and gives monochloramine. The monochloramine forms with phenol, in the presence of nitroprussiate and with a surplus of hychlorite, the indophenol blue, detectable with a colorimetric dosage at the wavelength of 630nm[20].

RESULTS AND DISCUSSION

Isolated analysis

According to the World Health Organization, the ammonium concentration of drinkable waters does not have to exceed 0.5mg/L[10].

With the values of the concentration of ammonium found in waters of the water table of studied zone (M'nasra), a classification of these values was imperative. So, four classes were established and summarized in the TABLE 1.

The results concerning the concentration of ammonium in 1993, 2003 and in 2007 for the various studied classes are recorded in the TABLE 2.

We have analysed the results presented in the TABLE 1 under the form of bar charts (Figure 2).

By analyzing the content in ammonium of these wells, we can draw the following conclusions:

Concerning the class 1, the results obtained in 1993 show that the class of the wells which have a concentration in ammonium lower than 0.5mg/L, represents only 4.08% of the total mass of wells. Besides, all the wells are polluted by the ammonium in 2007 and 2008.

Concerning the class 2, the global situation of these wells has slightly improved passing of an average in ammonium of 0.86mg/L in 1993 to 0.83mg/L, 0.78mg/L respectively in 2007 and in 2008.

On the other hand for the class 3, the situation of wells is widely degraded passing from their average in ammonium of 1.25mg/L in 1993 to 133mg/L, 1.26mg/L respectively in 2007, and in 2008. It is necessary to underline that even if the average in ammonium of the not conformed wells decreased slightly between 2007 and 2008, it is important to notice that the number of wells concerned increased.

On the other hand for the class 4, the situation of wells is widely degraded going from their average in ammonium of 2.08mg/L in 1993 to 2.58mg/L, 11.14 mg/L respectively in 2007, and in 2008.

Statistical analysis

The main results show that the overall averages of the concentration of ammonium in 1993, 2007 and in 2008 are respectively 1.3mg/L, 2.3mg/L and 3.3mg/L; i.e. an increase of 2mg/L of the ammonium concentration between 1993 and 2008 (TABLE 2). We have presented the results in figure 3 as a bar chart.

In spite of, the variance analysis of the ammonium concentration of the 49 wells of the zone of M'nasra did not show a significant difference between the studied periods, it is necessary to notice a degradation of water quality of the water table. Indeed, the rate of polluted wells in 1993 was 95.92% while this figure has reached 100% i.e. an increase of approximately 4.08 points. In that sense we can assert that the water table is more polluted.

Spatial analysis

To concretize better the analytical results presented in the previous chapter, we proceeded to a spatial analysis in order to see the impact of these results on the field. We elaborated thematic maps of the ammonium pollution of the water table of M'nasra in 1993, 2007 and 2008 on the basis of the obtained results, by

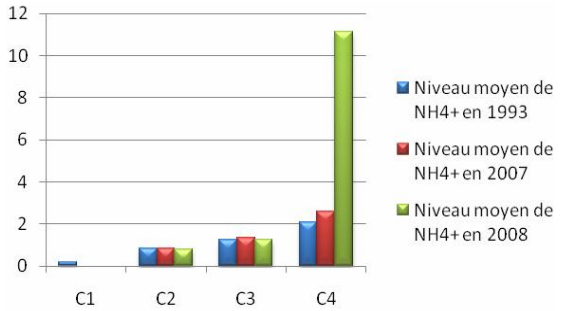

Figure 2 : The average levels of the concentrations in ammonium of waters of 49 wells of M'nasra in 1993, 2007 and in 2008

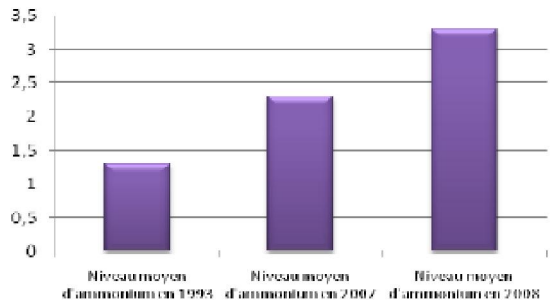

Figure 3 : Comparison of the average levels of ammonium between the studied periods

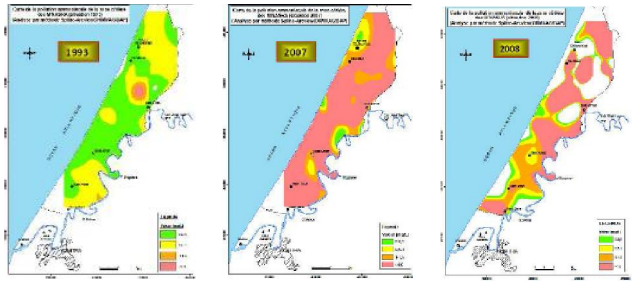

Figure 4 : Map of the ammonium pollution of the zone of M'nasra, Analyzed by the Spline Arcview method: (situation: 1993, 2007 and 2008)

TABLE 2 : Average levels, max, min, and standard deviation of the ammonium concentration at the level of the 49 wells in 1993, 2007 and in 2008

Parameters	(NH_4^+) 1 mg/L	(NH_4^+) 2 mg/L	(NH_4^+) 3 mg/L
Year	1993	2007	2008
Max Value	5,04	4,54	96,66
Standard deviation	0,71	0,97	13,63
Min Value	0,18	0,79	13,63
Mean	1,3	2,3	3,3
Standard according to the WHO	0,5	0,5	0,5

using (SIG) Arcview:

The first basic analysis of the maps above has shown that there is a total degradation of the quality of the water table between 1993 and 2008. We expressed the spatial results presented in the figure 4, in the form of a bar chart I the figure 5.

The space covered by the water table having a concentration in ammonium lower than 0.5mg/L

The space covered by the water table having a concentration in ammonium lower than 0.5 mg/L in 1993, would represent 22 075 Ha on 41 244 Ha mapped i.e. 53.52 % whereas the same space represents respectively in 2007, and in 2008, only 957 Ha over 41 593 Ha and 2 198 Ha on 31 368 Ha mapped i.e. 2.32 %, and 7 % of the total area.

These results show that the space covered by the water table having a concentration in ammonium lower than 0.5mg/L, 46.52 % of its ground between 1993 and 2008 and consequently, we have a surface of 19 877 Ha of which the water table of M'nasra has known a pollution by the ammonium between 1993 and 2008.

So, we noticed that the quality of the water table of M'nasra has known a slight improvement of 1 241 Ha between 2007 and 2008, indeed, the water table has a certain power of renewal thanks to the annual contribution of rainwater.

The space covered by the water table having a concentration in ammonium superior to 0.5mg/L

The space covered by the water table having a concentration in ammonium superior to 0.5 mg/L in 1993, would represent 19 169 Ha over 41 244 Ha mapped i.e. 46.48 % whereas the same area represents respectively in 2007, and in 2008, 40 636 Ha over 41 593 Ha and 29 170 Ha over 31 368 Ha mapped i.e. 97.7 %, and 93 % of the total surface.

These results show that the space covered by the water table having a concentration in ammonium superior to 0.5 mg/L has spread i.e. 21 467 Ha between 1993 and 2007, and we had a surface of 11 466 Ha of which M'nasra's water table has known a certain improvement between 2007 and 2008. Consequently, we have a surface of 10 000 Ha of which M'nasra's water table knew ammoniacale pollution between 1993 and 2008. This suits perfectly to the fact that this water table of M'nasra is a very productive and easily accessible water table, is intensively exploited for irrigation by private pumping. The number of wells dug in the water table exceed 20 000. This water table, because of the strong permeability of the ground and of the under-

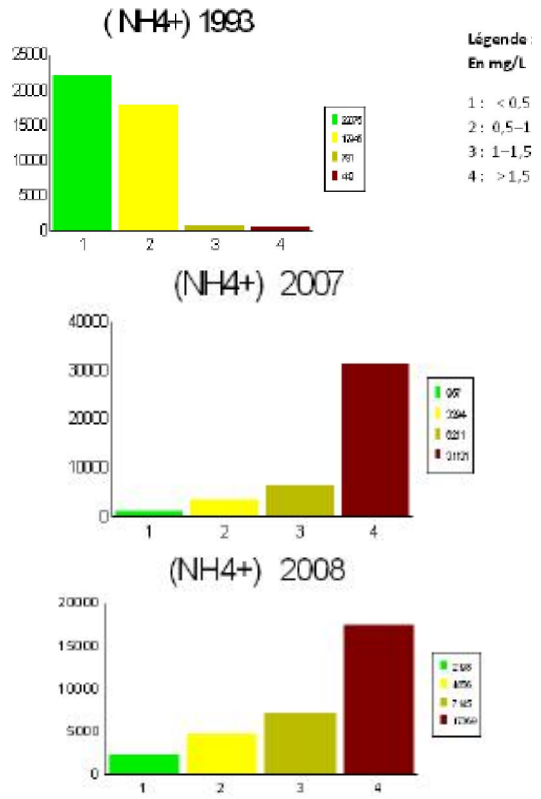

Figure 5 : Spatial distribution of the four classes of the ammonium concentration in 1993, 2007 and 2008

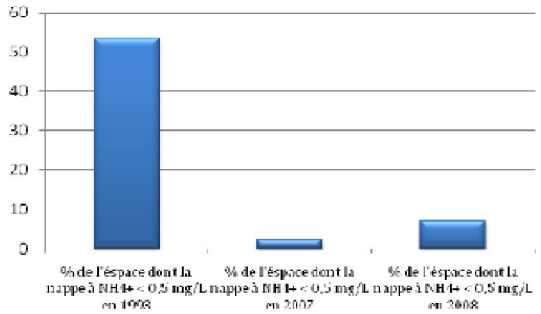

Figure 6 : Variation of the percentage of the space covered by the water table having a concentration in ammonium lowers than 0.5 (mg/L) in function of the time

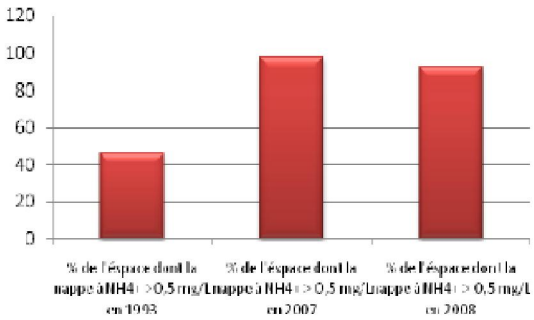

Figure 7 : Variation of the percentage of the space covered by the water table having a concentration in ammonium superior to 0.5 (mg/L) in function of the time

ground and because of its situation with a low depth, is very vulnerable to the diffuse agricultural pollution (N-NO3).

Comparative analysis

The obtained results showed a change of the ammonium pollution of the water table as well at the punctual level as at the spatial level. Indeed, the studied region is a part of these coastal zones, where the only water resources are of underground origin, circulating in a heterogeneous aquifer and its supply is mainly from waters of wells[20].

The zone of M'nasra knows deep transformations both about the social and economical level and at the agricultural and ecological level. For that purpose, it is important to underline that, in this area, the farming sector is in phase of self development essentially characterized by the extension of the irrigation from the water table via tens of thousands wells. Finally, our results are in accordance with several studies and they confirm the pollution of the M'nasra's water table by nitrogenous elements[22-27]. The water table of M'nasra is still the most important water table of the zone of Gharb, because of its excellent quality for the irrigation and because of its nearness to the ground surface, offering extremely interesting opportunities for its exploitation. This explains the advanced degree of the agricultural intensification observed in this zone. But the other side of medal stays in the use of the water of this water table as a drinkable water for a population exceeding 145 000 inhabitants.

CONCLUSION

The results of this work, allowed us to confirm the existence of an evolving and spread ammoniacal pollution of the water table in the region M'nasra. Consequently, the wells matching the standard of the WHO decreased of 4.08% of wells. The analysis of the results show that the overall averages of the ammonium concentration during the measurement campaigns of 1993, 2007 and 2008 are respectively 1.3mg/L, 2.3mg/L and 3.3mg/L i.e. an increase of 2mg/L between 1993 and 2008. Indeed, in 1993 only 2 wells among 49 matched the standard of drink ability according to the WHO, nowadays the totality of the prospected wells

are polluted and does not respect the standard of drinkability.

The spatial analysis, has confirmed a surface of 10 000 Ha where M'nasra's water table has known an ammoniacal pollution between 1993 and 2008. Currently, the water consumption from the water table is increasing intensively and constitutes an important sanitary risk for the people of the region of M'nasra.

REFERENCES

[1] P.Morlon, G.Trouche, C.Soulard; Rev.Agricultures, **1**, 15-27 **(1998)**.

[2] SCET-MAROC; 'Projet De Protection De L'Environnement Du Bassin De Sebou (PPBS), Secrétariat d'Etat Chargé de l'Environnement, **(1999)**.

[3] Le Gal Yves; Biochimie Marine. Masson, Paris, Milan, Barcelone, Mexico, **(1988)**.

[4] Lesouef; 'Elimination De L'azote Et Du Phosphore: Etat De L'art Et Perspectives D'avenir', Dans IFREMER Actes de Colloques 11, La Mer Et Les Rejets Marins, Bendor 13-15 juin 1990, 53-57 **(1991)**.

[5] S.Libes; 'An Introduction to Marine Biogeochemistry', John Wiley & Sons Inc., New York, Chichester, Brisbane, Toronto, Singapore, 597-609 **(1992)**.

[6] B.Chocat; 'Ecyclopédie De L'hydrologie Urbaine Et De L'assainissement', Technique et Documentation, Londres, New York, Paris, **(1997)**.

[7] Landreau; La pollution des eaux par les nitrates. Eau et Développement, Décembre, **10**, 49-58 **(1990)**.

[8] Lenntech; Copyright ©1998-2008, Traitement De L'eau Et De L'air, France- Belgique- Suisse-Canada- Pays Bas Rotterdamseweg, 402 M.

[9] G.W.Roth, R.H.Fox; J.Environ.Qual., **19**, 243-248 **(1988)**.

[10] WHO; 'Nitrate and Nitrite in Drinking Water', World Health Organization (WHO), Rapport WHO/SDE/WSH/04.03/56, 16, **(2003)**.

[11] Y.Hsissou, J.Mudry, J.Mania, L.Bouchaou, P.Chauve; 'Dynamique Et Salinité De La Nappe Cotière D'Agadir, IAHS Publi., **244**, 73-82 **(1997)**.

[12] A.Pulido-Bosch, F.Navarrate, L.Molina; Water Sci.Techn., **24(11)**, 57-69 **(1991)**.

[13] B.C.Richter, C.W.Kreitler; 'Geochemical Techniques for Identifying Sources of Ground Water Salinization', FL: Boca raton & C.K. Smoly, **(1993)**.

[14] L.H.J.M.Janssen, H.Visser, F.G.Roemer; Atmos. Environ., **23**, 2783-2796 **(1989)**.

[15] R.Walker; Food Add.Cont., **7**, 717-768 **(1990)**.

[16] H.Berdai, N.Aghzar F.Z.Cherkaoui, B.Soudi; Etude Et Gestion Des Sols., **9(1)**, 7à 23 **(2002)**.

[17] C.G.Kowalenko, D.R.Cameron; Can.J.Soil Sci., **56**, 63-70 **(1976)**.

[18] O.B.Yapo, V.Mambo, Meledje E.J.C.Djedjess, M.J.Ohou, A.Seka, A.S.Tidou, P.V.Houenou; European Journal of Scientific Research, **26(4)**, 565-576 **(2009)**.

[19] M.Zeraouli, M.Morchid; 'Fertilisation Azotée Du Poivron Sous Tunnel Dans Une Zone Sableuse A Nappe Proche De La Surface', Marocaine Des Sci Et Tech Du Développement Rural, **31**, 118 **(2001)**.

[20] Rodier François; 'Decomposition of Principal Series for Reductive p-adic Groups and the Langlands Classification', Operator Algebras and Group Representations, **2**, 86-94 **(1984)**.

[21] Anonyme; 'Agence Du Bassin Hydraulique Du Sebou', Coopération Allemende INWENT et MedWet Pour Les Zones Humides Et Méditerranéennes, Etude De Diacnostic De La Nappe De Mnasra, Wilaya De Kenitra, **(2006)**.

[22] S.Bricha, K.Ounine, S.Oulkhir, N.Elhaloui, B.Atrassi; Afriq.Sci., **3(3)**, 391-404 **(2007)**.

[23] I.Idrissi Alami, M.Zeraouli, M.Addou, A.Moukhtari, A.Soulaymani; Afriq.Sci., **3(3)**, 378-390 **(2007)**.

[24] I.IdrissiAlami, A.Rhidouani, M.Zeraouli, A.Haidar, A.Echchelh, M.Addou; Environmental Science: An Indian Journal, **5(1)**, 46-50 **(2010)**.

[25] I.Idrissi Alami, A.Rhidouani, M.Zeraouli, A.Echchelh, M.Addou; Environmental Science: An Indian Journal, **5(1)**, 51-58 **(2010)**.

[26] Z.Saadi, A.Maslouhi; Advances in Environmental Research, **7(4)**, 803-823 **(2003)**.

[27] R.K.Hubbard, J.M.Sheridan; J.Soil Water Conser., **44**, 20-27 **(1989)**.