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# IMPACT OF USE OF AGRICULTURAL INPUTS ON THE QUALITY OF GROUNDWATER CASE OF MITIDJA PLAIN (ALGERIA)

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**ABSTRACT:**

The use of agricultural inputs, especially in Great Plains agriculture-based, requires management and protection of water supplies that remain exposed to a high pollution potential. Mitidja in several catchments (16) are currently operated through wells, boreholes and springs. The majority of soils have infiltration rates suitable for irrigation. Groundwater Nitrates come mainly from agricultural activities where leaching is directly related to the use of fertilizers. The contribution of fertilizer regularly taking place from March with appreciable amounts especially in the areas of intense practice of gardening in all seasons, associated with increased livestock development, contributes significantly to increased nitrate concentrations exceeding the then permissible standard.

**Keywords**: *Mitidja, Groundwater, Fertilizer, Pollution, Nitrate.*

## I. INTRODUCTION

For many countries groundwater is the main water resource. This finding relates to the countries located in semi-arid and arid also characterized by a surface water resource is very limited. Thus groundwater should be protected and managed carefully, because in different sectors such as human consumption, agriculture and industry.

The agricultural water-intensive (70%) of the mobilized resources is often a source of conflict because the demand is increasing and therefore the allocation of resources is still insufficient, these conflicts are recurring due to the quantities mobilize.

Moreover, in order to increase production and achieve food self sufficiency, the use of the massive use of fertilizers and other inorganic nitrogen, and pesticides, to the detriment of the preservation of the quality of water resources, which often leads to direct contamination of groundwater resources (*Banton et al., 2000; Bailey, 2001*). Increasing the amount of fertilizer used globally in 1970 was 31.8 million tonnes and is approaching 134 million tons in 2005 (*Domange, 2005*), gives an indication of increased risk of pollution which are exposed to groundwater and surface water.

The work done by Cazalas Guatron in 1993 have shown that the degradation of water quality induced by nitrogen pollution from agriculture is growing for at least fifty years causing an imbalance between the natural replenishment of groundwater and needs levies.

In Algeria, the Mitidja plain, known for fertilization of its land is currently used, which requires the use of large dose of fertilizer to the exhibitor and pollution caused by fertilizers and other pesticides. Indeed ANRH services in 2004, have identified about 2000 wells for irrigation (agricultural wells). After using a portion of that water back toward the water laden with contaminants causing pollution of water stored in groundwater level. This work aims to determine areas of agricultural nitrogen discharges to water take place, allowing the understanding and modeling reliable transfer mechanisms.

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## 2. BACKGROUND

### 2.1. Location

The Mitidja plain covers an area of 1450 km$^2$ with an average length of 100 km and a width between 10 and 18 km. The boundaries of the aquifer coincide with those of the plain of Mitidja itself and extend from the region in the west to Hadjout area Réghaïa east. It lies between longitudes 2 ° 32'00 - 19'00 3 ° and latitude 36 ° 25'17-36 ° 47'40. Administratively, it spans four wilayas, Blida, Algeria, Boumerdes and Tipaza.

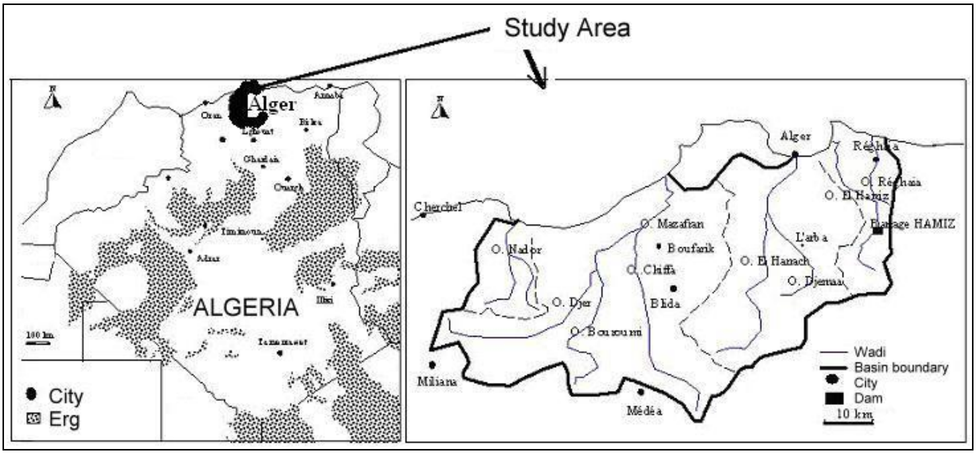


**Fig. 1** Carte de situation.

### 2.2. Rainfall

On a set of 14 rainfall stations selected, changing inter-annual rainfall between 1970 and 2005, shows a wet period: 1970 - 1976, followed by a long dry spell for almost two decades with extreme variations ranging between 331 mm and 863mm. Through all the plain, the annual average is estimated at 600mm.

### 2.3. Overview geomorphological

The Mitidja plain can be divided into 04 sub-basins (**Fig. 1** and **Table 1**) river basins draining the four main wadi of the region, belonging to the great watershed of coastal Algerian code 02. Surface water outfalls are located along the Mediterranean Sea.

**Table 1.** ***Summary characteristics of the four sub-basins.***

| Basin Name | Area (km$^2$) | Brief description |
|---|---|---|
| Nador wadi | 230 | Wadi Nador is the result of the confluence of several wadis side |
| Mazafran wadi | 1860 | About 60% of the basin area is mountainous. The Mazafran result of the confluence of Wadi Djer, Bou Roumi and Chiffa. |
| El Harrach wadi | 1270 | Wadi El-Harrach starts in the mountains of Tablat before emptying into the sea |
| Oued Hamiz | 380 | The Oued Hamiz being the main wadi draining the pond with that of Réghaia. |

The liquid flow rates the strongest feature-Wadi El-Harrach and Mazafran. Their average annual contributions are respectively of about 430 and 986 millions of $m^3$/year hm3/year.

## 2.4. Hydrogeology

Plain Mitidja is a coastal alluvial basin formed by subsidence and sedimentation. It is situated on an axis of subsidence oriented ENE-WSW. It is characterized by two types of aquifers (**Fig. 2a** and **2b**):

* Quaternary alluvium

* sandstone formations or sandstone and limestone of Astien.

These two aquifers are separated by yellow marl villa ranchian El-Harrach. The bedrock of the two aquifers is represented by marls Plaisancian.

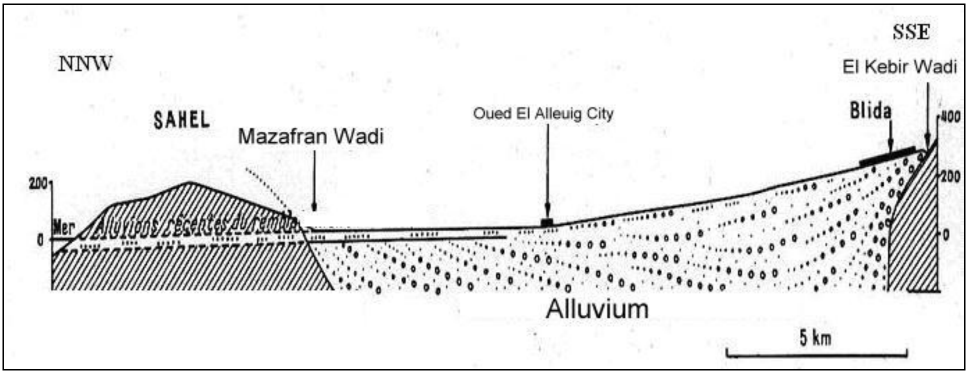


**Fig. 2a** Schematic section of Mitidja (after *A. Ayme*).

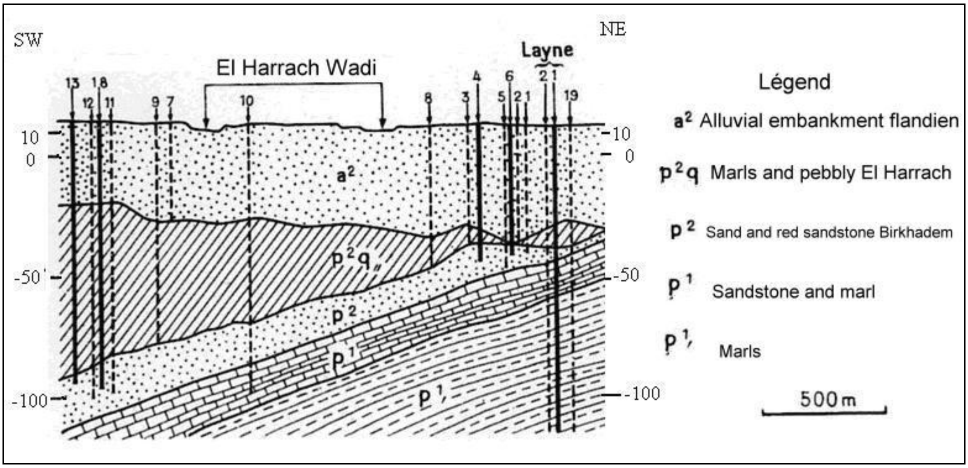
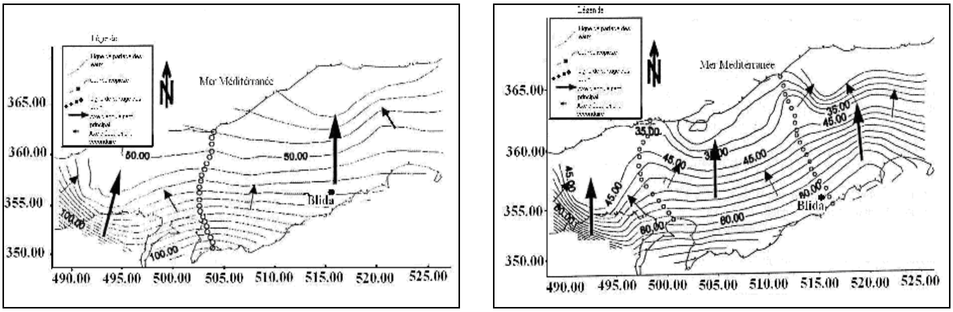


**Fig. 2b** Cutting polls.

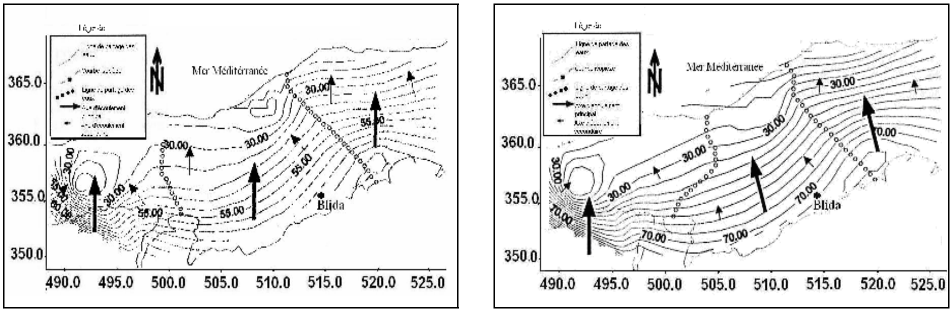
The bedrock of the two aquifers is represented by marls Plaisancian. The Quaternary alluvial aquifer consists mainly of gravel and pebbles alternating with silts and clays and clay, with lenses. This aquifer is to the upper surface and lower the formation of El-Harrach. Its average thickness is 115 meters. It is fed mainly by:

-Precipitation
-Infiltration of river
-Tank seepage through the Astien
-Infiltration in the southern strip of the Sahel at the foot of the Atlas Blidéen.

The units are operated by pumping from the collection structures, drainage of wadis and groundwater leaks into the sea all piezometric maps (**Fig. 3** (**a-d**)) revealed a general flow direction water supplied is from south to north. Between July 1981 and May 2002, one can notice a significant drop in piezometry across the plain of the order of 20 meters and a fluctuating groundwater level low enough to the east (3-4 meters) and significantly stronger in the west (10 meters).



a) July 1981 b) October 1992



c) November 2000 d) May 2002

**Fig. 3** Piezometric.

## 2.5. Soils

Soils Mitidja are all characterized by low to very low levels of organic matter with average values between 0 and 3.5%. The C / N varies between 4 and 13 on the surface, and between 5 and 9 in average depth.

The levels are highest limestone soils on Calcareous-Magnesian. In general, levels of limestone total do not exceed 12% except on the horizons of accumulation limestone where they can reach 40-50%. The active lime is relatively low, the vast majority of soils having a rate below 1% active lime. The highest values are between 12 and 16%.

The soil pH is generally alkaline with a mean value of 7.8 to 7.9 except for soil iron oxide $Fe_2O_3$ whose values remain between 6.8 and 7.0 (*Binns and Atkins, 1983*). The CEC of the soil is medium to fairly high, between 17 and 30 meq/100g. Forty measuring stations were used to characterize the main soil types and infiltration rates and moisture retention. Hydraulic conductivity tests were also performed. The table 2 shows the results of infiltration tests. Soil types correspond to the soil unit mapped on the site of the measuring station. The textures observed at stations measuring characterize the first meter of depth.

**Table 2.** ***Average infiltration rate compared to textures.***

| Texture | Infiltration rate Average [cm/h] | Infiltration rate Range [cm/h] |
|---|---|---|
| Clay and sandy clay | 4 ,5 | 0,2-16,4 |
| Silty clay-loam | 1,9 | 0,2-9,6 |
| Silt | 1,2 | 0,1-5,3 |
| Sandy loam | 2,3 | 2,0-2,4 |

The majority of soils have infiltration rates suitable for irrigation. Generally found higher rates at 12.5 cm / h in heavy textured soils, ie clay.

Cons by slow infiltration rates (0.3 cm/h) are found in soil and hydromorphic unsophisticated. This feature probably reflects the fact that the percentage of fine particles of silt is very high, closing the pores and preventing the water to circulate.

## 2.6. Farming

Farmland occupies a relatively large in the region despite the expansion of urban areas and may be a potential source of groundwater contamination. Indeed, the permissible limit of nitrate concentration set by WHO (World Health Organization) to 50mg/l, is largely outdated and affecting people's health. Groundwater Nitrates come mainly from agricultural activities where leaching is directly related to the use of fertilizers. Different agricultural activities involve spraying chemicals such as fertilizer, ammonium nitrate, ammonium phosphate and potassium sulphate. The contribution of fertilizer regularly taking place from March with appreciable amounts especially in the areas of intense practice of gardening in all seasons, associated with increased livestock development, contributes significantly to increased nitrate concentrations exceeding the then permissible standard. The **Tables 3**, **4** and **5** show that rates of artificial fertilizer applications vary from one type of crop to another.

**Table 3.** ***Distribution of quantities of ammonium nitrate from crop types in the Mitidja (Binns & ATKINS 1983).***

| Crop types | Amounts applied [quintals/ha] |
|---|---|
| Vegetable crops | 4 |
| Pulses | 2 |
| Citrus | 10 |
| Fruit growing | 5 |
| Vineyard | 3 |
| Cereals | 2 |
| Fillings | 1 |

**Table 4.** ***Average quantity of fertilizer used per year, a few examples around the world.***

| Country | Quantity / kg / hab | Crop type |
|---|---|---|
| Franch | 240 | Wheat |
| USA | 257 | Mais |
| Russia | 25 | Blé |
| Tanzania | 12 | Mais |
| South Korea | 320 | Riz |
| Cambodgia | 4 | Riz |
| Tajikistan | 461 | Cotton |
| Benin | 45 | Cotton |

**Table 5.** ***Global consumption of fertilizer.***

| Country | Million tons of nutrient |
|---|---|
| China | 55,69 |
| USA | 19,9 |
| India | 18,4 |
| Brasilia | 5,9 |
| Franch | 4,8 |
| Germany | 3,0 |
| Pakistan | 2,8 |
| Indonésia | 2,7 |
| Canada | 2,6 |
| Espagnia | 2,3 |
| Australia | 2,3 |
| Turkey | 2,2 |
| United Kingdom | 2,0 |
| Vietnam | 1,9 |
| Mexico | 1,8 |

## 3. LAND COVER

Like the different regions of the country and especially during the black decade (1992-2001), the region experienced different forms of occupation. These are summarized in **Table 6**.

**Table 6.** ***Evolution of the distribution of land in (%).***

| Land | 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 | 19 |
| Urbanized area | 28 | 29 | 31 | 28 | 27 | 30 | 27 | 26 | 28 | 28 | 30 |

We note that the crops (**Fig. 5**) occupy about 50% of the area allocated, this translates into a significant contribution in fertilizer ammonium nitrate, exposing the water to a potential pollution.

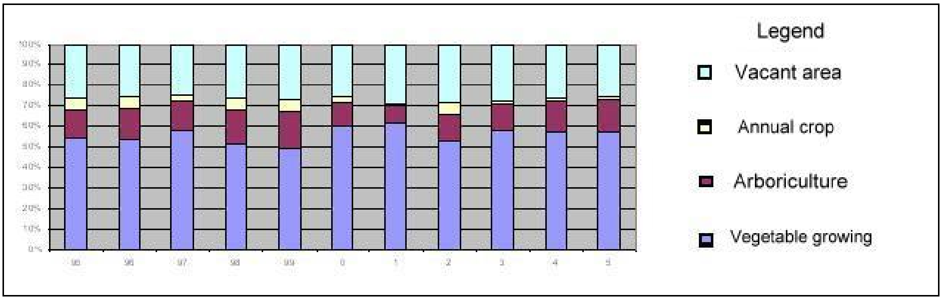


**Fig. 5** Land use by crop.

## 4. RESULTS AND DISCUSSION

### 4.1. Observations of Nitrates

Nitrate concentrations vary in space and time. We remark on two successive wells, the concentrations vary in a wide range. They can range from 0 to over 50 mg/l. This variation indicates that the degree of alteration of water differs from one area to another (**Fig. 6**).

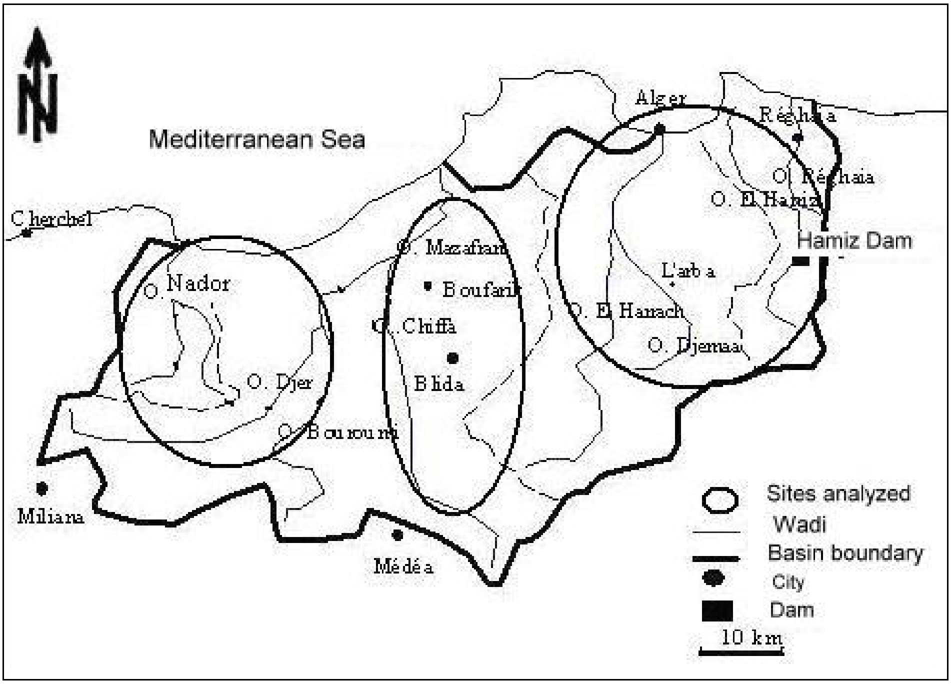


**Fig. 6** Map of sites studied.

### 4.2. Observations on a case by case

Contrary to the general study of catchments providing only enough information about the particular study can highlight the positive or negative pollution. We can observe an incipient decline in the level of nitrate concentration during dry periods before the heavy rains do further increases in concentrations.

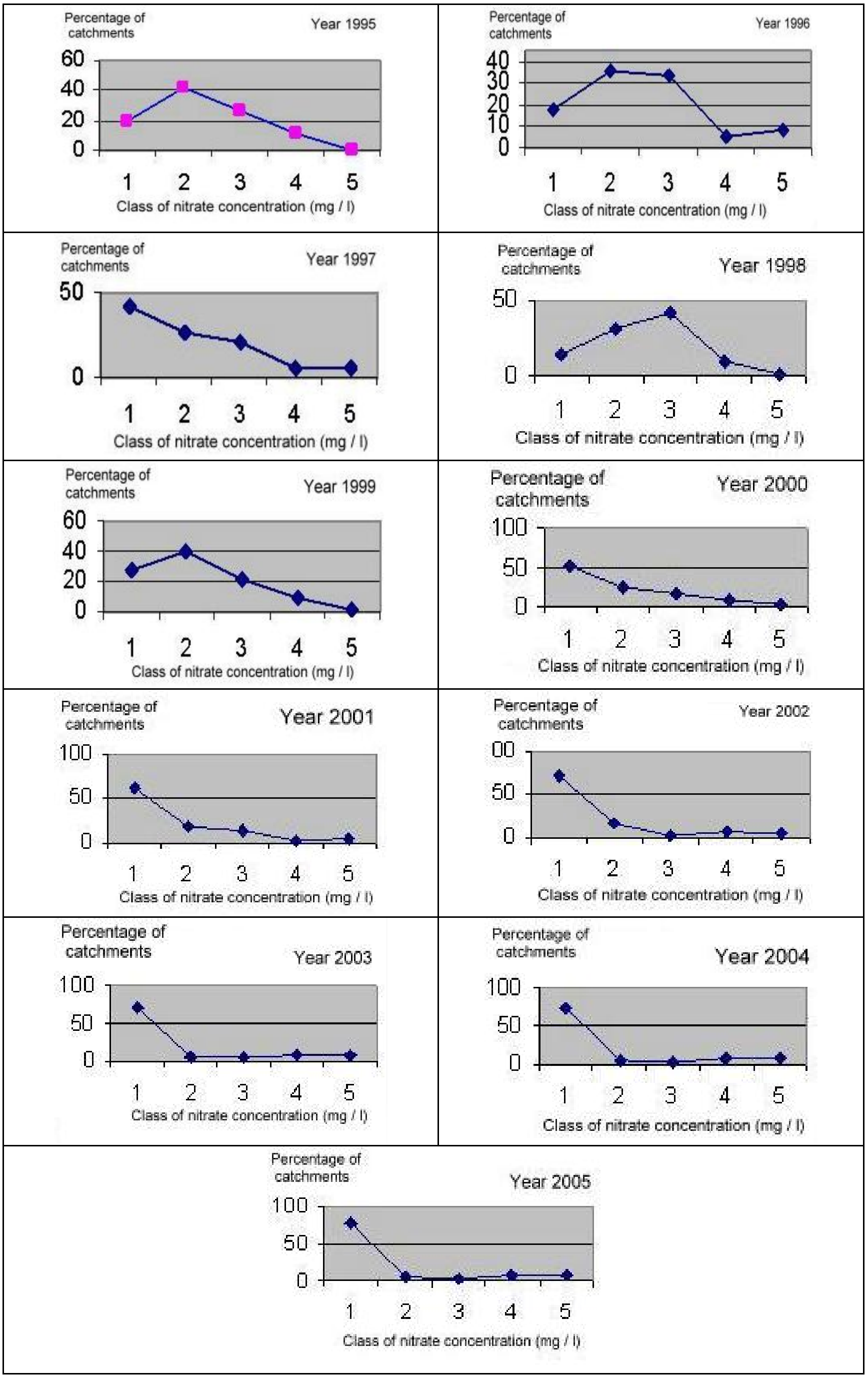


**Fig. 7** Evolution of the distribution of collection sites in percentage (%) in the various classes of nitrates during the observation period.

Moreover, we observe that rainfall also almost identical example of the years 1996 and 2001, it appears a net increase of polluted sites belonging to the first and third class levels, the percentage of sites increased up to threefold (**Fig. 7**). In contrast, the second class shows a regression rather sensitive sites catchments, where the percentage was divided by three. Catchments and sites heavily affected by pollution caused mainly by nitrates, could be explained by the fact that in several localities, all agricultural activities have resumed, use lots of synthetic mineral fertilizers and organic amendments rich nitrogen derivatives in addition to the problems of infiltration of wastewater generated by factories and other human activities. To this end, various measures should be advocated with the financial community, so that farmers can change their type of farming practices in a first phase. The evolution of nitrate concentrations (**Fig. 7**) shows that the class with a high concentration follows a constant distribution throughout the observation period affecting the groundwater quality and a tendency to the emergence of areas of low concentration (**Fig. 5**) characterized by the absence of any agricultural activity before 1995.

In the region, agriculture is still predominant and livestock has a very high growth (**Fig. 8** and **9**). The evolution of farming from 1995 clearly has an affinity with the distribution of nitrate concentrations (**Fig. 8**).

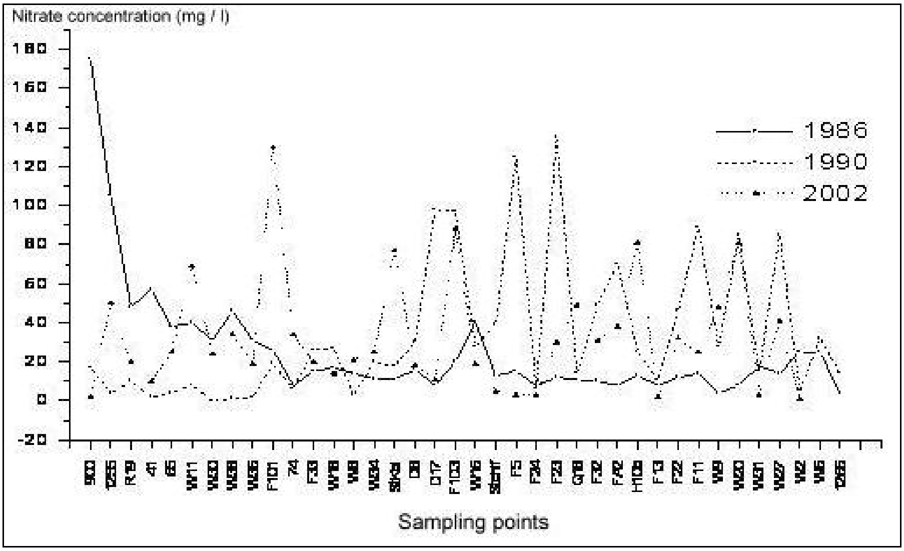


**Fig. 8** Evolution of nitrate on the floodplain.

It must be emphasized that the problem of data quality of groundwater is in terms of representative ness because controls are often carried out upstream of the distribution network. An examination of several sets of measurements available reveals a wide variety of situations with generally a strong correlation between land use and rate of progression of groundwater contamination by nitrates (**Fig. 9**). The establishment of precise measurements of nutrient transfer relies on all available data and different time since 1995, many variables (type of livestock, rain, piezometer) must be measured to identify the various processes The analysis involved the calculation of flow and carried to the sampling sites confirm that nitrate concentrations decreased during flood by dilution.

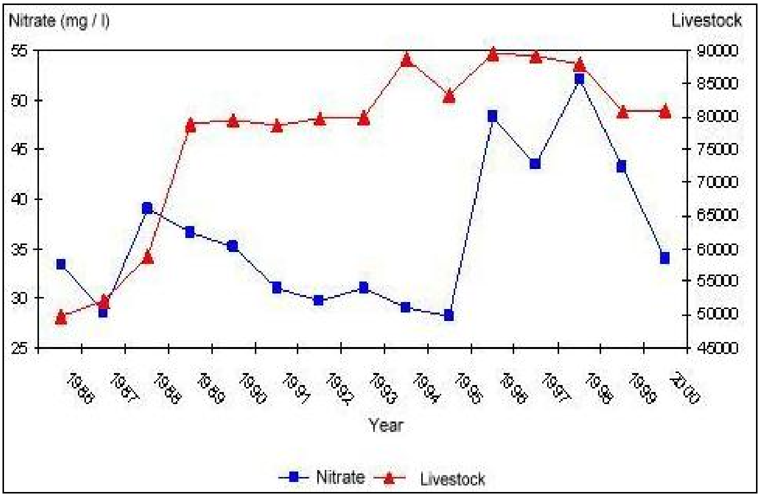


**Fig. 9** Evolution of nitrate concentration and Livestock.

## 5. CONCLUSION

Determining the origin of nitrogen and verification of the spatial distribution of nitrogen inputs are methods of approach as a basis for explaining the spatial distribution of the levels of NO3-in groundwater. A crude comparison of nitrogen inputs from the housing and farming accounts for nitrogen inputs in the study area. The inherent vulnerability of the plain through the contamination of surface soil, and agricultural and human activities occurring over the aquifer, increase the risk of nitrate contamination of groundwater. The main source of nitrogen is the NO3-leaching from agricultural practices directly related to farming and nature of the soil-filter unsaturated zone. However, on cultural practices, the impact on intake of groundwater NO3-remains difficult to assess in a dynamic context very diverse. Observations have also revealed that intakes of nutrients exceeded largely on data provided by the agricultural services. Excess nitrogen applied will enrich an impromptu soil and any excess will be drained into the water.

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