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Research Article

DETERIORATION OF THE QUALITY OF GROUND WATER IN AGRICULTURAL REGION. CASE MITIDJA (ALGERIA)

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ABSTRACT

In Algeria the plain of Mitidja, famous for the fertilization of its soil, on overuse, is exposed to pollution due particularly to fertilizers and other phytosanitary. The spatio-temporal distribution of the concentrations of major ions, namely nitrates, would explain the transfer and circulation mechanisms of these elements within groundwater .The disparity in nitrate levels shows exposure of the Mitidja aquifer to pollution over its entire extent. The geological origin of the high concentrations of nitrates in places cannot alone explain this distribution. The levels are higher during recharge and irrigation due to the leaching effect of agricultural soils. The use of highly nitrogenous chemical fertilizers in agriculture, compared to the evolution of piezometric levels, causes a significant increase in nitrate concentrations due to their transport from the surface to the aquifer.

The subterranean waters of the Quaternary aquifer in the Mitidja show in certain areas concentrations greater than 250 mg / l (Hamiz region in the eastern part of the Mitidja).

This high concentration results mainly from irrigation (market gardening).

Keys words: Mitidja - Water- Ground water-Agricultural- Rainfall - Nitrate

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1. INTRODUCTION

In the Mediterranean countries, as well as those of arid and semi-arid climatic conditions [1,2] require the use of irrigation and promote the increased use of fertilizers and pesticides to improve and stabilize crop yields [3-5]. Food self-sufficiency is the goal, farming has become an important driver of quality degradation of water resources inducing direct contamination in particular those groundwater [6]. The amount of nitrogen used globally in 1970 of 31.8 million tons was close to 134 million tons in 2005 [7] to reach 241millions tons in 2014. The degradation of water quality caused by nitrogen pollution from agriculture has increased since fifty years causing an imbalance between the natural recharge of groundwater and needs samples [8-10].

Agriculture is currently the source of water pollution in parts of Europe and America, but especially in the Mediterranean where, for reasons of unfavorable weather [11], irrigation with quality water sometimes poor is an essential technical requirement [12-15].

Algeria like all the countries of the world has not escaped this phenomenon of pollution of aquifers. In southern Algeria, it is wastewater that is the cause of groundwater contamination, such as the examples of the M'zab valley [16,17] and the valley of Oued Souf [18]. On the other hand, in northern Algeria, it is more a pollution by nitrates following intensive use of fertilizers by farmers. For example, the water table of the Mitidja of a reservoir of 2 billion m^3 of water of very good quality. Today, exploited at more than 90% of its capacity, the water table of the Mitidja is polluted by nitrates [19,20]. Threatened from a quantitative and qualitative point of view, the water table of Mitidja is no longer able to meet the demand for irrigation and drinking water supply. To this end, the National Water Resources Agency drilled in 2017 the first borehole to a depth of 200 m [21]. It is in this sense that this article is oriented to study the process of deterioration of the water quality of the groundwater of the Mitidja plain.

2. TABLE CLOTH OF MITIDJA

The plain of the Mitidja covers an area of 1450 km^2 on an average length of 100 km and a width of between 10 and 18 km (Figure 1). The extension of the water table is intertwined with that of the plain of Mitidja since Hadjout area in the west to the Réghaïa region to the east (between longitudes 2° 32'00 – 3° 19'00 and latitudes 36 ° 25'17-36° 47'40). Administratively, it covers the provinces of Blida, Algiers, Boumerdes and Tipaza.

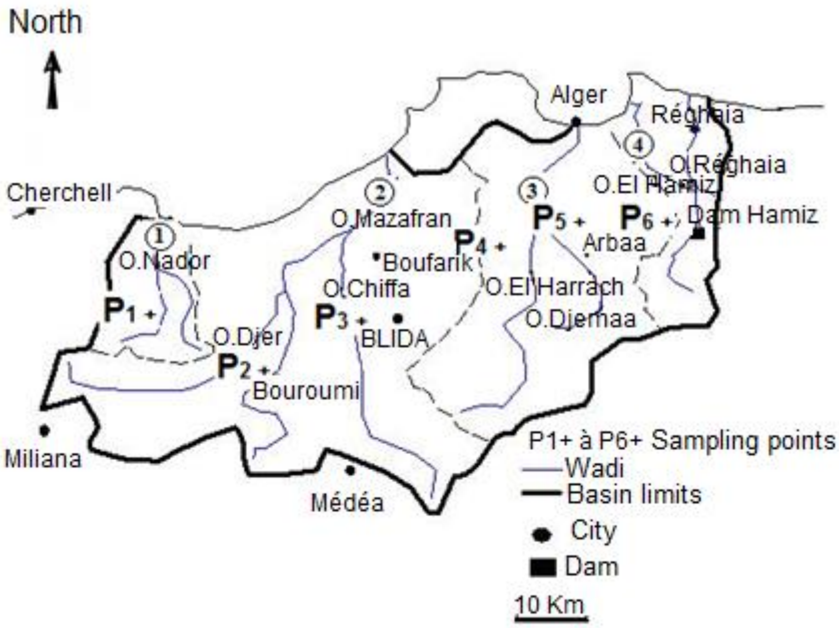


Fig.1. The four sub basins Mitidja

Geomorphological the Mitidja plain is divided into four sub-basins. The outlets of surface water are located along the Mediterranean Sea (Table 1) and (Figure 1) draining the main wadis of the region and belongs to the great watershed of Algerian coastal (code 02). The outlets of surface water are located along the Mediterranean Sea.

The main characteristics of the 04 sub-basins are described in Table 1, where the largest areas concern the (Nador) and (Mazafran) sub-basins.

Table 1. Summary characteristics of the four sub-basins of the Mitidja plain

Basin Name	Area (Km^2)	Brief description
Oued Nador	230	Wadi Nador result of the confluence of several secondary wadis
Oued Mazafran2	1860	About 60% of the basin area is mountainous. Wadi Mazafran result of the confluence of wadis Djer Bou-Roumi and Chiffa
Oued El Harrach	1270	Wadi El Harrach originates in the mountains of Tablat before emptying into the sea.
Oued Hamiz	380	Wadi Hamiz drains the pool with one of the wadi Réghaia

The inter-annual evolution of precipitation (Figure 2) between 1978 and 2011, allows highlighting a wet period up to 1986, where it was able to record 1106 mm Blida station, followed by a long drought for almost two decades. The replenishment of reserves generally takes place until November, when the rainfall exceeds the ETP. Thus, evapotranspiration for the entire basin represents 80.13% of the precipitation.

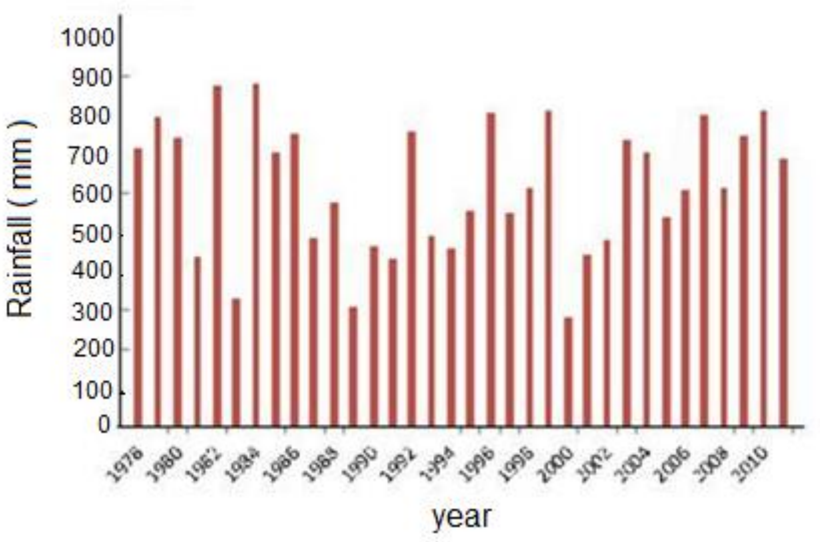


Fig.2. Evolution of rainfall in Mitidja between 1978 and 2011

On the hydrogeological, the plain of the Mitidja is a coastal basin formed by subsidence and sedimentation. It is located on an axis of subsidence oriented ENE-WSW. It is characterized by two types of aquifers (Figure 3):

- Quaternary alluvium in this study.
- The sandstone formations or gréso limestone of Astien.

Both aquifers are separated by yellow marl Villafranchian of El Harrach. The bedrock of the two aquifers consists of marl Plaisancian.

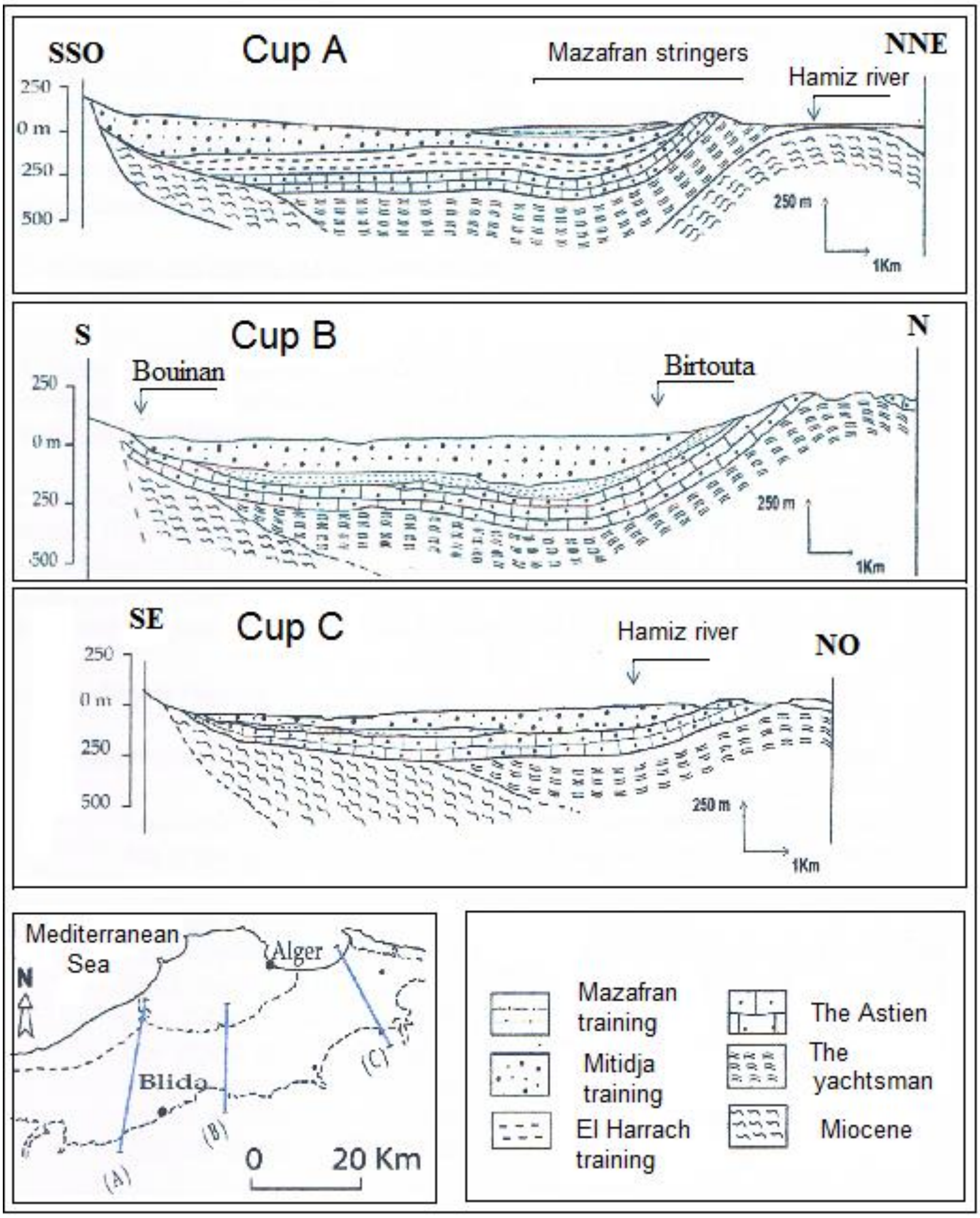


Fig.3. Geological sections at the Mitidja [22]

Overall, the largest declines in the groundwater level characterize the upstream areas of the plain, where many wells dried up and some wells have lower rates compared to April 1996. For information, until 2005, the number of operating structures was around 2400, the largest number being that of agricultural irrigation works. Given the large number of operating and weak meteoric inflows during drought years works, the web is regularly subjected to intense exploitation. Another consequence is a sea water intrusion is observed in the web of the Bay of Algiers and its surroundings where the dry residue rate reached 2500 mg/l [23].

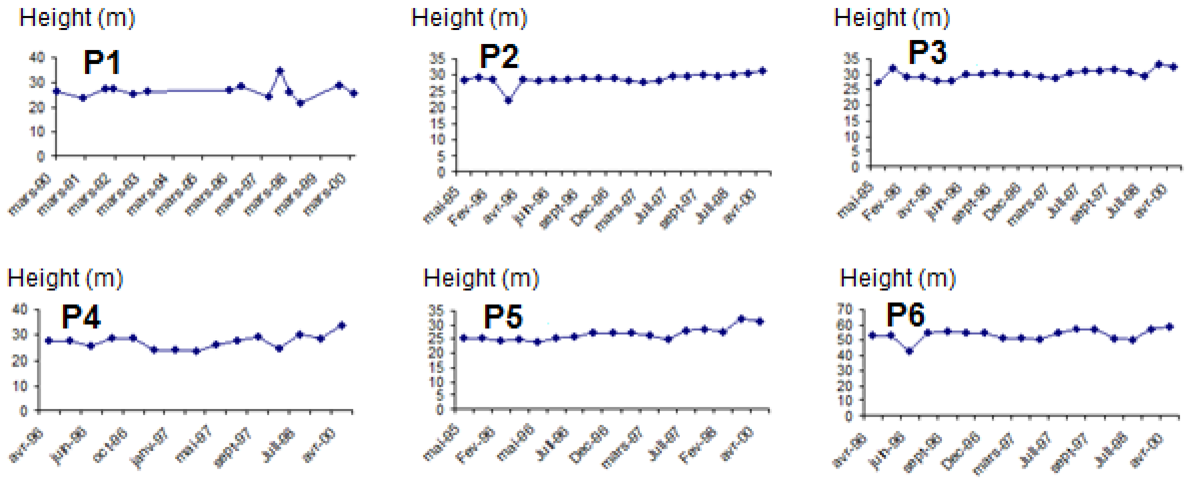


Fig.4. Evolution of the piezometric at points P1, P2, P3, P4, P5 and P6

Drawdowns observed across the web show a variation of the piezometric levels between 0.40 and 11.85 m. In the Center region, some lifts are observed between Boufarik and Arbaa between (P4 and P5). These lifts are mainly due to infiltration of rainwater recorded from the end of 1999 (Figure 4).

3. AGRICULTURE MITIDJA

The soils of the Mitidja are characterized by low levels at very low organic matter with average values between 0 and 3.5%. The C / N ratio varies between 4 and 13 on the surface, and between 5 and 9 in depth. The pH of soil is generally basic with an average value of 7.8 to 7.9 except for soils rich in iron oxide (Fe_2O_3) whose values are between 6.8 and 7.0 limestone contents are highest on calci-magnesian soils . In general, in total limestone contents do not exceed 12%, except on the horizons of accumulation where they can reach 40 to 50%. The active limestone is relatively low, the vast majority of soils having a lower rate to1%. The highest values are between 12 and 16% [24]. In Mitidja, rates of fertilizer application vary considerably from one type of culture to another (Table2).

Table 2. Distribution amounts of ammonium nitrate with respect to types of culture in Mitidja [25]

Crop types	Applied amounts (kg / ha)
Vegetable crops	400
Dried vegetables	200
Citrus	1000
fruit Trees	500
Vineyard	300
Cereals	200
Fillings	100

The total agricultural area (SAT) of the plain of Mitidja representing all useful agricultural area (UAA) and unproductive land (course, livestock buildings and forests) is of the order of 164 000 hectares. The UAA is around 100,000 hectares [26], 60% are irrigated for intensive crops requiring very large inflows and fertilizer, specifically for market gardening (Table 3). The rest is dry crops, where the water supply is exclusively dependent on rainfall.

Vegetable crops mobilize huge amounts of irrigation water especially between April and September and use large amounts of fertilizer, mainly based on ammonium nitrate.

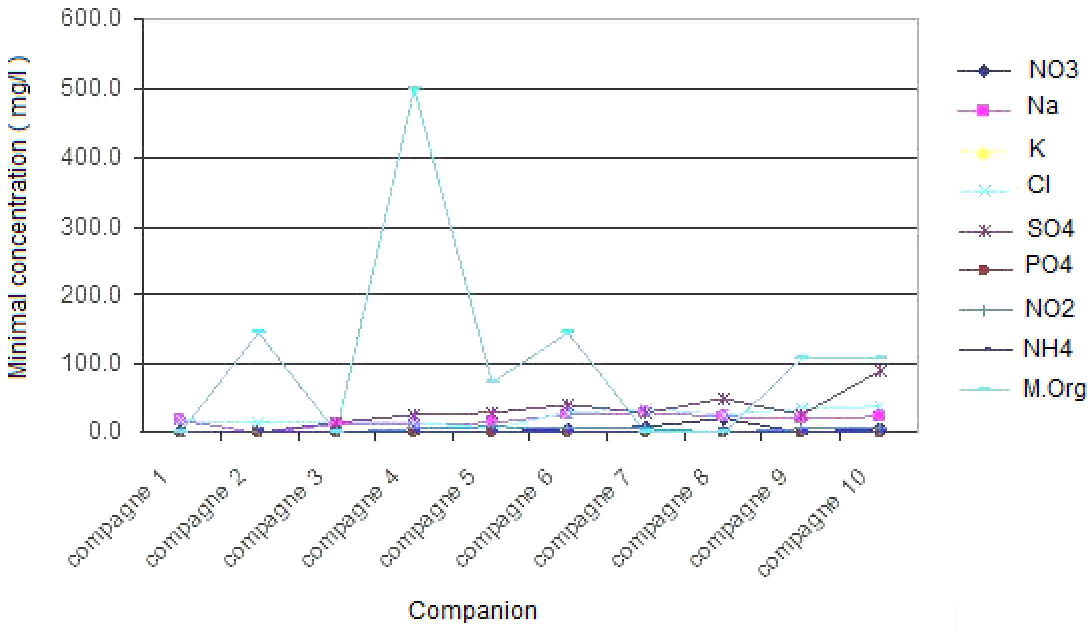
The Table 3 represents the land use in percentage during the ten years of observation as well as the different crops and other activities.

Table 3. Land use percentage over time

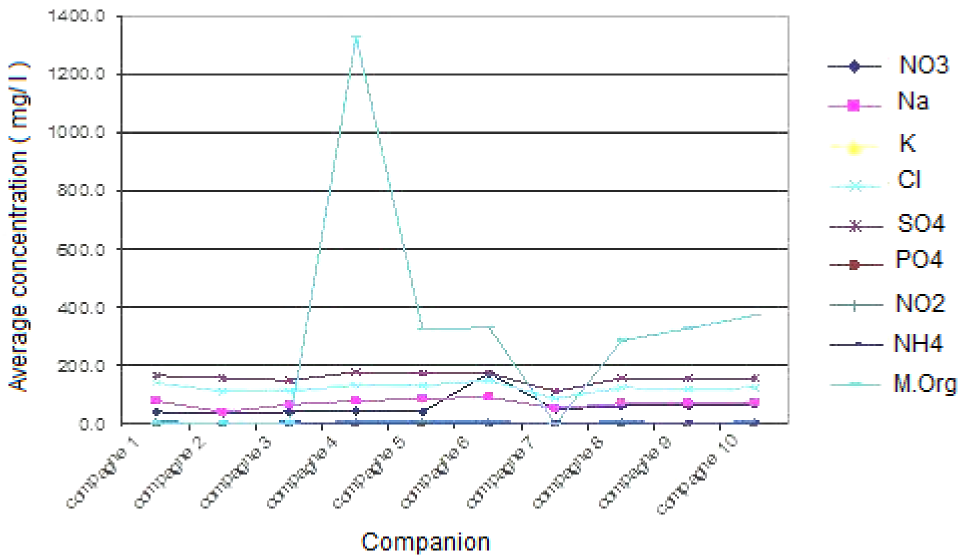
Dates	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Vegetable crops	39	38	40	37	36	42	45	39	42	41	40
Arboriculture	10	11	10	12	13	8	6	10	9	11	11
Annual crops	4	4	2	4	4	2	1	4	1	1	1
Vacant area	19	18	17	19	20	18	21	21	20	19	18
Urban area	28	29	31	28	27	30	27	26	28	28	30

4. CORRELATION OF IONS

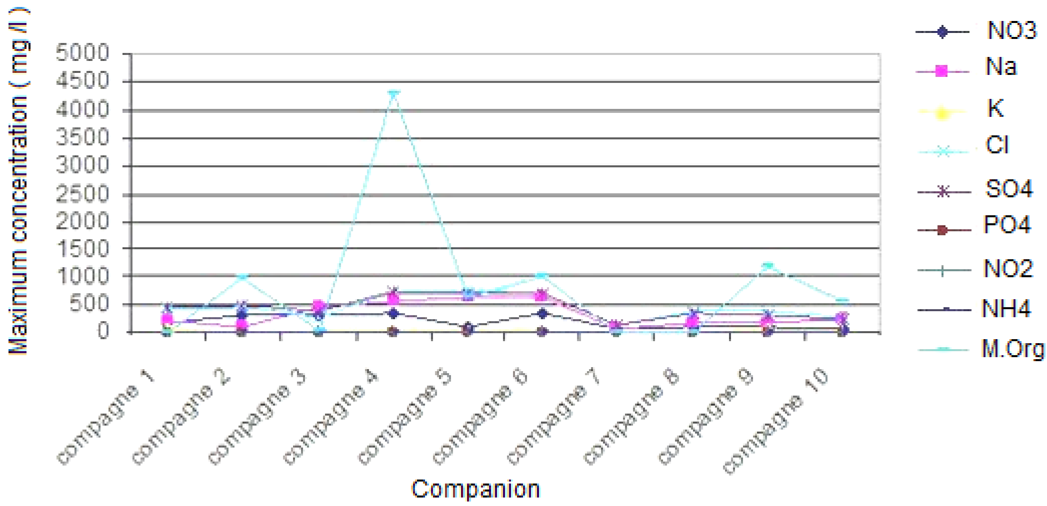
The changes in concentrations (Figures 5 (a, b and c)) of the major elements show certain homogeneity during the entire observation period (1985-2000). However between campaigns 3 and 5, one notes the presence of a peak characteristic of the organic materials. This could be explained by the nature of domestic waste and the use of wastewater for irrigation out of control.



a) Minimal concentration (mg/l)



b) Average concentration (mg/l)



c) Maximum concentration mg/l)

Fig.5. Correlation of major ions over time

5. EVOLUTION AND ORIGIN OF NITRATE CONCENTRATIONS

Changes in nitrate concentrations over a period of observation of 12 years show the following major features (Figure 6):

- from 1985 to 1988, the highest concentrations affect the western part of the plain,
- March 1991 to 1998, the eastern and central show trends to increased nitrate concentrations,
- until 2000, the levels become more important in the eastern part,
- until 2004, the rate of the stronger nitrates remain localized in the center and east of the plain.

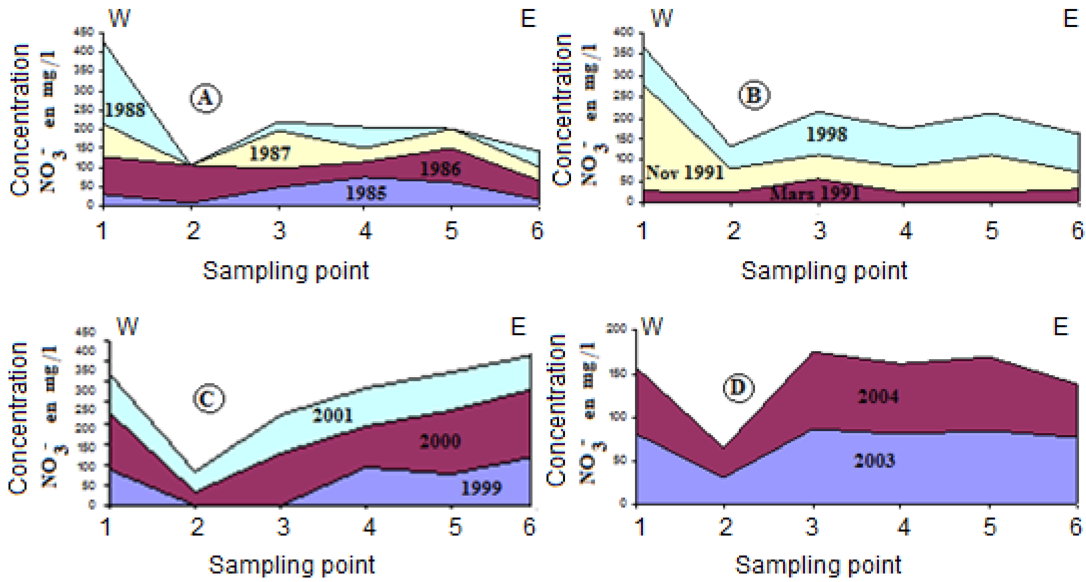


Fig.6. Change in Nitrate concentrations between 1985 and 2004

The spatial distribution of the change in nitrate levels shows a generalized extension of the pollution of the web of the Mitidja over its entire extent (Figure 6) except where P2 in this sector the amount of nitrogen fertilizer used is negligible. The geological origin of these relatively high concentrations in some places cannot alone explain this distribution. The less affected areas by nitrates are often localized where the roof of the aquifer comprises a thick layer of clay or impermeable formation. This is a vertical barrier preventing nitrates from seeping up to the web. The irrigation water loaded with nitrates also appears to increase the pollution load. The groundwater recharge is affected by water precipitation effective contribution in the variation and distribution of nitrate concentrations. The levels are highest during recharge and irrigation due to the effect of leaching from agricultural soils. The use of nitrogen fertilizers in agriculture (Figure 6), compared to changes in groundwater levels (Figure 4), reveals a significant increase in nitrate concentrations because of their transport from the surface towards the web. Groundwater table of Quaternary of Mitidja reveal in some areas values above 250 mg/l (Hamiz region, eastern Mitidja). This high concentration is mainly irrigation (market gardening) from the wastewater from industrial and urban waste. Furthermore, the use of nitrogen fertilizer and more manure. The contribution of nitrogen fertilizer combination with rainfall events mark the leaching of agricultural land through water infiltration favored by good permeability. Hence a high load of nitrate in the first meters from the surface which is transmitted to groundwater. The speed of groundwater contamination process remains dependent on the depth of the static level.

6. CONCLUSION

Determining the origin of nitrogen as well as verification of the spatial distribution of nitrogen inputs are methods of approach as a basis for explaining the spatial distribution of the levels of NO_3^- in the web. A rough comparison of nitrogen inputs mainly from housing and farming accounts for nitrogen inputs in the study area. The inherent vulnerability of the plain of Mitidja through contamination of surface soil and the human and agricultural activities taking place above the aquifer, increase the risk of contamination from groundwater nitrates .The main source remainder nitrogen leaching from agriculture NO_3^- directly related to farming practices and the filter character of soil-unsaturated zone system.

However, about farming practices, the impact on the intake of NO_3^- tablecloths remains difficult to assess in a very diverse dynamic context. Also observations have shown that fertilizing contributions exceeded widely to data provided by the agricultural services. The excess nitrogen applied will enrich an impromptu soil and any surplus will be drained to the table.

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