International Journal of Vocational and Technical Education Research
Vol.7, No.3 pp.32-40, 2021
Print ISSN: ISSN 2059-1187,
Online ISSN: ISSN 2059-1195

IMPACTS OF THE USE OF DISTANCE EDUCATION ON LEARNING IN LIFE AND EARTH SCIENCES

El Bouqdaoui k., Mounchid K., Charki M.
[a] Faculty of Sciences Aïn Chock University Hassan II, Casablanca, Morocco

ABSTRACT: *Unlike captive aquifers that are relatively protected by their impermeable roof, the Berrechid water table is very vulnerable to pollution from the ground surface. This pollution can be either localized (discharges of domestic and industrial wastewater, solid wastes leached by seepage water, either diffuse (Fertilizer application of soils, treatment of crops with plant protection products). This last mode of contamination presents the danger of being spread over large areas, and therefore of being difficult to control.To model the nitrate transport in the Berrechid aquifer, we used the MT3DMS model coupled with the hydrodynamic model previously created using MODFLOW; this in order to have a decision support tool for optimal management of the region's groundwater resources.Various simplified water management scenarios are examined, in particular artificial recharge and reduction of pumped water volumes for irrigation. The results show that the halving of current withdrawals would improve the current situation of the Berrechid aquifer by avoiding the appearance of dewatering zones in 2025, with a considerable drop in nitrate concentrations in almost the entire aquifer. This model that we developed could thus be a useful tool for the management and protection of groundwater in the Berrechid aquifer***.**

KEYWORDS: Groundwater, Protection, Modeling, MT3DMS, MODFLOW, Berrechid.

INTRODUCTION

Adverse weather conditions and intensive groundwater exploitation have led to alarming decreases in levels in most of the semi-arid to arid zones of Morocco (Margat 1983, CSE 2001). Per capita water reserves, which are already approaching the stress threshold of 1000 m^3/inhabitant / year, would be around 500 m^3/inhabitant/year in 2020 (Bzioui, 2000). Several studies carried out in this respect have repeatedly highlighted the piezometric deficit, over-exploitation, quality degradation and inadequate management of water resources (Margat, 1983, USAID/ORMVA, 1999, CSE, 1992; Arioua, 1995).

The Berrechid aquifer is relatively small in size compared to the water needs in the region (drinking and industrial water supply, irrigation, etc.). This should, a priori, encourage a particularly vigilant approach in its quantitative and qualitative management. The MODFLOW modeling provided a better understanding of the hydrodynamic functioning of the aquifer. During this modeling, the balance sheet turned out to be negative over the simulated period; this is due to increasing exploitation of groundwater, combined with dry climatic conditions (El Bouqdaoui, 2008).

The results of the simulations carried out by MT3DMS show a degradation over the years of the quality of the Berrechid aquifer, especially in the northwest and southwest where the nitrate contents exceed the maximum allowable value; this could be explained on the one hand by the presence in these areas of an uncontrolled landfill and discharges of wastewater (industrial and domestic), and on the other hand by the use of nitrogen fertilizers. The modeling of the transport phenomena has also highlighted the high sensitivity of the aquifer to the water supplies of the Settat plateau (southern border of the aquifer), in addition to those of surface (El Bouqdaoui et al., 2009). The previously developed model has been used as a tool for forecasting purposes. Various simplified water management scenarios are discussed, including artificial recharge and reduction of pumped water volumes for irrigation, as well as their influence on groundwater nitrate concentrations in the Berrechid aquifer.

The study area

The Berrechid plain, with a total area of 1600 km^2, is located south of Casablanca (Fig. 1). It is in the form of a bowl with a large radius of curvature of elliptical shape whose major axis is oriented substantially South West-North East, a length of about 60 km. It is limited to the South-East by the Settat Plateau, to the North-East by the Mellah Wadi Valley, in the southwest by the Souk-Jemaa peneplain, and in the north-west by the coastal Sahel consisting of dunes parallel to the shore (ONEP, 1997).

The study focuses on the area of the Berrechid aquifer where the Boumoussa and El Heimer wadis are real open sewers. At the level of these wadis are installed four effluents (Fig. 1):

- The effluent 1: it receives the domestic discharges of the east part of the city of Settat and the industrial district.
- The effluent 2: it is located on a pond accumulating rainwater and wastewater industrial waste of the city of Berrechid.
- Effluent 3: it is located on a storage basin (main collector) of rainwater and discharges of industrial and domestic water from the city of Berrechid.
- The effluent 4: it is located on the wadi El Heimer, at the exit of the main collector of the city of Berrechid.

Effluents 2 and 3 pass through a lagoon-type treatment plant whose capacity is very much exceeded and as a result, it remains ineffective in the face of too large volumes of water that it receives. The waters are then pushed back to El Heimer Wadi, north of the town of Berrechid (Kholtei, 2002).

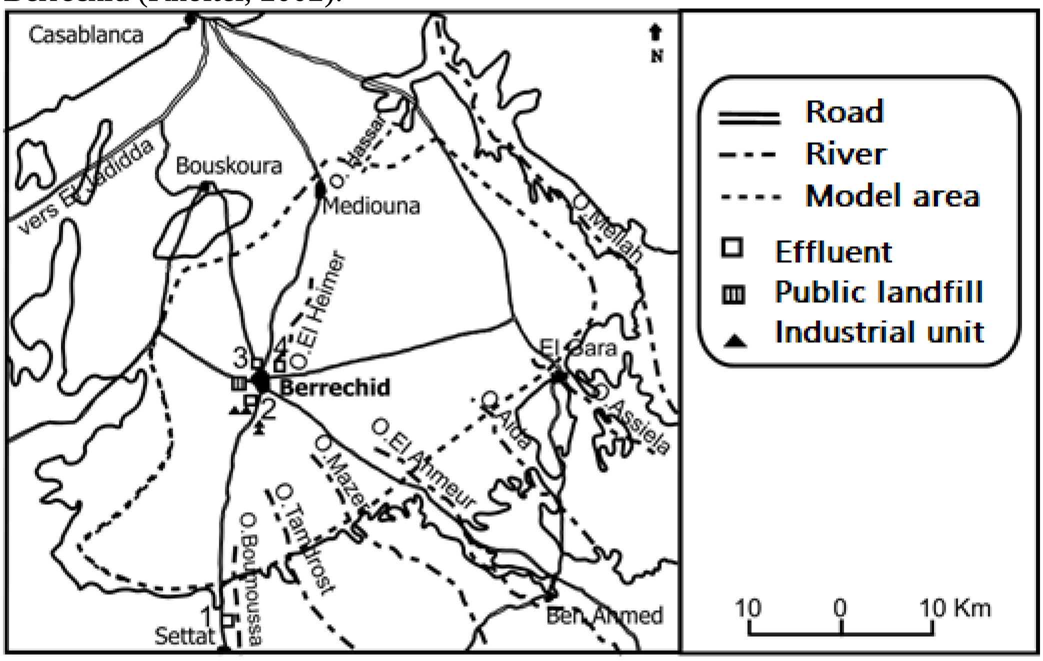

Fig.1. Location of pollution sources at the level of the modeled area (from DGH, 1997, Kholtei, 2002).

Health effects of nitrates

The increase in nitrogen levels in groundwater in rural areas in Morocco is not only the consequence of the intensive application of nitrogenous fertilizers, but also of the discharge of urban wastewater into the natural environment and the discharge of industrial agro-food effluents, which are rich in organic matter (Conseil Supérieur de l'Eau et du Climat, 1988).

The pollution of groundwater tables by nitrates is a health problem responsible for two potentially pathological phenomena:

- Methaemoglobinaemia: The presence of methaemoglobin decreases the oxygen transport capacity of the blood at the level of the organs, (Bontoux, 1993; Levallois and Phaneuf, 1994) .
- Cancer risk: In an acidic environment, nitrite ion forms nitrous acid. In the presence of a halide ion, the nitrosamines formed have carcinogenic potential, mainly that of the stomach (Miquel, 2003; Leclech, 1998).

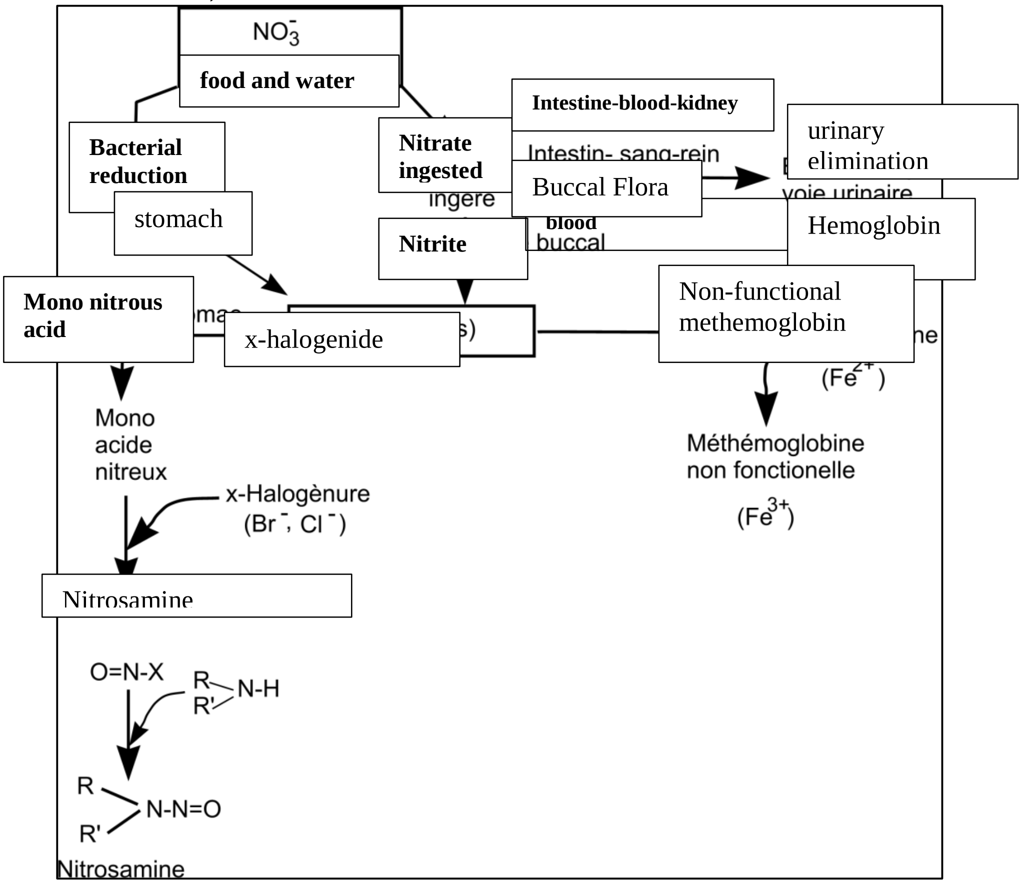

Fig.2 Becoming nitrates in the body (Leclech, 1998)

MATERIEL AND METHODS

The numerical model that we used was realized thanks to the MODFLOW programs for the flow and MT3DMS for the transport; these two numerical codes are interfaced to GMS 4.0 (Groundwater Modeling System) developed by "Environmental Modeling Research Laboratory of Brigham Young University" in collaboration with "U.S. Army Engineer Waterways Experiment Station "(Environmental Modeling Research Laboratory, 1999).

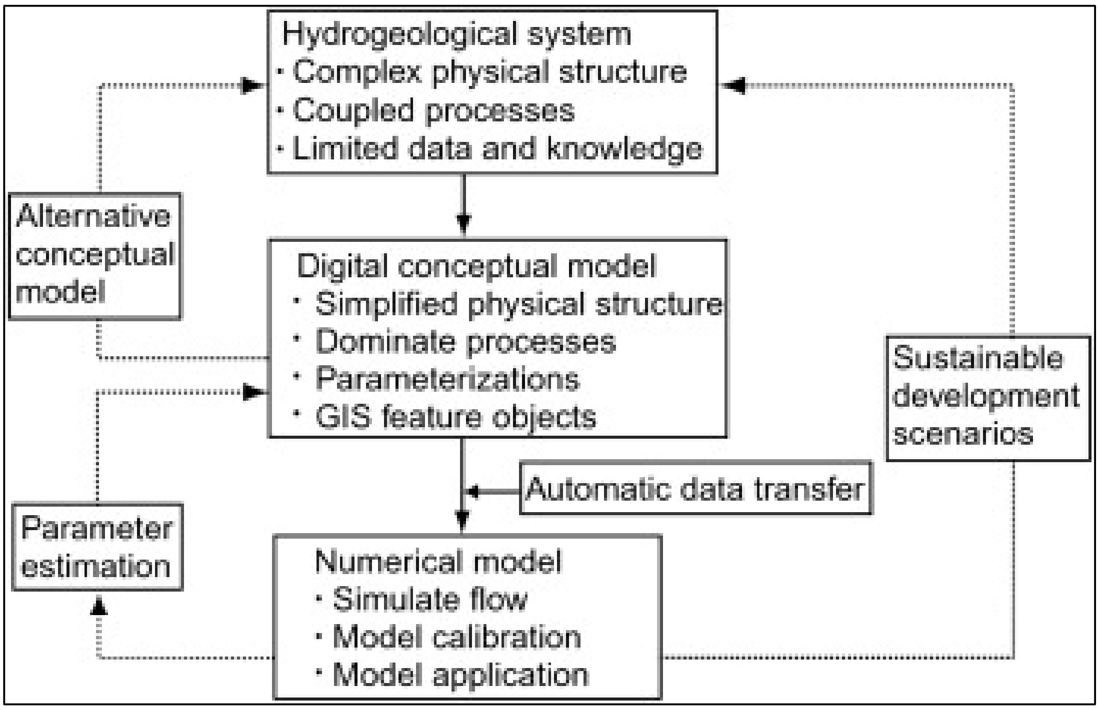

Fig. 3. Flow chart for the development of conceptual model for scenarios simulations.

The reserves of the Berrechid aquifer were evaluated and long-term prediction simulations (year 2025) were carried out using the hydrodynamic model previously developed.
(El Bouqdaoui et al., 2008, 2009, 2018). Simplified scenarios for the quantitative and qualitative management of this aquifer have also been carried out, namely: the one-off injection of surface water from the wadis by artificial recharge and the reduction of volumes pumped for irrigation, as well as their effect on the distribution of nitrate concentrations in 2025.

RESULTS AND DISCUSSIONS

The results of the simulations show an increased and continuous decline in the water table, especially in the center where the drops reach 16 m in the year 2025 (El Bouqdaoui and Aachib, 2019).
The study of the impact on groundwater quality of the Berrechid aquifer of the two scenarios of artificial recharge and reduction reducing the volume of water pumping volumes for agricultural purposes

Scenario 1: Punctual injection in wadis and its impact on groundwater quality

The Berrechid aquifer depends on the recharge from the effective rains, but also from the floods of the wadis and the settlements of the Settat plateau.
In this scenario, the simulation consists of an artificial recharge, at the level of the five rivers located in the south (Wadis Boumoussa, Tamdrost, Mazer, El Ahmeur and Aida), with a flow rate of 650 L s^{-1} per well for one month, a total volume of 8.42 Mm^3, while maintaining the same external stress conditions of the water table.

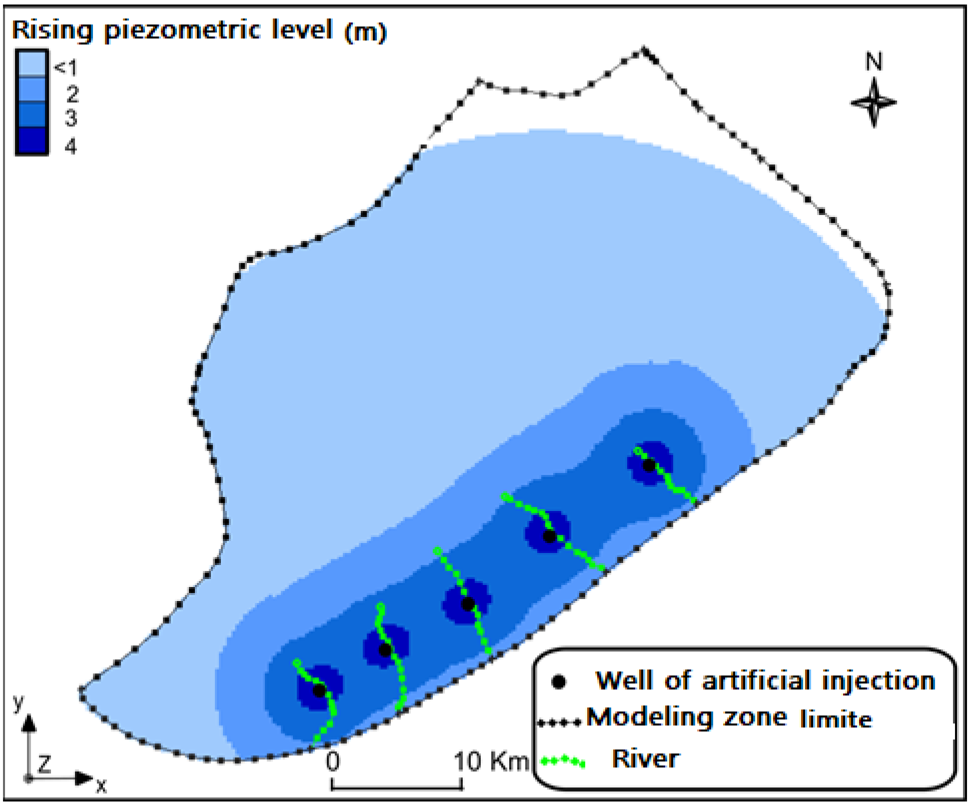

Fig. 4. Influence of artificial recharge on the water table in 2025 (El Bouqdaoui and Aachib, 2019).

Fig. 5 shows the influence of this recharge on the plume of nitrate pollution. In the south where the refill was carried out, the nitrate contents were attenuated to values lower than the permissible limit value (50 mg L^{-1}). In the southwest and northwest, nitrate concentrations were also diluted but not up to standard because of the weak effect of recharge in these areas. The problem of improving the quality of the Berrechid aquifer lies in the non-homogeneous decontamination of this aquifer. It may be more appropriate to reduce pumping volumes for irrigation.

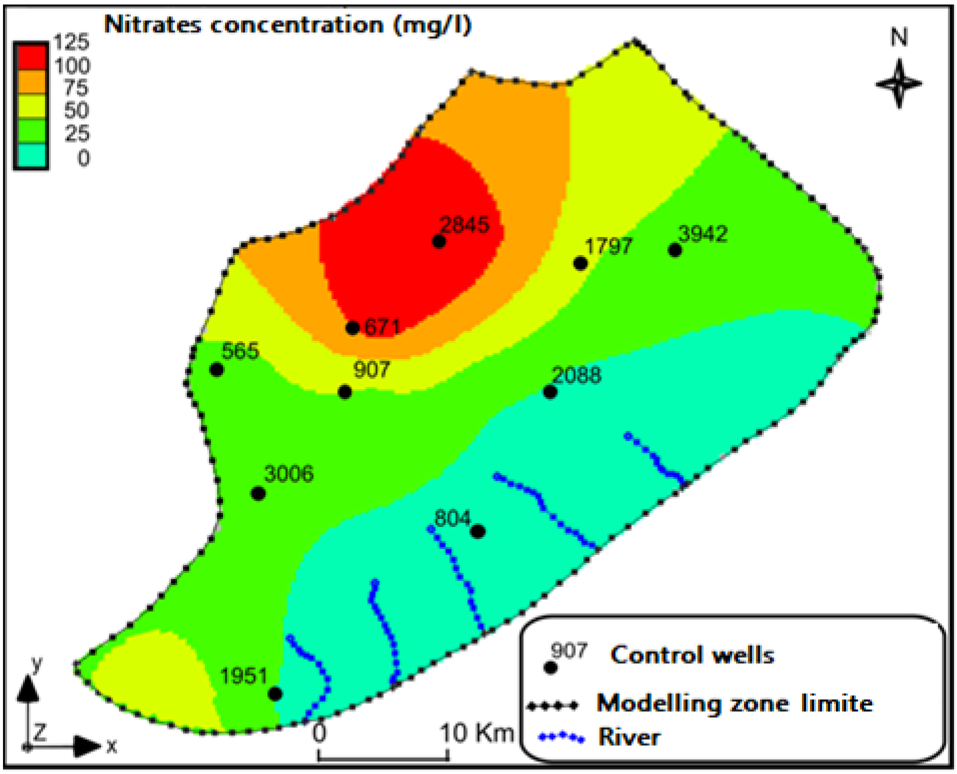

Fig. 5. Influence of artificial recharge on nitrate pollution.

4.2. Scenario 2: Reducing pumped water volumes for irrigation and its impact on groundwater quality

We have carried out simulations to reduce the pumping volume by 25%, 50% and 75% compared to the current flow rate; this implies that the irrigated areas continue to increase but by using more economical irrigation techniques. A good management of surface water allocated to agriculture will also make it possible, in periods of drought, to save the equivalent of the volume of groundwater made available to this agriculture, while preserving its quality.

The analysis of the different quantitative simulations shows the power of the water table in 2025, with a reduction of 50%, we note the complete disappearance of these bare areas by 2025; and from a reduction of 75%, the thickness of the aquifer continues to increase, leading to a marked improvement in renewable water resources (El Bouqdaoui and Aachib, 2019).

Figs 6 and 7 show the effects of the reduction of 50% and 75% of the volumes pumped for agricultural purposes on the quality of the water table in 2025. These reductions are marked by the dilution of nitrate concentrations, with values below the permitted standard (50 mg L^{-1}), except in the south-western and north-western areas where there are point sources of pollution (effluents, uncontrolled discharges) (see Fig. 1). The lowest concentrations are recorded in the area adjacent to the southern limit of supply.

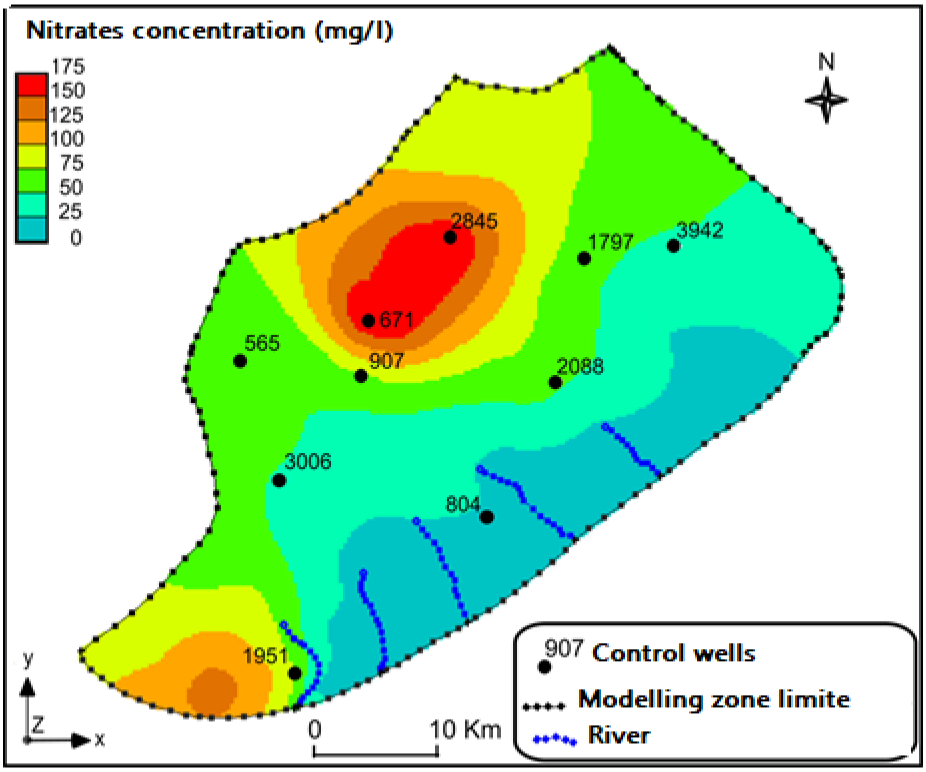

Fig. 6. Distribution of nitrate levels simulated in 2025, with a reduction of pumping volumes of 50%.

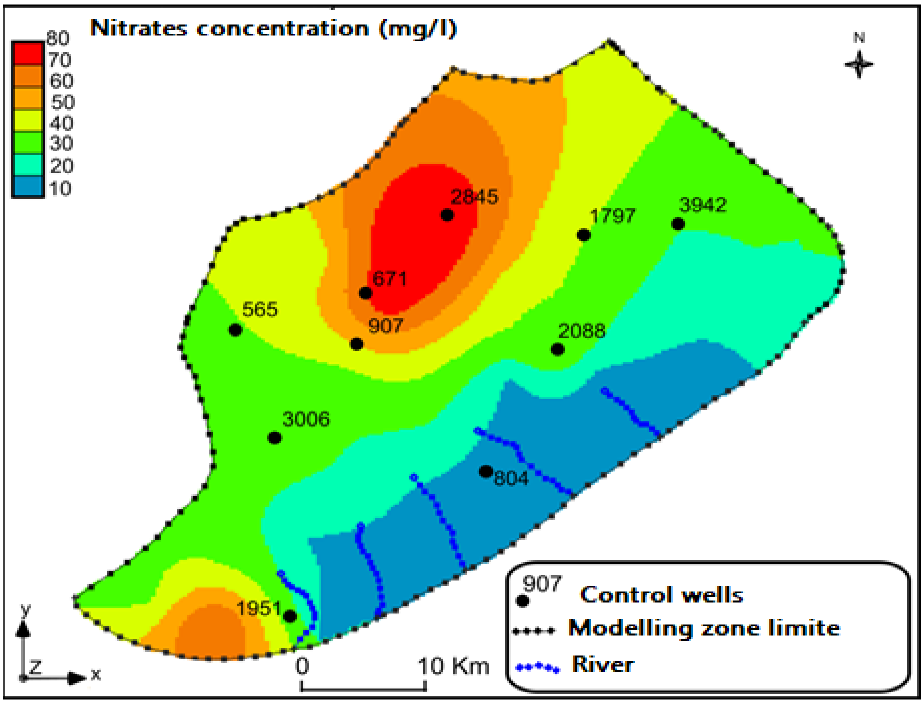

Fig. 7. Distribution of nitrate levels simulated in 2025, with a 75% reduction in pumping volumes.

High nitrate concentrations in most of the control wells indicate leaching of significant amounts of nitrogen products to groundwater. In general, poor water quality over much of the groundwater, combined with the adverse effects of drought over the past two decades, has led to an increase in this problem in some areas.

Faced with this alarming situation, the simulation of some scenarios for the decontamination of its resources was carried out by: reducing the volumes of samples intended for irrigation. The results of the simulated scenarios show that after respective reductions of 25%, 50% and 75%, the water table levels will start to rise in 2025, filling the dewatering areas.

Good quantitative management of the water resources of the Berrechid aquifer will also lead to an improvement of the water quality of this aquifer. This has been evidenced by the reduction in the volumes of water pumped for agricultural purposes. With a 75% reduction, nitrate concentrations will fall below the admissible threshold (50 mg L^{-1}) in most of the groundwater, except near the uncontrolled landfills to the west of the town of Berrechid, and in the wastewater discharges of the El Heimer and Boumoussa wadis. Eliminating the sources of this point source pollution will certainly contribute to improving the water quality of the Berrechid aquifer. It should be noted that the injection of uncontaminated water into the wadis only causes a local improvement in the quality of the aquifer.

It should also be noted that following an increasing demand for water, and with the existence of factors still unmanageable, intervening in the management of groundwater must also be taken into account, such as climate change, withdrawals often numerous and poorly controlled.

CONCLUSION

Sing the GMS software, some scenarios for restoring water resources in the Berrechid aquifer were carried out by simulating artificial recharge and reduced pumping volumes and their effect on the distribution of nitrate concentrations. Limiting the use of pumping for irrigation shows that a halving of current withdrawals will significantly increase the groundwater level by causing the disappearance of dewatering zones and also a decrease in nitrate concentrations below the admissible threshold (50 mg L-1) in almost the entire aquifer. It also seems imperative to limit the siting of polluting industrial units outside developed sites. Changing the agricultural practices used in the region, reusing wastewater instead of discharging it into the natural environment in the open air and using controlled landfills can make a significant contribution to improving groundwater quality in the region.

References

Arioua, A, 1995. Évolution de la qualité des eaux de l'oued Oum Er Rbia (Maroc) avec essai de modélisation ». Thèse de 3e cycle, université Cadi Ayyad, Marrakech, Maroc.

Bontoux J., 1993. Introduction à l'étude des eaux douces, eaux naturelles, eaux usées, eaux de boisson, édition Cebedoc, liège, 169 p.

Bzioui, M., 2000. Politique et stratégies de gestion des ressources en eau au Maroc. Académie du Royaume du Maroc. Session « La politique et la sécurité alimentaire du Maroc à l'aube du XXIe siècle, Rabat, Maroc.

CSE (Conseil supérieur de l'eau), 2001. La gestion de l'économie de l'eau et Recommandations des sessions du conseil supérieur de l'eau et du climat et les actions entreprises pour leur mise en œuvre, 9e session, Agadir, Maroc.

CSE (Conseil supérieur de l'eau), 1992. L'économie de l'eau dans le secteur de l'irrigation ». 6e session.

DGH (Direction Générale de l'hydraulique) (Direction de la recherche et de la planification de l'eau), 1997. Etude de la plaine de Berrechid, mission 1. Description et analyse. Edition définitive (Annexes A et B).

El Bouqdaoui, K., 2008. Modélisation de Contribution à la modélisation de l'écoulement et de la pollution par les nitrates en vue d'une meilleure gestion de la nappe de Berrechid (Maroc) . DOCTORAT National en Sciences de l'Environnement, Uni. Hassan II. Fac. Sc. Ain chock Casablanca,Maroc

El Bouqdaoui K., Aachib M., 2019. Simulations of some scenarios of management restoration of Berrechid aquifer (Morocco). International Journal of Engineering and Advanced Technology (IJEAT), 8(4), 1735-1741.

El Bouqdaoui K., Aachib M., 2018. Delimitation of the perimeters of protection of groundwater catchments of the berrechid aquifer (Morocco) through hydrogeological modeling. Journal of Geoscience and Environment Protection. Special Issue on Environmental Quality, 6, 101-112.

El Bouqdaoui, K., Aachib, M., Blaghen, M,. Kholtei, 2008. Modélisation de l'écoulement de la nappe de Berrechid (Maroc), Revue internationale de l'Eau : La Houille Blanche, 2, 69-75.

El Bouqdaoui, K., Aachib, M., Blaghen, M,. S., Kholtei, 2009. Modélisation de la pollution par les nitrates de la nappe de Berrechid (Maroc) », la Revue Internationale des Sciences et Technologie : Afrique Science, 05(1), 99-113.

Environmental Modeling Research Laboratory, Groundwater Modeling System – GMS Reference Manual, Birmingham Young University, Birmingham, (1999).

Leclech B., 1998. Environnement et Agriculture, 2eme édition. Edition Synthèse agricole.

Levallois P., Phaneuf D., 1994. La contamination de l'eau potable par les nitrates: analyse des risques à la santé. Can. J. Publ. Health, 192-196.

Kholtei, S., 2002. Plaine de Berrechid ; Caractérisations des eaux usées de Settat et de Berrechid; Evaluation de leurs impact sur la qualité des eaux souterraines et risque toxicologique . Doctorat d'Etat ès Sciences Physiques. Spécialité: Chimie Appliquée et environnement, Uni. Hassan II. Fac. Sc. Ben M'sik. Casablanca, Maroc.

Margat, J., 1983. Analyse de la situation due aux effets de la sécheresse etre commandations de mesures appropriées à leur atténuation par l'exploitation ders eaux souterraines . Rapport de mission dans la province d'Errachidia et Ouarzazate. Note BRGM.

Miquel G., 2003. La qualité de l'eau et de l'assainissement en France. Office parlementaire d'évaluation des choix scientifiques et technologiques. Tome I, 198p.

ONEP (Office Nationale de l'Eau Potable), 1997. Etude de schéma directeur d'assainissement liquide de la ville de Berrechid. Rapport final de la mission A.

USAID/ORMVAT (US Agency for International Development/Office régional de mise en valeur du Tadla), 1999. Résultats et technologies développées à Tadla, Maroc . Projet Management des ressources de Tadla (MRT). Rapport n° 83. Tadla : ORMVA.