

Agro-Ecological Study of the Plain of M'sila, Western Northern Zone of the Basin of Hodna, Wilaya of M'sila, Algeria

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Abstract: Algeria is vast country which presents several bioclimatic stages and agro-ecological which supports the production, a multitude of agricultural produce. The steppe forms integral part of this extent of which importance is hardly lower than the other areas. Hodna is in the middle of the Algerian steppe, it is a relatively degraded basin of 25000 km², consequence of a prolonged dryness and an overgrazing. This study is devoted to the diagnosis of the current location of the perimeter of the plain of M'sila which is in the Western Northern zone of the basin of Hodna on a geographical area of a surface of 780 km². The population is dense in North with the existence of an urban centre and a relatively populated rural area in the South, the population is less dense with relatively distant urban centers. The plain of M'sila receives an annual rain average of 213.20 mm, the rains of Autumn are sometimes torrential which gives birth to abrupt risings and devastators. The thermal amplitude of the station of M'sila is of 35.02°C. The dominant winds are the wind of West known as Dahraoui, wind of North known as Bahri and the Sirocco which is hot wind and blowing dryness of the South and which blocks the development of the cultures by accentuating their drying. The diagram ombrothermic allows to identify existence; only one period of 3 months dryness, the end of May at the end of August. The zone study is made up an alluvial plain of low altitudes, <400 m made of alluvial deposits of quaternary (alluvia, clays and sands) with a soft slope <3%, pertaining to steppe bioclimatic stage. The ground is not very advanced of alluvial contribution with limono-argillaceous texture rather deep. Occupation of the ground by the vegetation is diversified, one noted a broad diversity of the agricultural activity which settled current the last years which exceeds 54,700 ha, the fallow exceed half of agricultural surfaces during the agricultural partner 2009/2010, the cultivation of cereals which occupies 36% of the grounds followed by the fodder cultures and fruit-bearing arboriculture at a rate of 5 and 4%, respectively. The exploration of the not cultivated plant species of the area study, counts 550 tax relating to the steppe communities with Chott El Hodna. One finds there many species endemic with the area of Hodna such as *Saccocalyx saturoides*, *Arnebia decumbens* and *Linaria laxiflora* that one finds only in this area. As well as endemic species North African such as *Muricaria prostrata*, *Lonicophora capiomontiana*, *Rhanterium suaveolens*, *Stippa tenacissima* L., *Artemisia herba alba*, *Anabasis oropediorum* L., *Salsola vermiculata* L., *Atriplex halimus* and *Salicornia arabica* L. The zone of study, like the majority of the steppe zones is with vocation agropastorale with manpower of the ovine breeding bordering the 130.000. The zone study belongs to the large catchment area of Chott El Hodna, characterized by a very dense hydrographic network where the rivers take their sources in the mounts of Hodna, the principal river is El-K'sob. The near total of water of the plain of M'sila has a temperature which varies between 21.5 and 22°C, this translated by a strong corrosion of the casing of the drillings. The majority of water of this plain have a strong conductivity, therefore a degree of raised mineralization in the event of irrigation with this salt water charged one can expect falls of outputs.

Key words: Hodna, biodiversity, course, steppe, culture, plain of M'sila

INTRODUCTION

By its geographical position, Algeria presents a multitude of bioclimatic and agro-ecological stages leaving place to varied an enough range of agricultural produce. Indeed to preserve a medium to produce

diversified speculations and to fix the populations, actions must be small and concretized for a sustainable development and which aims at the rational and perennial exploitation natural resources and from there mitigate, the degradation of the natural environment. In the middle of the Algerian steppes, Hodna constitutes a well

individualized natural entity. It is a basin of 25,000 km² relatively degraded, surrounded by rather high mountainous solid masses. This vast zone is relatively low in fertile and well maintained grounds, vegetable resources and surface water. This is not other than the consequence of a too prolonged dryness, a turning into a desert relatively threatening and ill-considered actions of overgrazing.

Indeed the aspects of degradation of the medium generally touch the natural resources namely; water strongly mineralized and more the share of time polluted the lack of vegetable cover on the ground associated with the cultivation methods accelerated the phenomenon of erosion as well as sylvo-pastoral vegetable resources not identified and very badly exploited. This reality and all these constraints lead us to complete this study which aims at knowing certain aspects of the degradation of the natural environment of the plain of M'sila.

MATERIALS AND METHODS

This study devotes to the diagnosis of the current location of the perimeter of the plain of M'sila.

Localization of the zone of study: The plain of M'sila which is located in the Western Northern zone of the basin of Hodna, it is integrated within the geographical framework of the high plains of the of Algiers basin (Amroune, 2008). This zone is limited in North and the South by the coordinates Lambert: 249 and 279 km in the West and the East by the coordinates Lambert: 665 and 691 km; this delimitation gives a geographical area of a surface of 780 km². The zone of study presents an extremely interesting criterion which is in North the pattern of the settlement is dense with the existence of an urban centre and a relatively populated rural area. In the South, the population is less dense with relatively distant urban centers and a rural area less inhabited because of the dryness, poverty and the lack of means.

Climatic study of the zone study: The area study is subjected to a complex climatic mode. Indeed, this area is in the zone of transition between the Mediterranean influences from North and those of the desert subtropical continental climate of the South.

Pluviometer: The zone of M'sila is located between the isohyets 500 mm (Mounts of Hodna) and 150 mm at the level of Chott (plain of Hodna) (Lakroune, 1999) with a rain annual average of 213.20 Misters. This rain influences the mode of Chott El Hodna and the rivers (Table 1, Fig. 1). The rainiest months are spread out September

Table 1: Monthly and annual average precipitation (mm)

Months	S.M.M
Jan	19.5
Feb	13.5
Mar	15.4
Apr	21.8
May	28.1
Jun	9.4
Jul	4.3
Aug	8.4
Sep	27.1
Oct	24.7
Nov	20.9
Dec	20.2

S.M.M: Weather station period 1988-2007; Weather station of M'sila

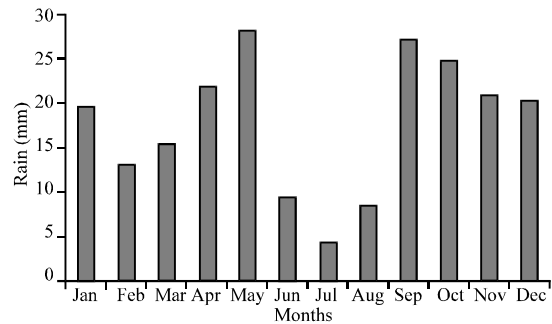


Fig.1: Histogram of average precipitations monthly annual (mm) of the station study

at May. The rainy season starts in September, the rains of Autumn are sometimes torrential and more or less catastrophic and under these conditions the streaming intensifies and gives birth to abrupt risings and devastators (floods of M'sila river, Autumn, 2007). As for the rains of Winter, they are less violent. The monthly and annual distribution of average rain over one 19 years period (1988-2007) is recorded in Table 1. The ten 9 last years knew several dry years. Since 1987, the station of M'sila recorded 9 years with <200 mm and a year only with >300 Misters, the phenomenon of the dryness strongly touched the zone study. The aridity of the climate and the insufficiency of precipitations give on water a limiting character of the agricultural development and even a factor of survival.

Temperature: Two principal characteristics mark the steppe climate; a low rainfall and strong thermal amplitudes. Concerning the thermal amplitude of the station of M'sila is of 35.02°C, this value is ecologically important because it represents the extreme thermal limit to which each year on average the plants must resist the high temperatures or low as testify to it; elsewhere power of their radicular system and the reduction of their foliar system in order to reduce their hydrous deficit. The annual average temperature in the zone of study is evaluated with 19.4°C (Table 2 and 3,

Table 2: Monthly and annual averages of the temperatures (°C) of the station of M'sila (1988-2007)

Months	m (°C)	m (°C)	(M+m)/2
Jan	3.50	13.9	8.7
Feb	4.30	16.1	10.2
Mar	7.60	20.2	13.9
Apr	10.50	22.9	16.7
May	16.00	27.9	21.9
Jun	20.90	34.6	27.8
Jul	24.40	38.5	31.5
Aug	24.10	38.0	31.0
Sep	19.20	32.2	25.7
Oct	14.60	25.7	20.2
Nov	8.40	18.9	13.6
Dec	4.70	18.9	11.8
Mean	13.20	25.3	19.4
M-m	35.02	-	-

Weather station of M'sila

Table 3: Mean velocities of the wind in m/s station of M'sila (1988-2007)

Months	Sp.
Jan	3.5
Feb	3.9
Mar	4.2
Apr	5.2
May	4.6
Jun	4.7
Jul	4.4
Aug	4.1
Sep	3.8
Oct	3.7
Nov	3.6
Dec	3.8

Sp: Speed moy (m/s); Weather station of M'sila

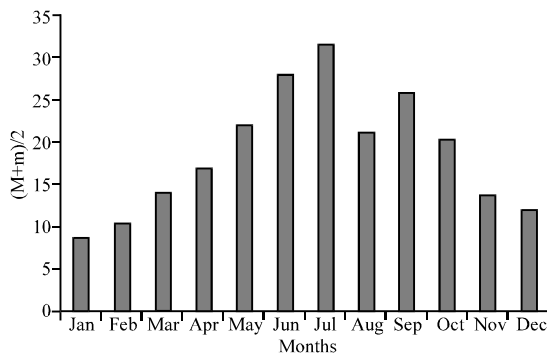


Fig. 2: Histogram of the monthly and annual averages of the temperatures of the station of M'sila

Fig. 2). The coldest month is January with 8.7°C and the hottest month is 31.5°C July. The monthly averages of the recorded minimal temperature are of 3.5°C, in January 2005 one recorded -0.4°C, those of the maximum temperatures are of 38.5°C. The maximum temperature is recorded in July, 2005 with 41°C. The knowledge of absolute extreme values is interesting because it is often a good indicator of the tolerance levels with respect to the factor temperature, it persists in generally only during a very short, insufficient time to influence together of the spontaneous vegetation.

Wind: The zone d' study is been windy enough, the winds which blow in the area of M'sila is:

- Wind of West known as Dahraoui who is most rainy (Dekkiche, 1974), it is frequent in Autumn, Winter and in Spring
- Wind of North known as Bahri who is less frequent, it is cold and dry
- Winds with variable directions which blow, especially during the dry seasons

Sirocco: Hot and dry wind, breath in general of the South, it blocks the development of the cultures. Constitutes the cause of weak carpet vegetable in the wilaya of M'sila by what the hot and dry winds accentuate the drying of the substrate.

The winds of North are frequent during the Winter whereas those of the North-East distributed well over all the year reach easily in the basin of Hodna by the valley of the Barika river. Those of the South reach Hodna only in Summer, period during which they blow with extreme gusts. Whatever their directions, the winds which blow on M'sila has relatively.

Evaporation: The evaporation is a parameter important to quantify because it influences the piezometric level of the subterranean water (surface tablecloth) also causing the formation of efflorescence's salt works. The values of evaporation recorded at the station of M'sila lie between 2,000 and 3,000 mm year⁻¹ are an average of 2,593 mm with a maximum in July (384,30 mm) and a minimum in December (84,35 mm), the annual average >19 years is of order of 212,63 Misters ETP varies with altitude parallel to the temperature. The hydrous mode is affected by a rate of very high evaporation from where irrigation of the cultures requires (Table 4).

Diagram ombrothermic: When researchers builds the diagram starting from the averages >19 years (Fig. 3), we notes the existence; only one period of 3 months dryness to the end of May at the end August and only one wet period spreading out beginning of September at the end of May.

Climatic synthesis: The climatic conditions of studied zone are severe, the high temperatures of the Summer cause the evaporation of the grounds and the perspiration of the plants, weak precipitations is not enough to constitute a reserve useful for the plant. Climate of the study zone of type Mediterranean, sudden in its Southern most part the Saharan influence, it comprises one fresh and wet disturbed season in Winter and a calm,

Table 4: Monthly and annual averages of evaporation in mm of the period 1989-2007 station of M'sila

Months	Exp.
Jan	85.7
Feb	113.1
Mar	173.3
Apr	203.8
May	262.6
Jun	334.9
Jul	384.3
Aug	348.2
Sep	251.5
Oct	197.1
Nov	112.4
Dec	84.3

Exp: Evaporation; Weather station of M'sila

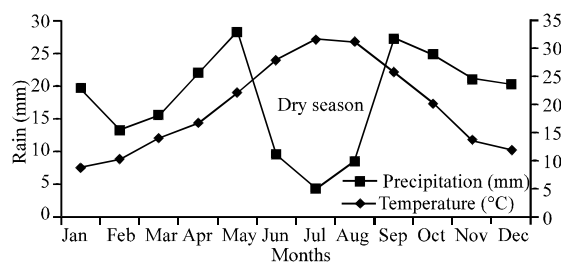


Fig. 3: Ombrothermic diagram of the study zone period 1988-2007

hot season and dries in Summer. The study zone is located in the steppe bioclimatic stages which include the grounds of the North of Sebkh where the average temperature oscillates between 16 and 19°C. The number of dry months very variable is from 5-9 months, the very irregular rains. The thermal amplitude ranging between 33 and 36°C to indicate a continentality accentuated.

According to the climagramme of EMBERGER, the climate of the area of Chott El Hodna is a moderated arid climate at Winters, it is characterized by dryness almost at all the year. Vegetation no matter what low but very particular for this wetland with arid climate for fauna a typical ecosystem offers, it would split to preserve.

Pedological study

Relief: The zone of the project is located in the mountainous Northern part of the wilaya of M'sila, characterized by a gradient altitudinal decreasing of North in the South by accentuated mounts formed by the mountainous chain of Hodna which is aligned systematically in the form of an anticline Djebel Maadid (1869 m). Vigorous alignment of this solid mass constitutes the genuine wall of all the climatic disturbances coming from North which supported a prevalence of the arid semi-climate in the interior zones while reducing the beneficial effects of the Mediterranean climate. This zone is attached to the plane grounds which constitute an alluvial plain of low altitudes, <400 Mr. It is

formed in general alluvial deposits of quaternary (alluvia, clays and sands). It opens on the Saharian Atlas by a plentitude of the relief with soft slopes <3%, component of this fact a place of accumulation where various rivers are converged of which most important are: Soubella river; Loughmane river and the river main artery of El K'sob river.

This last river of high agricultural potentialities is the feeder valley and the pivot of the agricultural activity of the area based particularly on the cultivation of cereals, associated with the market gardening's and the arboriculture of apricot tree predominance.

Ground resources: The grounds of the mounts of Hodna consist of limestones of marnes and conglomerates. The plain is covered with alluvia from 15-50 m thickness which represent the best grounds for agriculture in irrigated. One distinguishes three types of grounds on the level of the plain; not very advanced grounds of alluvial contribution to limono-argillaceous texture rather deep, grounds vertic located in the depressions and halomorphic grounds in the zones close to the Chott. The grounds are salted a fur and as one approaches the Chott. These grounds are little with fairly deep and are appropriate for the practice of the intensive agriculture.

RESULTS AND DISCUSSION

Occupation of the ground: Various categories of the occupation of the study area are biologically productive mediums (agricultural domain and pastoral) and those of non-productive mediums (urbanized places and water surfaces).

Occupation of the grounds by the vegetation: The prospection of the zone of study and the harvest of data near the agricultural services have enabled to us a important to note a broad diversity of agricultural activity which settled current the last years contrary with what one practiced before where the area characterized much more by the cereal and fodder cultures, in spite of the ovine and caprine breeding.

Occupation of the grounds by the crop plants: The cultivated grounds are prevalent and extend on 54,729 ha including 6,119 ha to carry out in irrigated. They are primarily made up of arable lands (cereal cultures and fallow), the cultivation of cereals which occupies 36% of the grounds followed by the fodder cultures and fruit-bearing arboriculture at a rate of 5 and 4%, respectively primarily per rustic plantations of apricot

Table 5: Distribution of the AUS (DSA)

Communes	AUS (ha)
Ouled Derradj	7132
M'tarfa	8702
Souamaa	8660
Ouled Madhi	6000
M'sila	8240
Chellal	3250
Ouled Mansour	12745
Total	54729

AUS: Agricultural Useful Surface

Table 6: Surface of the various types of culture on the level of the study zone

Types of culture	Area (ha)
Culture of legumes	345
Cereals	16056
Culture forager	2250
Fruit-bearing arboriculture	1958
Without culture	23938

DSA, 2010

trees, olive-trees and fig trees. The Agricultural Useful Surface (AUS) is distributed through the various communes in a heterogeneous way. However, it appears clearly that the commune of Ouled Mansour only concentrates with it 24% of the arable lands. The other communes are almost equal with approximately 15% each one except the area of Chellal which has a weak AUS with only 6% (Table 5). The fallow and the grounds at rests exceed half of agricultural surfaces during the agricultural partner 2009/2010.

Broadly the zone remains faithful to the cultivation of cereals which occupies 36% of the grounds followed by the fodder cultures and fruit-bearing arboriculture at a rate of 5 and 4%, respectively (Table 5). On the other hand, these data vary much according to the area. Fruit-bearing arboriculture and the truck farming become extensive in the areas of M'tarfa and Souamaa whereas in Ouled Mansour and in Ouled Derradj, the fodder cultivation of cereals and cultures remain dominant (Table 6). There exists a variability of fruit-bearing species cultivated contrary, the apricot tree which remains very far the most dominant species. Currently, researchers noted that other species start to be installed in the various areas. Primarily the olive-tree where it largely compared carries it to the other species.

Occupation of the grounds by the courses: The grounds of course are consisted several facies; course with *Stipa tenacissima*, *Artemisia herba alba*, *Arthrophytum scoparium*, *Astragalus armatus*, *Atractylis serratuloides*, *Salsola vermiculata*, *Anabasis articulata*, *Thymeleae hirsuta* and *Ampelodesma mauritanica*. The grounds of course are distributed on all seven communes with 51,417 ha which constitutes the same value as the Useful Agricultural Surface (AUS). They are primarily made up of steppe courses containing *Stipa tenacissima*, *Artemisia herba alba*, *Salsola* and *Anabasis*.

Ecological characteristics: The floristic exploration of the area undertaken since, >1 century Rebound in 1867, cite 349 species relating to the steppe communities of Chott El Hodna. Currently, 550 let us tax were listed there (Kaabeche, 1990). One counts there many endemic species with the area of Hodna such as *Saccocalyx saturoides*, *Arnebia decumbens* and *Linaria laxiflora* that one finds only in this area. As well as endemic species North African such as: *Muricaria prostrata*, *Lonicophora capiomontiana* and *Rhanterium suaveolens*.

Type of vegetable formation: The vegetable formation is a whole of the plants which present a physiognomical character of size common runs. This character can be a criterion of size of stratification, of density, heard space and aspect of biomass (Bounab and Ownas, 2005). In North Africa, the steppes are low and very open formations containing graminaceous and/or of chamaephytes long-lived (Bounab and Ownas, 2005). Essential of the landscape of the territory El-Hodna is consisted steppe formations, the vegetable cover marks North in the South by a vegetable cover which depends on several types of factors; climatic factor order, soil order and entropic order. One distinguishes from North towards the South:

- In the plains of the calcicoles groupings with esparto (*Stipa tenacissima* L.) and *Genista saharae*, localized in the commune of M'sila with a slope >12.5%. This composition occupies a surface of 462 ha. Like Armoise (*Artemisia herba alba* Asso) and of the groupings gypso-calciphiles (*Anabasis oropediorum* L. and *Salsola vermiculata* L.)
- In Chott Argilo-halophilous groupings (*Atriplex halimus* L.) and hyper-halophilous groupings (*Salicornia arabica* L.) which disappear in Sebkhia or the vegetation is non-existent (Mimoune, 1995)

Occupation of the grounds by the livestock production: The zone of study like the majority of the steppe zones is with vocation agriculture and courses. The courses which hear on 51417 ha, especially constitute the broad wide ones of pasture for the ovine breeding. Consequently, from the census of the animal livestock, it arises that the ovine breeding remains the most important activity. Nevertheless and following the encouragement of the stockbreeders to be directed towards other types of breeding, the bovine breeding takes more and more importance, especially O. Derradj and M'tarfa with 600. Each one thus explaining the importance caused of the

Table 7: Animal manpower of some communes of the area of the study zone

Study zone	Bovine	Sheep	Caprine	Poultry
O. Derradj	600	14000	500	-
M'tarfa	600	17000	500	-
So umaa	300	17000	400	-
O. Mansour	333	20530	520	129800

DSA, 2010

fodder cultures in these communes. To also note that poultry farming is largely practiced with O. Mansour where it second directly the ovine breeding with a manpower bordering the 130.000 (Table 7).

Urban areas: The urban areas represent 6,300 ha. The dam El-K'sob located in the commune of M'sila occupies a surface of 130 ha.

Water resources

Surface water: The study zone belongs to the large catchments area of Chott El Hodna, characterized by a very dense hydrographic network where the rivers take their sources in the mounts of Hodna the principal river is El-K'sob river.

The whole of surface waters converge by streaming towards the basin of Hodna. The intensity of believed considering the torrential character of the rains supports the erosion of the grounds and the stranding of the hydraulic infrastructures downstream (stopping and barrage for the spreading of surface waters).

Subterranean water of the area study: Subterranean water of the study area knew a regressive evolution which had primarily at the last periods of dryness and the overexploitation of the tablecloths by drilling. The ground water is fed by infiltration of water of precipitations and flows of surface and a contribution per drainage starting from the tablecloth.

Physicochemical analyses of water was carried out on several water points distributed on the whole of the sector of study, the goal of this part is to define the chemical composition and water quality underground with respect to portability and the irrigation.

Chemical composition: The chemical composition dominant are: Chloride Magnesium, Chloride Calcium (CaCl_2) (MgCl_2), Sulphate Calcium (CaSO_4), Epsom salt (MgSO_4) with 77%, Chloride Sodium (NaCl), Chloride Potassium (KCl), Sulphate Sodium (Na_2SO_4) with 23% (Amroune, 2008).

Aptitude for irrigation: The near total of water of the plain of M'sila has a temperature which varies between 21.5 and 22°C, these results in a strong corrosion of the casing of the drillings. The majority of water of this plain

Table 8: Directives for the interpretation of the quality of a water of irrigation (Salinity)

Restriction for the irrigation	IT ($\mu\text{S cm}^{-1}$)	Samples (%)
None	<700	0
Light with moderate	700-3000	61
Strong	>3000	39

Table 9: Lower outputs of certain cultures in relation to the salinity of the water of irrigation

Culture	Conductivity (EC) ($\mu\text{S cm}^{-1}$)			
	5300	6700	8700	12000
Barley	5300	6700	8700	12000
Wheat	4000	4900	6400	8700
Fall of output (%)	0	10	25	50

have a strong conductivity therefore a high degree of mineralization. The aquifers are exploited anarchically for the irrigation. The majority of the water points of the area of study represent a light restriction on moderate with 61% and a strong restriction including/understanding 39% of the water points (Amroune, 2008). In the event of irrigation with this salt water charged, one can expect falls of outputs (Ayers and Westcot, 1988) of certain cultures practiced on the level of the plain of M'sila (Table 8 and 9). It is recommended in this case to use this water for tolerant salt cultures, to practice cultures on the light grounds (sandy) to make additional contributions of water and to make drainage (Amroune, 2008).

Study of the toxicity of the plants: Toxicity appears in the plants following the absorption and the accumulation of certain substances contained in the water of irrigation. These toxic substances cause the failure of harvest like the case of sodium and that of chlorine.

Sodium: The use of a water of irrigation rich in sodium generally results in an accumulation of sodium in the ground. The modifications which can appear in the ground are function of the frequencies of irrigations (Ayers and Westcot, 1988). The cultures absorb sodium into same as water and this one concentrates in the sheets while water escapes by perspiration. It can result toxicity from it if the accumulation of sodium reaches a concentration exceeding the tolerance of the culture. The characteristic symptoms are the burns and the reddening of the foliage as one necrosis fabric located on the edge of the sheets.

Chlorine: If the chlorine contents are $<4 \text{ me L}^{-1}$ account for 17% of the water points which constitutes a light restriction. Those ranging between $4-10 \text{ me L}^{-1}$ constitute a light restriction on moderate; it corresponds to a percentage which varies between 44-39% of the water points tested whereas, 44-39% of the water points present a strong restriction.

CONCLUSION

The plain of M'sila located in the Western Northern zone of the basin of Hodna is a zone with strong potentialities floristic and faunal indeed it includes a very rich biodiversity covering together study territory. It is a zone with arid climate which extends on 780 km² of which useful agricultural surface raise with 51,829 ha including 6,119 ha to carry out in irrigated, the fallow with it only accounts for 50% among the most dominant cultures are: Cereals with 36% followed fodder culture and arboriculture with 5 and 4%, respectively of the AUS.

The plain of M'sila has vocation agriculture and courses of which manpower of the livestock is cash diversified the sheep the bovines the caprine ones and the poultries. The courses constitute major the part of the total surface with 51,417 ha, the steppe species most dominant are *Saccocalyx saturoides*, *Arnebia decumbens* and *Linaria laxiflora*, *Muricaria prostrata*, *Lonicophora capiomontiana*, *Rhanterium suaveolens*, *Stippa tenacissima* L., *Artemisia herba alba*, *Anabasis oropediorum* L., *Salsola vermiculata* L., *Atriplex halimus* and *Salicornia arabica* L.

The study zone belongs to the large catchments area of Chott El Hodna characterized by a very dense hydrographic network, the whole of surface waters convergent by streaming towards the basin of Hodna. The ground water is fed by water of precipitations, the majority of water of this plain have a strong conductivity therefore a raised degree of mineralization, these results in a strong corrosion of the casing and drillings. All this biodiversity is confronted has constraints ecological, pedology and climatically and human orders by not organized and abusive exploitation of the grounds of

course (overgrazing, clearing), this phenomenon is intensified by aggressiveness of the arid climate and harmful action of the winds.

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