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

I.Idrissi Alami[1]*, A.Rhidouani[2], M.Addou[1]

[1]Laboratoire D'Optoélectronique et de Physico Chimie des Matériaux, URA CNRST, URAC- 14 Maroc Faculty of Science BP133, (MOROCCO)

[2]Regional Laboratory of the National Office of Drinkable Water, Laboratory of the Agro-Pedology of the Regional, (MOROCCO)

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ABSTRACT

We have been interested in the study of the nitrogen pollution of M'nasra's water table. This one is located in the Gharb region in Morocco where 145 000 people live. It ensures the development of a dynamic irrigation over an area of about 38 000 Ha in which more than 50% of lands are sandy soils that are very permeable. We have carried out 80 campaigns of measurement in 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 results of the statistical analysis have shown a mutation of the nitric and the ammoniacal pollution in the region. This reveals that 87 % of observed wells do not respect the World Health Organization (WHO)Moreover, the spatial analysis has confirmed an area of 2 285 Ha and 19 885 Ha in which the water table has known respectively a nitric and a ammoniacal pollution between 1993 and 2008.

KEYWORDS

Nitric;
Ammoniacal;
Water table;
Pollution;
Degradation;
M'nasra.

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 117 kg 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] and[4]. 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[5]. The presence of ammonia in the environment result from metabolic process, agricultural and industrial[6], intensive livestock breeding can produce much more important concentrations in surface waters[7]. 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[8]. Generally speaking, problems posed by the exploitation of a coastal aquifer are complex[9] and[10]. 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[11] and[12]. 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 80 wells were observed in the campaign periods 1993 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[13].

Sampling and measurement methodology

The choice of these wells has essentially been based on two criterions: the intensification of crops and the depth of the water table (Figure 1).

Dosage of ammonium

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

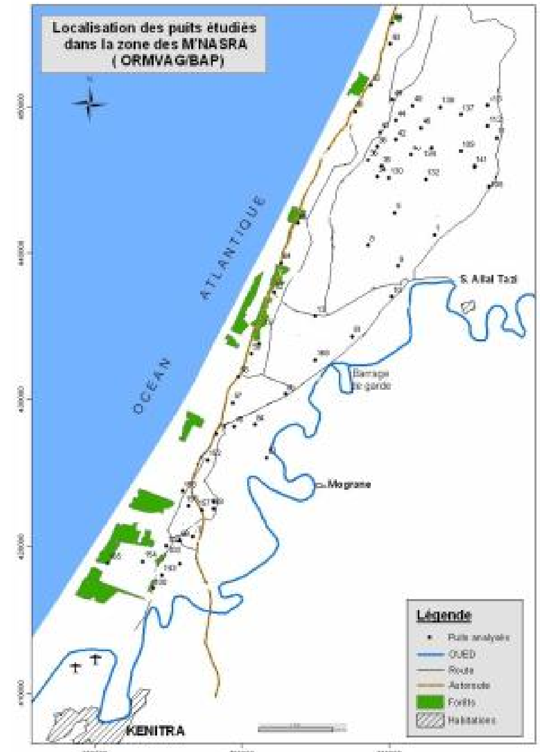

Figure 1 : Localization of the 80 studied wells within the zone of M'nasra

colorimetric dosage at the wavelength of 630 nm[14].

Dosage of nitric

The nitrates have been measured by molecular absorption spectrometry. After their reduction in nitrite on cadmium, the nitrates are quantitatively reduced in nitrites by cadmium (Cd) covered of a copper layer after a treatment by copper sulfate. The produced nitrites form with 4-amino benzene sulfonamide a diazoic compound, this one coupled with N-(Naphty-1) ethane-1,2-diamine form a pink complex that is likely of being measured with a spectrophotometer at a wavelength of 540 nm[14].

RESULTS AND DISCUSSIONS

Statistical analysis

To do not have a negative impact of human health, the concentration of nitrate and the ammonium in drinkable waters should not exceed respectively of 50 mg/L and 0,5 mg/L[8].

In order to assess the nitric and the ammonium pollution of the water of our wells, we have done 80 measurement campaigns on the different periods: 1993 and 2008.

The characteristics of the water of the 80 wells in 1993 are presented in the TABLE 1.

TABLE 1 : Nitric and ammonium composition of water from wells in 1993

Parameter	Nitric	Ammonium
Average	121	2,1
Min Value	9,00	0,2
Max Value	300,00	6
Standard deviation	70	0,82
Number of samples	80	80
Standard according to the WHO	50	0,5

The characteristics of the water of the same 80 wells in 2008 are presented in the TABLE 2.

TABLE 2 : Nitric and ammonium composition of the water from the same wells in 2008

Parameter	Nitric	Ammonium
Average	155	4,5
Min Value	30	14
Max Value	555	100
Standard deviation	14,23	12
Number of samples	80	80
Standard according to the WHO	50	0,5

The main results show that the general means of nitrate concentration in 1993 and 2008 are respectively of 121 mg/L and 155 mg/L; it represent an increase of 34 mg/L between 1993 and 2008. Moreover, the main results show that the overall averages of the concentration of Ammonium in 1993 and in 2008 are respectively 2,1 mg/L and 4,5 mg/L; i.e. an increase of 2,4 mg/L of the Ammonium concentration between 1993 and 2008.

The comparison of averages of different studied parameters during the measurement campaigns of 1993 and 2008 is represented in the Figure 2.

The comparison of the bar charts presented below, has clearly shown a positive correlation between the studied parameters such as; the nitric concentration and the concentration of ammonium. These factors cause an increase of the nitrogen pollution of the water table. By comparing the general mean of the calculated nitrate and ammonium concentrations, we can clearly notice that this mean increases in function of time. The statistical analysis of the nitrate and the ammonium concentrations of the 80 wells, and so each zone A and B

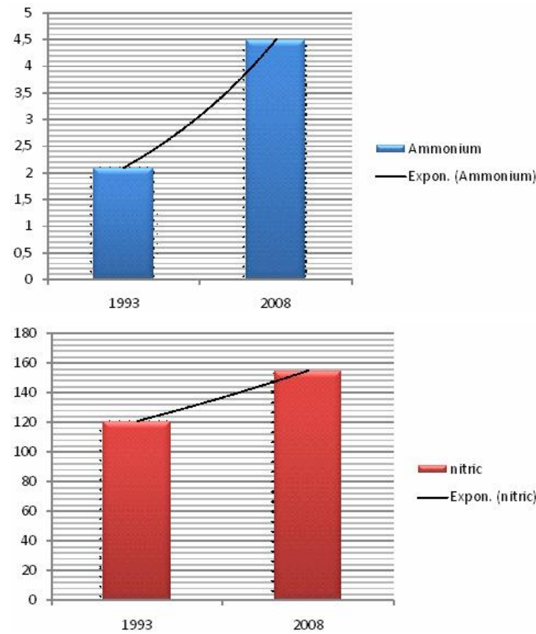

Figure 2 : Comparison of the studied physical and chemical parameter averages in function of time.

of the area of M'nasra, in 1993 and 2008 is presented in the TABLE 3. Just like we have reported before, the zones A and B are also noted:

Zone A: It is the zone located at the North of the coordinate line Y= 430 000 m, it represents 80 % of all the studied wells.

Zone B: It is the zone located at the South of the coordinate line Y= 430 000 m, it represents 20 % of all the studied wells.

TABLE 3 : Variance analysis of the 80 wells and at the level of the North zone and at the South of the line Y= 430 000 m of M'nasra's zone

Analyse statistique	Analyse de variance des nitrates 1993 - 2008	
	ammonium	nitric
Zone A	HS	HS
Zone B	S	S
Zone + Zone B	HS	HS

This statistical study has shown us two essential things:

The nitric and ammonium pollution are concentrated mostly in the North part of the coordinate line Y= 430 000 m, of the area of M'nasra.

The results obtained in 1993 show that the wells having a nitrate concentration superior to 50 mg /L, represent 73% of wells.On the other hand, the same wells represent 87 % in 2008. Moreover, The results obtained in 1993 show that the wells having a ammonium concentration superior to 0,5 mg /L, represent 94% of wells. On the other hand, the same wells represent 100 % in 2008, an increase of approximately 6 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 and the nitric pollutions of the water table of M'nasra in 1993 and 2008 on the basis of the obtained results, by using (SIG) Arcview (Figure 3):

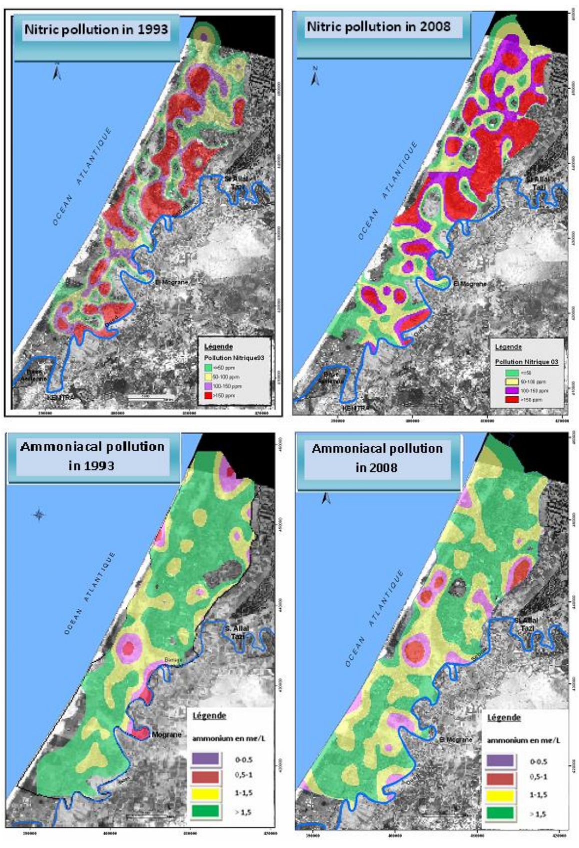

Figure 3 : Map of the nitric and ammonium pollutions of the zone of M'nasra, analyzed by the Spline Arcview method: (situation: 1993 and 2008).

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.

The area covered by the water table having a nitrate concentration inferior to 50 mg/L in 1993, would represent only 6 655 Ha over 36 007 Ha mapped i.e. 18,48% whereas the same area used to represent in 2008, 4 370 Ha over 37 706 Ha mapped i.e. loss of 11,58% over the total area (Figure 4). These results show that the area covered by the water table having a nitrate concentration inferior to 50 mg/L, has lost in importance i.e. loss of 2 285 Ha between 1993 and 2008.

Moreover, the space covered by the water table having a concentration in Ammonium lower than 0.5 mg/L in 1993, would represent 21 075 Ha on 41 244 Ha mapped i.e. 51.09 % whereas the same space represents respectively in 2008, only 1 190 Ha on 31 368 Ha mapped i.e. 3,79 % of the total area (Figure 4). Consequently, we have a surface of 19 885 Ha of which the water table of M'nasra has known a pollution by the Ammonium between 1993 and 2008.

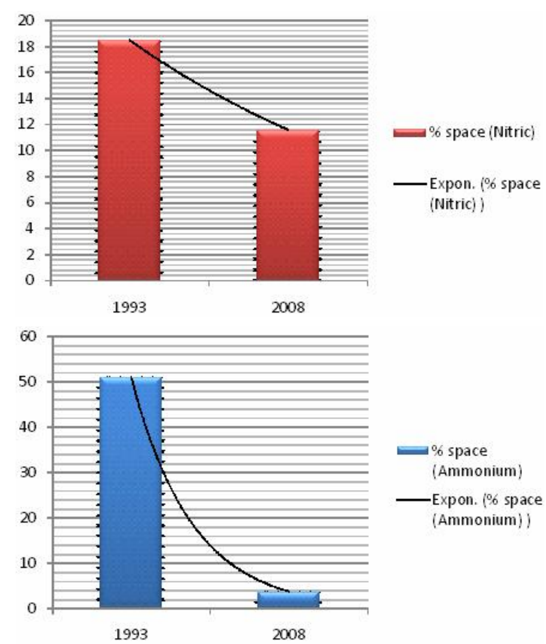

Figure 4 : Variation of the percentage of the area covered respectively by the water table having a nitrate concentration inferior to 50 (mg/L) and ammonium concentration inferior to 0,5 (mg/L) in function of time

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 underground 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[15].

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[16-19] and[26] and[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 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 n° **1**, 15-27 **(1998)**.

[2] SCET-MAROC., Projet de Protection de l'Environnement du bassin de Sebou (PPBS). Etude pour un programme d'action visant à minimiser et à contrôler l'impact des engrais et des pesticides sur l'environnement du bassin de Sebou. Sous-mission 2.1. Secrétariat d'Etat Chargé de l'Environnement, **(1999)**.

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

[4] Lesouef et al.; Bendor 13-15 Juin 1990, 53-57 **(1991)**.

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

[6] Lenntech; Copyright ©1998-2008. Traitement de l'eau et de l'air. France - Belgique - Suisse - Canada - Pays Bas Rotterdamseweg 402 M.

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

[8] WHO; Nitrate and Nitrite in Drinking-water (Background Document for Development of WHO Guidelines for Drinking-water Quality). World Health Organization (WHO), Rapport WHO/SDE/WSH/ 04.03/56, 16 **(2003)**.

[9] I.Idrissi Alami, M.Zeraouli, M.Addou, A.Moukhtari, A.Soulaymani; Afriq.Sci., **03(3)**, 378-390 **(2007)**.

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

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

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

[13] M.Zeraouli, M.Morchid; Marocaine des Sci.et Tech.du Développement Rural, **31(118)**, **(2001)**.

[14] Rodier François; Monographs Stud.Math., 18, Pitman, Boston, Mass.-London, (Neptun, 1980), **2**, 86-94, **(1984)**.

[15] A.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)**.

[16] S.Bricha, K.Ounine, S.Oulkhir, N.Elhaloui, B.Atrassi; Afriq.Sci., **03(3)**, 391-404 **(2007)**.

[17] I.Idrissi Alami, A.Rhidouani, M.Zeraouli, A.Haidar, A.Echchelh, M.Addou; Environmental Science: An Indian Journal, **5(1)**, 201 **(2010)**.

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

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