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Study of the Fluctuations of Subsoil Waters of the Plain of Ghriss Mascara –Algeria

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Abstract

The plain of Ghriss covers a vast surface of approximately 1185 km ^{2}. It is located in the wilaya of Mascara with an average altitude of 585.03 m. With a semi-arid climate and a recurring secheress, this area recorded only one mean annual rain of 257.81 mm between 1994 and 2004 whereas it was located between isohyets 400 and 500 mm. The plain of Ghriss is an area with agricultural vocation with a truck farming dominating. The mean level of water of the wells or drillings in this plain is estimated at 70 m and several wells of observations of the piezometric network are dry. The volume of water extracted is estimated at 88 hm ^{3} / year whereas the contribution of the water layer is not that 66 hm ^{3} / year is a deficit of 32 hm ^{3} / year. This plain suffers from an overexploitation due to practical agriculture and the demographic growth through the AEP. By hoping for a fast return of the favorable weather conditions, a policy of management of water is inevitable to save this plain which is the richest of the oranie from the agricultural point of view.

Keywords: Subsoil waters – Deficit – Overexploitation - Plain of Ghriss – Algeria .

1. Introduction

The world demographic growth and the increase in water consumption per capita generate increased needs, and increasingly many uses. Agriculture is the water large-scale consumer through the irrigation, industry, is also a large consumer: chemical industry, dyeing, steel-works, power stations and nuclear. The domestic needs are also to take into account with knowing: food, hygiene and other uses. Briefly, the use of water has several destinies like: energy resource (hydroelectricity); means of transport: river, channels, lakes; transportation routes of first importance, on all the continents; fish, like economic activity (pisciculture) in the lake, rivers, pond. To satisfy these multiple needs and uses, an inventory of water in an area, is of primary importance and amounts taking stock of surface water and subsoil waters, under all their forms and in all situations. They are "potential" resources, measured or calculated by hydrological assessments, which are not always accessible. Indeed, the food of considerable countries in the process of development is tributary of the water of the underground water layers used for the irrigation. Without a more durable management of this resource, areas among the most populated world will have to face a crisis of great width in the near future. In these areas, the subsoil waters became the pillar of the agro-alimentary economy but this invaluable resource is not exploited in a durable way. Being dependent on subsoil waters for the irrigation, the countries carry out an excessive pumping which causes an alarming fall of the level of the fresh water reserves. To underestimate this problem would be catastrophic, particularly for the poorest, which is stripped vis-a-vis the water shortage. Thus, of research on subsoil waters with an aim of identifying and of promoting new ways for a better management of this resource are necessary. Three major problems must be taken into account: the exhaustion of the water layers caused by overexploitation, the insufficient drainage responsible for clogging and the salinisation of the grounds, and pollution due to the intensification of agriculture, industry and other activities human.

The objective of our study is to evaluate the subsoil water resources available in the principal aquiferous horizons of the plain of GHRISS, to follow their possible fluctuations for finally proposing one of plan of management of this resource which is not always renewable. We will try to show through graphs and statements of the various wells and piezometers which our area of study is indeed prone to disproportionate exploitations which generate consequent folding backs **[2]**.

2. Data and Methods

2.1. Geographical situation of the plain of Ghriss

"Mascara, historical city and baston of resistance, is to a few 80 km in the South-east of Oran, on the Southern side of the mounts of Beni chougrane. It is the place head of Wilaya including 8 very modest localities around whose a significant population in the douars disseminated in the plain saw. One of it, Sidi Kada, with the mausoleum of Sidi Mahiéddine, sheltered in the past the Tribe of the Emir ".

From the agricultural point of view, this area constitutes one of the richest regions of Oranie.

Wilaya de Mascara is located in the Algerian west; it is borded to the East by Wilaya de Tiaret, in North Wilayas d' Oran and Mostaganem, in the West by Wilaya de Sidi Bel Abbès and in the South by Wilaya de Saïda.

"As far as the plain of Ghriss is concerned, it belongs to the watershed of Macta (14389km²). It includes a surface of 1185 km² covering all under basin of the Fékan wadi." This plain was occupied by marshes which persist still nowadays in the area of Maoussa (marsh of Sidi Lahssen) and of the north of Tizi.

It is limited:

- In North, by the Mounts of Beni Chougrane.
- In the South, by the Mounts of Saida.
- In the West, by the Mounts of Bouhanifia (Djebel Oucilles).
- In the East, by the plate of Tighennifine, beyond whose the basin of the Mina wadi starts. The morphology of the plain presents various aspects:
    - In the North and the West of the piémonts forming low reliefs.
    - In the center of the pilot hillocks of another environment and rather high rock monticules.
    - In the South of significant solid masses of tabular aspect, capped exceeding tops 1000 meters (mounts of Nesmoth)

In the East, a raising of the ground forms the ground of Témaznia between Tighennif and the valley of the Haddad wadi (Figure 1) **[1],[8]**.

Figure 1: Situation of the Plain of Ghriss

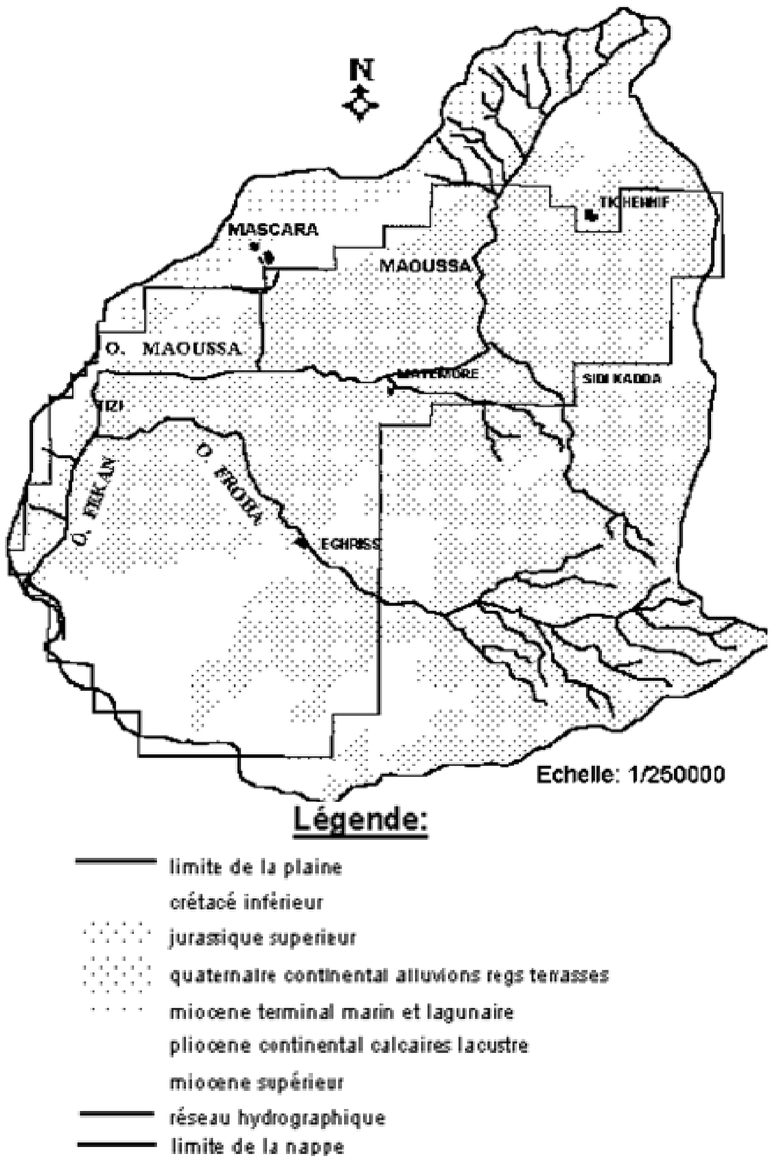


Table 1: Results of the morphometric study [2].

Physical characteristics of the catchment Area		**Unit**	**Value**
Surface		Km²	1170
Perimeter		Km	160
Coefficient of GRAVELIUS			1.31
Length of the rectangle are equivalent		Km	60.75
Width of the rectangle are equivalent		Km	19.25
Quotient of the components			3.15
ALTITUDES	Maximum	M	1080
	Minimal	M	350
	more frequent	M	450
	Median	M	680
	Average	M	585.03
	to 95 %	M	520
	to 5%	M	1040
INDICES OF SLOPE	Total	%	8.56
	Means	%	12.02
	de ROCHE	%	3.125
Length of the principal talweg		Km	18
Made uneven specific		m	292.72
Density of drainage		Km/Km²	0.694
Frequency of the rivers		Km^{-2}	0.57
Modulus of elongation		-	0.261
Frequency of the elementary talwegs		Km^{-1}	0.373
Report/ratio of junction		-	2.37
Report/ratio length		-	1.81
Coefficient of torrentiality		-	0.26
Time of concentration		Hours	12.29

2.2. Data used

We used the piezometric data provided by the national agency of the hydrous resources of oran during the period (1970-2002) [3].

2.3. Description of the piezometric network of the plain of Ghriss

Until 1998, as regards piezometric follow-up, only the aquifer of quaternary was concerned with the pilot network, composed into major part of well.

Thereafter, seven (7) piezometers were produced and inserted into the network. This one counts today seventy six (76) wells of observation. However, it should be announced that on these 76 wells, only 41 has a measurable water level; the other wells are either dry or could not be measured (abandoned, hostile zone, closed…). lowerings of the outline levels of water, the draining of the wells low depth, the proliferation of illicit drillings generally reaching the substratum, the deepening of the other works and the dryness which has persisted for several years frequently generates changes wells of observation. Many wells were dry lasting of the years or were the subject of an enlarging (Figures 2, 3 and 4) **[4]**.

Figure 2: Piezometric chart of the plain of Ghriss – Low waters 86

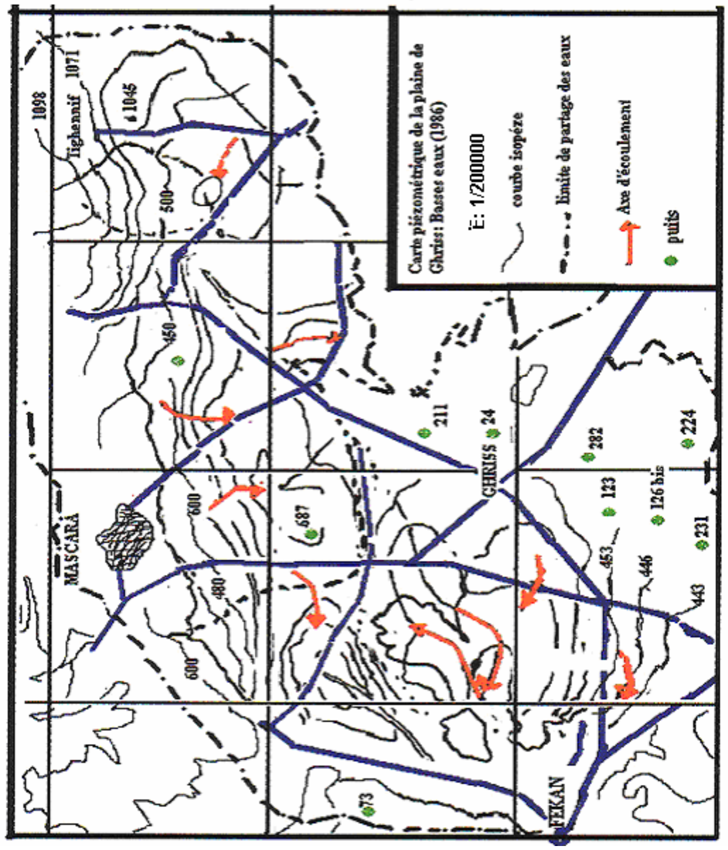


Figure 3: Chart of localization of the piezometric inspection network of the plain of Ghriss

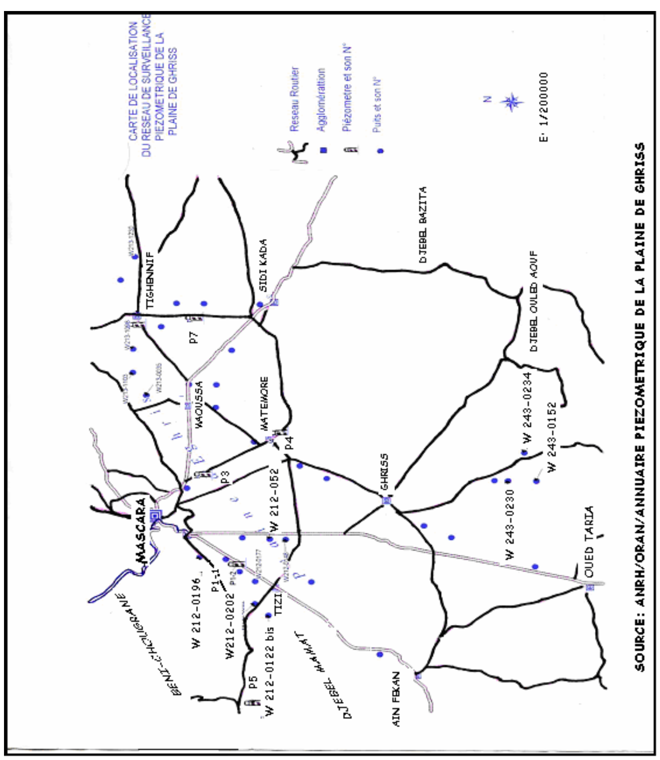


Figure 4: Piezometric chart of the plain of Ghriss – High waters 86

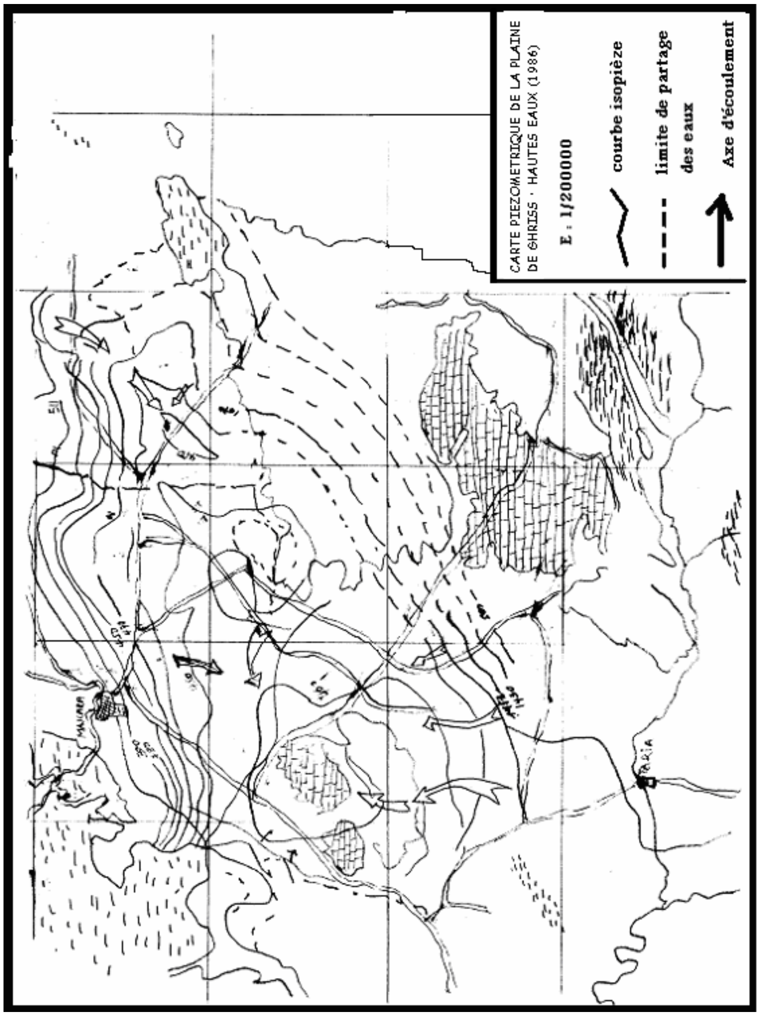


Table 2: Inspection network of the piezometers

Name	Supervised water layers	X	Y	Depth m
P1-1	Alluvia	263.42	230.25	50
P2-1	Water limestones	263.40	230.25	190
P3	Water limestones	271.20	232.75	95
P4	Limestones and dolomites	274.90	227.35	131
P5	Conglomerates	280.27	228.25	80
P5	Sandstone and sand	284.10	237.65	90
P7	Sandstone and gravels	284.77	233.60	60

2.4. Evolution of the fluctuations of the outline levels of water

The water layers of the plain of Ghriss exceeded the critical point today that everyone feared with apprehension. Indeed, the water levels in the wells are with more than seventy (70) m. Thus the wells are transformed into true drillings by the farmers who drilled inside the surveys going to great depths (+ 100 m), which does not allow the passage of the probe for piezometric measurement.The method of traditional irrigation and consequently the monoculture of large potato consuming water accentuate the general folding back of the water layers of the plain of Ghriss. For better illustrating this folding back, we will trace graphs starting from measurements of some pilot wells and those of the seven (7) piezometers installed in the network.

Table 3: Variation of the outline level of water in the pilot wells between Mars 1970- Mars 2002

N° of the well/chart	Mach 1970	March 2002	Folding back
W212-0242	2.64	48.21	45.57
W212-0381	2.75	48.91	46.16
W212-0152	5.15	Sec	--
W212-0519	14.08	65.41	51.33
W212-0290	10.60	36.15	25.55
W213-0810	16.10	69.02	52.92
W213-1014	8.60	40.88	32.28

The table above shows the static levels and the folding backs of the water levels noted between Mars 1970 and Mars 2001. The figures mentioned clearly indicate the significant lowering of the outline levels of water with a negative amplitude higher than 53 m by places. This situation shows that the plain of Ghriss entered a critical stage putting even its existence in danger (Figure 5).

Figure 5: Folding back in the wells: March 1970 – March 2002

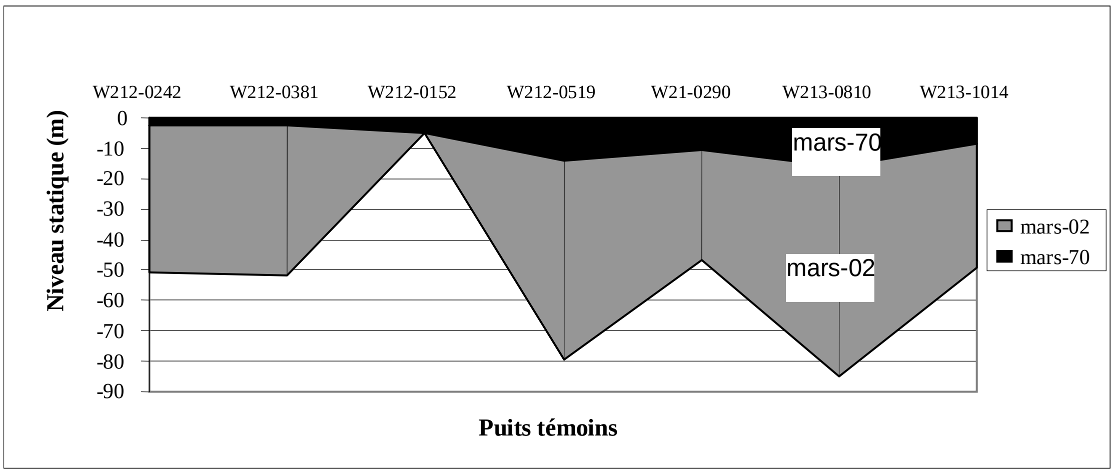


Table 3: Evolution of the water level in the piezometers between Janv 97 and Janv 2002

N° piezometer	NS (m) Janv 97	NS (m) Janv 02	folding back
P1-1	40.52	Sec	+ 50
P1-2	56.86	78.81	19.95
P3	51.24	57.16	5.92
P4	54.42	82.44	28.01
P5	53.32	72.41	19.09
P6	16.47	18.6	2.13
P7	34.94	38.9	3.96

Let us note that:

- The P1-1 piezometer: of a 50 m depth which supervise the water layer of the alluvia is dry since July 1999 to date.
- The P1-2 piezometer: who supervises the water layers of water limestones recorded a folding back of almost 20 m during the period of Janv 97 and Janv 2002.

The observations raised on the piezometers show that all the water layers are touched by strong folding backs. Even the water layers of dolomitic limestones which was considered as water layers of reserve considering the depth of its roof is touched (Figure 6) **[5],[6]**.

Figure 6: Folding back in the piezometer s : Janv 1997 – Janv 2002

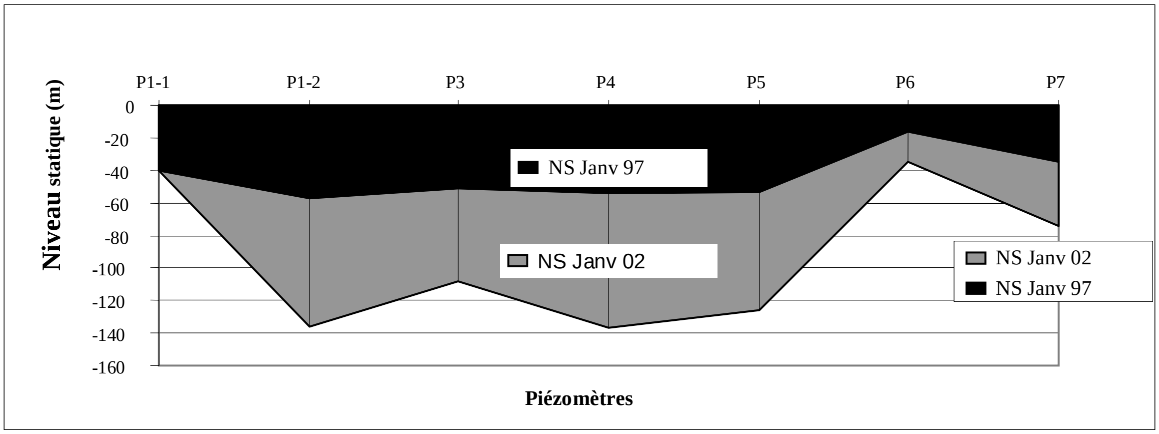
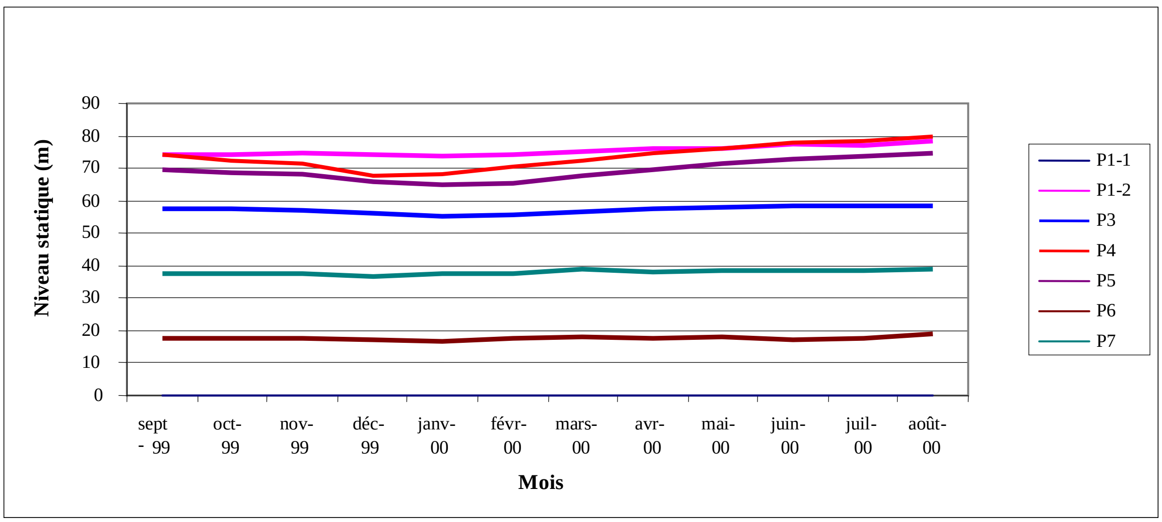


Figure 7: Variation of the static level in the piezometers between 1999 and 2000



By comparing for example the static level of the P1-2 piezometer between 1997, 1999 and 2001, one notices clearly that the water level which was around 60 m in 1997 in September passes to approximately 75 m in the same month into 1999 before exceeding the 80 m with the current of the year 2001. It is also noticed that during the summer the folding back is acuter compared to the rain periods where a weak refill of the water layers is recorded (Figure 7). In September 1997, passes to approximately 75 m in the same month into 1999 before exceeding the 80 m with the current of the year 2001.

2.5. Combined graphs. Relation between monthly rain and the monthly static level

The combined graphs carried out from measurements of the static level of the P1-2 piezometer and those of the rain in the plain during years 1997, 1999 and 2002 confirm that the folding back is more significant when the rain is weak. Indeed, the rainy period generates a weak refill which will be consumed at once during the summer because the area is of an agricultural vocation (Figures 8 and 9).

Figure 8: Graph combined between the static level and the rain: P1-2 in 2002

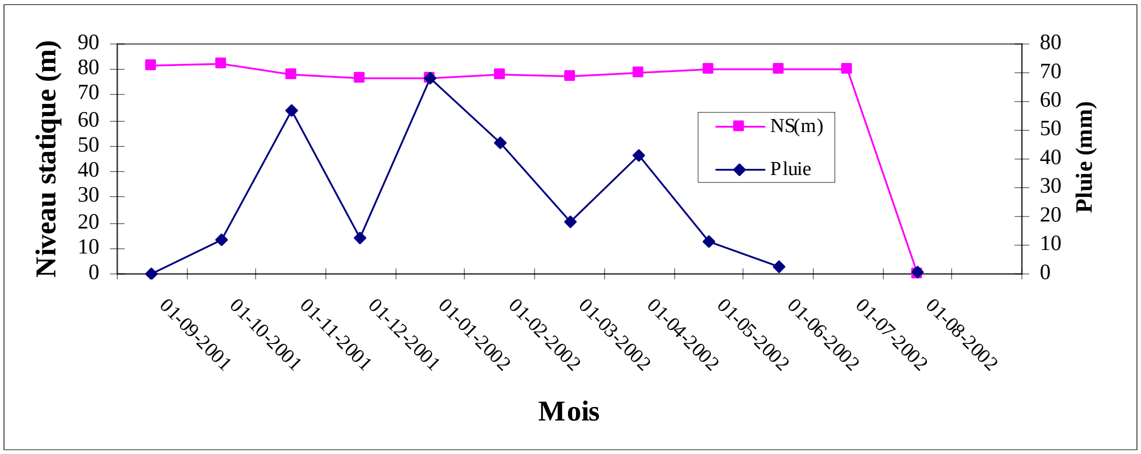
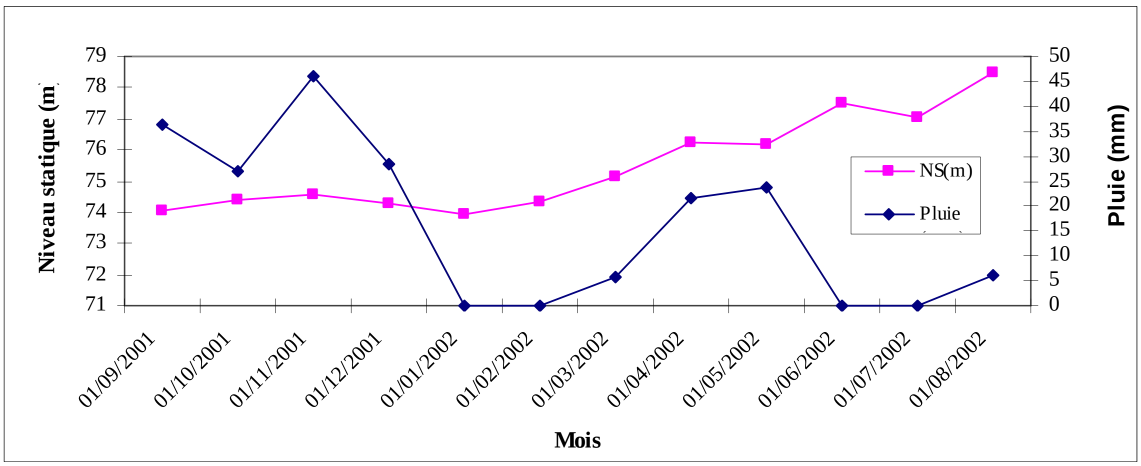


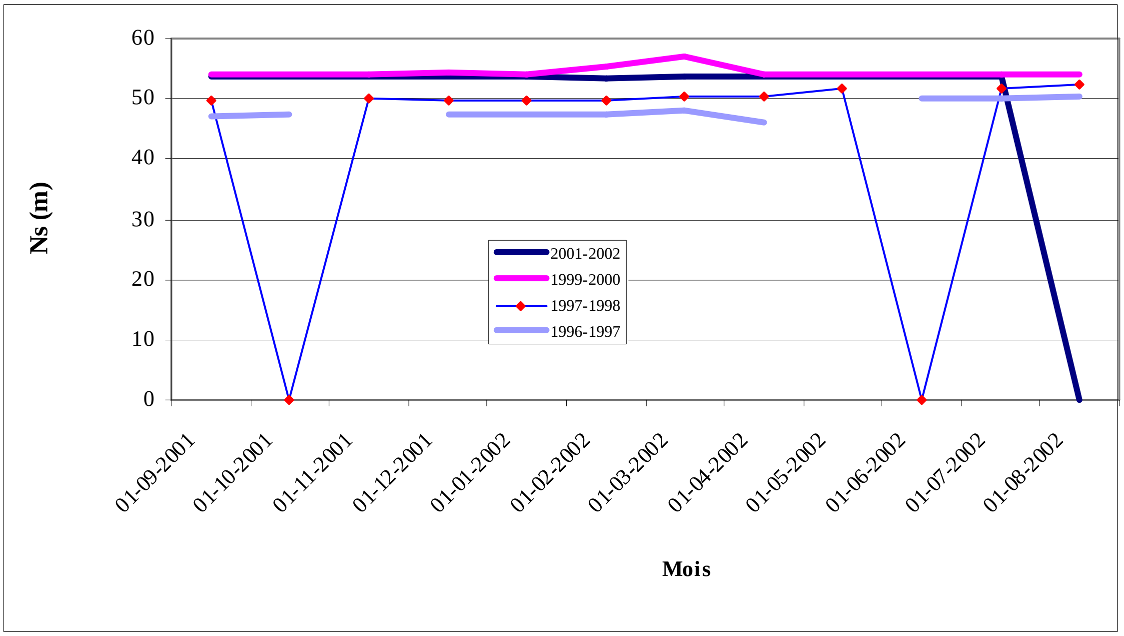
Figure 9: Combined graphs: static level and the rain : P1-2 en 1999



2.6. Comparison of the annual static Level. Pilot cases of two wells

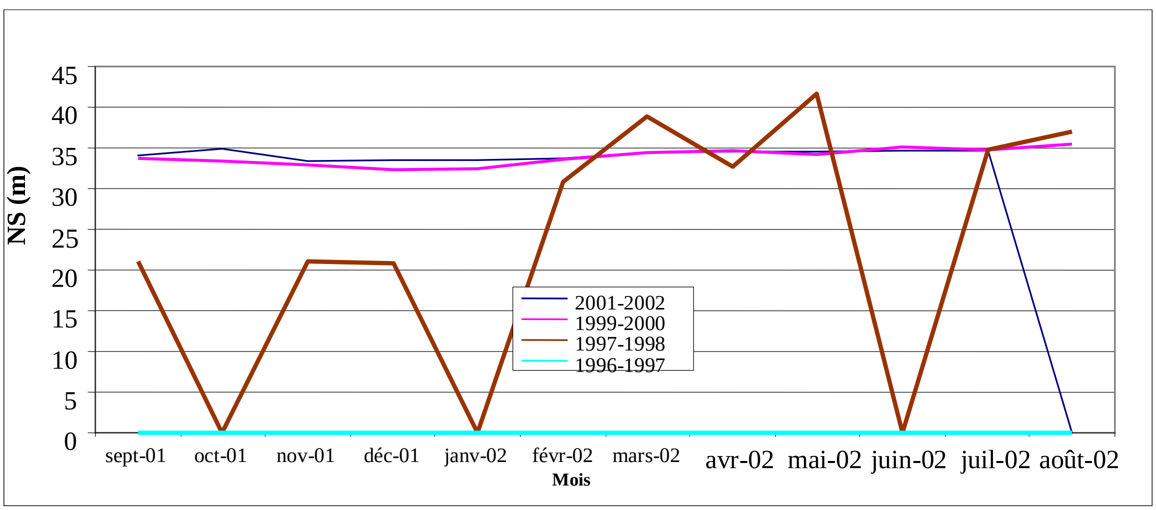
It clearly comes out from this comparative graph that the pilot well W212-0092 underwent folding backs between 1996 and 2002. The static level this well was on average lower than 50 m in 1996 but in 2002 it borders the 60 m is a sensitive average folding back of approximately 10 m (Figure 10).

Figure 10: Comparison of the NS of the Well witness W212-0092 of 1996 to 2002



It is also noticed that the outline level in the well W212-0122 (a) which was fairly with the turn of 25 m in 1997 reached more than 30 m in 2002; The agriculture practise in the area requiring much water and has dryness which prevails particularly in the Algerian West are by far the principal reasons of the folding back generated in the underground water layers of the plain of Ghriss (Figure 11) [7].

Figure 11: Comparison of the NS of the pilot Well W212-0 122 (a) of 1996 to 2002



2.7. Assessment of the exploited underground resources: *(Source D H W Mascara)*

The assessment of subsoil waters of the plain of Ghriss indeed shows an overexploitation of this water. the wells, drillings and the AEP use this water in respective proportions of 57%, 19%, and 24% the contributions of the water layers being clearly in decaf of volume extracted to satisfy the needs for the area, it are obvious that the assessment is overdrawn (Figures 12 and 13).

* Volume exploited by well: Among the 4975 inventoried wells, 2395 are exploited with a volume of 17 Hm^3 / An is a flow of 862 l/s.

- * Volume exploited by drillings: Among 903 listed drillings, 679 are exploited with a volume of 50 Hm^3/An is a flow of 2600 l/s.
- * Drillings intended for the AEP of the population: 54 and 22 communes for a volume of 21 concern Hm^3/An is a flow of 681 l/s. The total volume exploited starting from the tablecloth of the plain of Ghriss is then estimated at 88. Hm^3/An .

Table 4: Assessment of the exploited underground resources

Contribution of the water layers	56 Hm^3/An
Extracted volume	88 Hm^3/An
Déficit	32 Hm^3/An

Source: D H W Mascara

Figure 12: Assessment of the water resources exploited

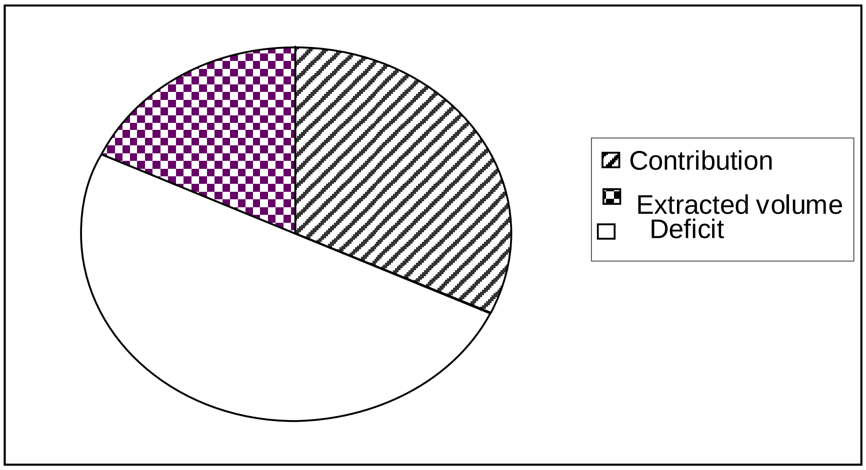
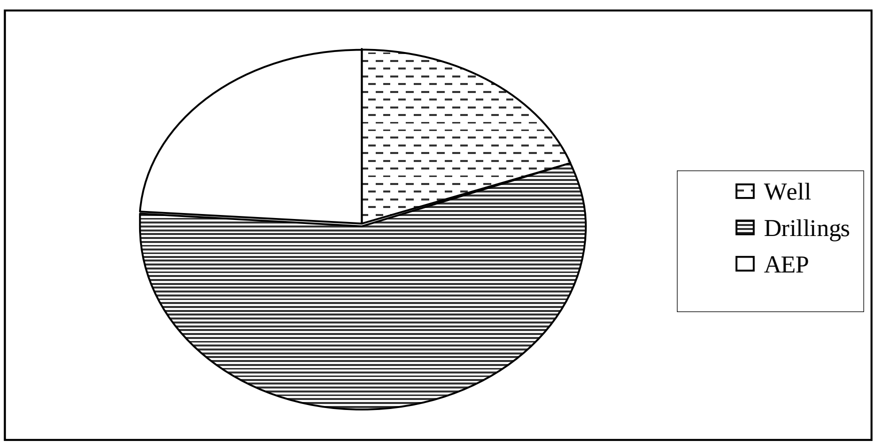


Figure 13: Distribution of water by exploitation



Conclusion

The plain of Ghriss crosses one of the most critical periods of its existence particularly from 1986 . After the supplantation of shrubby agriculture (vine) by the truck farming large-scale consumer water, the outline level of water dropped in the wells. This phenomenon becomes extensive with the urbanization and initially the dryness. The multiplication of illicit drillings goes there from its contribution by generating the overexploitation of the various tablecloths.

To fight against this alarming folding back, of the following measurements are necessary:

- To rehabilitate the piezometric inspection network by founding a "police force" of control to prevent the development of illicit or major drillings.
- In particular to found a method of irrigation more economic of water drop by drop while introducing new cultures less consuming water (cereals).
- To practise cultures of density and significant radicular depth, ideal for the hydrous food of the water layers because the infiltration of rainwater is facilitated by microporosities created in the profile of the ground by the roots.
- To control the demand for water and its use because an abuse causes the contamination of the water layers (level of higher sea) and the subsidence.
- To relieve the water layers of overexploitation by making recourse to nonconventional water: desalination of sea water or installation of the stations of purification of raw waters.
- To multiply reserves collinaires to allow the water layers to reload itself.
- To think of providing the needs of the area (AEP, IRRIGATION.....) while seeking to bring back the water of another basin in order to relieve the underground water layers.
- Lastly, to think of the artificial refill which consists in injecting water with the water layers to cause its refill.

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