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The salinization of the earths in an endoreic basin The Hodna [Algeria]

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Cuvette du Hodna (Image Nasa Wind)

Introduction:

The basin of Hodna extends on a surface from 8000 Km². She occupies a central position in Algeria and in the medium of a catchment area of 25000 Km². She is surrounded of mountain, the Tellian Atlas in North and the Saharian Atlas in South (SL), but in a precise way, it is limited to North by the Mounts of Hodna, which are made of a mountainous chain, whose altitude varies from 1400 meters to 1890 meters (Tarf, djeddoug, Maadid, Guettiane, Boutaleb, Belezma). In East is limited by Aurès (Djebel Metlili, 1660 Southern meters]. Au South, it is limited by the repercussion of the chains of the Saharian Atlas (Mounts of Zab, Mounts of Ouled Nails, 800 and 1200 meters). At the West, it is open towards the plains Algéroises (plain of Sersou, 700 meters) and in the East towards the High plains constantinoises by the opening of the Wadi Barika (800 meters)

This geographical configuration confers an original individuality to him is a natural entity diversified in detail and comprises according to the North-South direction (Fig-1-)

- The piedmonts (Djerr) spread between the curve 700 and 500 meters;
- The plain of the Hodna begins 500 to 430 (limit of the artésianisme);
- The Chott (border) is between 430 and 400 meters;
- The Sebkha (salty lake) is surrounded by the curve 400 meters;
- The Rmel (sandy zone) of 400 to 600 meters.

However as one sees it the limits between the different units are at a time topographic and as one is going to see it farther are as sedimentological and pedological. This situation confers him a climatic régime forcing, because it is subtracted of the Mediterranean maritime influences because of the double mountainous screen that the form the Atlas Tellien (Titteri, Bibans, Babors) and the Mounts of the Hodna. On the other hand the chains of the Atlas Saharien that are low encourage the entry of the drying climatic influences of the Sahara. The Hodna in his whole receives 200 on average only to 250 mm of rain. What is been able to for the barley and wheat that asks for 300 to 350 mm, therefore the recourse to the irrigation is a necessity. The pluviométrie rarely passes 350 mm and it is irregular in the time and the space. But the Hodna certain years undergo a régime honestly of the Sahara (150 mm of rain), it is the drought that can last several years. What contributes to the increase in salinity. According to, [1] which worked on the variability of the salinization in the perimeter of Hmedna (Relizane) during the three crop years (95/96/97), they noted that the contents salts record falls of rise during the periods dry. The following table is very significant (Tab-I-)

Tab-I- Influence of pluviometry on salinity.

Time	cumulated pluviometry	Salinity dS/m
Nov. 95 - Mars 96	326.10	2.41 - 0.50
June 96 - Oct. 97	86,90	0.56 - 0.74
Nov. 96 - Mars 97	121.75	0.74 -0.52
June 97 - Oct. 97	105.70	0.55 - 0.60

The amplitude thermal average is of 22 ° CS. To this effect the evaporation is curiously strong (290 mm/an). The region knows of the rigorous winters with averages of 30 to 20 days of frost. In 2003, there were two days of exceptional frost (- 12 °C) in the month of February, all has been burnt. The summers are hot and dry with 20 to 30 days / year of sirocco [hot and burning wind] that dry in some hour's soils and vegetation. The Hodna is a windy

region, because winds don't meet an obstacle. The openings are and west encourage the circulation of winds that engulfs them in the pan. Winds are and of the Northwest are dominant of September to March and are bearers of rains. But in summer the winds of the South and the Southeast are the most dominant of June to August, but if it is a dry year, they can start to the month April. They often release as storm of sand and dust and especially if they are hot and burning become catastrophic and intolerable. The problem of the erosion and the blinding especially takes the size if soils are damaged. To this diversity of landscapes a pedological diversity corresponds and the analysis géomorphologique demonstrates it well. In more are himself of the fragile soils to very fragile, little deep and poor in organic matters. The pedological constraints of these soils (salinization, crust and chalky rut, stony reg), limit their faculties' culturales and their use are uncertain. The characteristic vegetation of the Hodna is on the whole of type steppique, but adapted to the conditions of the middle. It is damaged by the surpâturage and the extraction of the plants and it deteriorates again on this day by the abusive reclamations and the ascent of salts by the uncontrolled enhancement. From the North to the South the plant material dominating according to the units of the middle (Tab-II-):

Tab-II - Distribution of vegetation and use.

Units	Type of vegetation	Vernacular name	Local name	use
Mountains [700 to 2000 m]	forest	Pinus halepensis Quercus ilex	Snouber bellout	Forest and bovine course
Piedmont [500 to 700 m]	steppique	Stipa tenassissima Artemisia herba alba Esparto	Halfa Chih	Localized cultures and ovine course
Plain [430 to 500 m]	Steppique Saltiness begin to appear	Atriplex halimus Ziziphus lotus Lugum spartum	Gtaff Sedraya Snagh	Cultures and episodic ovine courses
Chott [400 to 430 m]	Steppique halophyte	Tamarix gallica Salsola tetrandra Salicornia Arabica Arthrocnemum indicum	Tarfa	Culture possible if drained zones Course for camel
Sebkha [400-390-400 m]	Salinity is more excessive [280g/l]	No vegetation	No vegetation	Traditional extraction of salt
Rmel [400 to 600 m]	Steppique Affinity of sahara	Aristida pungens Retama reatam Caligunum	Drinn Rtem Arta	Mixed course ovine and camelin Presence of cordon dunaire[100Km Put currently in excessive value

The superficial and underground water resources don't miss. This characteristic made that the Hodna is a region of former human occupation since the Neolithic, as testifies the

found historic vestiges of it. The survey of the FAO (1975) estimated resources of superficial waters to 323.106 m³, of which only 28.106 retained by the only dam in the pan; and 145.106 retained by the traditional ceds for the irrigation by epannage of rise in the water level and the 150.106 m³ remaining throw himself in the sebkha. The natural conditions make of this space a territory fragile particular steppique of which the constraints (erosion water and wind and salinization) are the limiting factors to all enhancement.

1) The characteristic géomorphologiques:

The natural elements are studied in the setting of the compartments inspired géomorphologiques of the concept geosystémique. "This is permits a setting in evidence reasoned of the general features that would be less clearly individualized by a merely analytic gait" [2].

1.1) The superior and intermediate levels: the rut, a constraint for vegetation.

The levels of the old and middle Quaternary (QV and QIV) present themselves coin forms it of glaze of ablation, développées to the foot of the reliefs, en a set of surface levelled and emboîtées, qui is crowned locally of crusts and chalky ruts calco-gypseous. These levels form the North piedmont (Djerr) and have been attacked and he/it is again by a violent enough linear erosion. He doesn't subsist these levels that of the shreds as thongs based on marls gypseous mio-pliocène eroded in badlands. The presence of the crust chalky zonal, thick and hard, limits the infiltration and don't offer the conditions favourable to the plant life and to the optimal retention of water.

The levels of the middle Quaternary (QIII and QII) are fit together in the precedents or stacked slightly. The material is coarse. But the rut becomes calco-gypseous with a reduction of the funding. The dripping of surface is again is even important and in part, the scouring puts in outcrop the gypseous rut that takes in surface the aspect of a cobblestoned crust polygonal. The erosion by dripping is least that the level superior and explains itself by the more permeable nature of the middle [absence of crust hardened]. The ruts are little thick and crumbly, letting the roots more or less penetrate offering so to the vegetation of the conditions a more favourable to subsist. The characteristic plant landscape of the this rank is a low woody steppe. The most widespread espèce is *Artemisia herba alba* with *Noaea mucronata*. The dusty miller decorated to really adapt to the climatic constraints and to the beating soils.

1.2) The lower levels: Of the important potentialities limited by the hydromorphie and the saltiness.

The recent alluviums constitute the plain of the hodna that spreads between the rating 500 to the contact of the piedmont and the rating 400 on the outskirts of the sebkha. Their formations are bound to the strong density of the hydrographical network that includes the wadis nourishing itself/themselves in mountainous environment more humid [semi-arid] Where the important erosion explains the load raised of waters in products strong come to deposit the level sub-arid. One distinguishes three sedimentary wholes: Q1-Q0-Qa.

The Q1 whole is represented by strata conglomeratiques strengthened by yellow clays [revised marls and altered of the substratum mio-pliocène] that contain the thin sands and small crystals of gypsum. This level doesn't include a chalky or gypseous rut.

The Q0 whole to dominance of thin elements, he/it is composed of three strata. The first stratum in superposition with The Q1. elle is constituted by yellow clays to intercalation of sandy lentils. Toward the downstream these clays present gray stains to greenish. It is the indication of the hydromorphie. The middle stratum includes pebbles wrapped in a matrix gley-sand. The superior stratum the clays become brawn to blackish containing of the crystals of gypsums. The effects of the salinity begin to that to make feel

The Qa whole is constituted of silts and clay that covers the whole plain of the hodna and that is the most privileged environment for the cereal culture, but he is permeable and slightly salty. But dice that one arrives to the limit of artésianisme the salinization affirms itself distinctly and the vegetation halophile begins to proliferate in abundance. The practice of

arboriculture becomes difficult and the arable surfaces [cereal culture] lessen. But dice that one advances toward the sebkha, the salinity doesn't increase little by little and the cultures are practically more possible.

To the South of the sebkha, the plain offers a different landscape. She/it is essentially constituted of wind formations that conceal largely the old formations. These formations present themselves as fields of dunes, nebkas and micros nebkas. In this plain the only arable zones are he of big sandy épandages that one calls here The Maadhers. The characteristic formations of the borders of the sebkha are constituted of gypseous sands, the rate of gypsum reaches 74% and the level of the water table is to 5 m. The practice of the culture is difficult. The plant cash answer presence gypsum well and to the salure. This sandy plain is a fragile environment where the discount in movement of the sands is a constraint for the setting in valeur, s'ajoutant to the salinization of soils. But broadly speaking the salinization remains a major constraint for the faculty cultural of soils in the pan of the Hodna.

2) The soils of the Hodna: A morpho-pedological heritage in relation with the conditions of the middle (Tab-II-):

From the North to the south one distinguishes a succession of soils according to the topographic compartmenting.

- The Mounts of the Hodna carry the chalky brown soils or the calcic brown soils, relatively rich in organic matter. In association with them one finds mineral soils often raw or of the low level soils, characterized by the dominance of limestone. On the zones to weak slope, the culture of the cereals without irrigation is developed extensively.

- On the piedmonts appear to the indications of an aridification of the climatic conditions already. Soils have a weak rate in organic matter. This whole forms the zone of the glazes with as character dominating an accumulation of limestone and gypsum. On the old glazes the accumulation appears as crust and hard rut, whereas some crumbly ruts appear on the glazes means and especially of the heaps of chalky nodules.

- The plain of the Hodna (recent glaze) are characterized by low level soils, developed from alluvium of marls (Miocene), it is a heavy soils and with of the gypso-saline characters more or less accentuated. Soils developed from colluvions and alluvium coming from the grés, conglomerats and chalky have a middle texture with stratifications and are less affected by salts.

- The Chott surrounding the sebkha and the sebkha she carries soils to gypso-saline accumulations of tablecloths that become honestly saline in the sebkha (Na Cl).

- The Rmel, to the south of the chott, the situation is all other. The central part was and was again greatly influenced by massive contributions of wind sands, forming the wind raw mineral soils of contribution to which follows glazes encrusted comparable to those of the North, but ensablés. In the isolated mountains that emerge in the zone of the Rmel (Méharga, Split Them, Fozna... etc.), or that limit the pan hodnéenne, one recovers the calcic chalky or brown brown soils.

After this brief geographical preview on the succession of soils in functions of the units géomorphologiques and the knowledge of the characteristic physico-chemical soils are necessary for orientation and the choice of the models of amenities to undertake in a given zone. The relation, relief-geomorphology-soil, shows us that the Hodna is subdivided in six pedological zones (Fig-2 -). Henceforth, the soils of the Hodna are known well thanks to the survey pedological agro led by TG.BOYADGEV, Hodna project (FAO, 1975). The above stated subdivisions obey conditions linked pédogénétiques to major pedological phenomena: the steppisation, the vertisolisation, the halomorphie, the gypsomorphie, the calcimorphie

One noticed that the saltiness increases when soils are herited and vertiques. But this increase remains tributary of the local conditions of the middle, as in our case (presence of a source of salt, climate evaporating, presence of an endoreic zone). However, as for the rate of clay increases, and as for oneself passes the dry surroundings that are favorable to the

conservation of the soluble salts toward more humid surroundings that they rather encourage their lixiviation [3].

3) The constraint bound to the soils of the Hodna: the salinization:

Currently in the world, on the 280 millions of hectares irrigated, one estimates that 27% are affected by the secondary salinization, and 50% are threatened some [4]. The salinization is a process that corresponds to the accumulation of the soluble salts in soil. This one disrupts the working of the system soil-plant, is notably of the to at modification of the osmotic potential of the soil liquid phase [5]. To this effect in the arid regions of the Mediterranean, the saltiness is a major problem dragging important losses in the agriculture. According to the world resources institute [6], the salinization of the to the secondary irrigation spreads to a rate accelerated (Tab-III-)

(Tab-III-): Rate of the saltiness in the countries of the Mediterranean.

Country	% of the earths reached	country	% of the earths reached
Alegria	10 – 15	Grèce	7
Cyprus	25	Jordan	16
Egypt	30 – 40	Morocco	10 - 15
Spain	10 – 15	Portugal	10 - 15
Palestine	13	Syria	30 -35

One of the essential problems of the culture irrigated in the Hodna is the one of the quality of the waters of irrigations. Of this fact the accumulation of the soluble salts in soils is one phenomenon characteristic and generalized in the Hodna. From the North to the South and of is Ouest, nearly all the soils are affected has different degree by salts [7]. However the accumulation of salts has different origins:

- In relation with the waters of irrigation, but observes itself more especially in the irrigated perimeters. After every irrigation, it is current to see to the of two or three days a lies down half note that appears on the borders of the seguia and the clods of earths, but in the bottom of the seguias and the inter sillions this phenomenon doesn't observe itself (Photo of author 1-2).

- Wind origin, he has been put strongly in evidence in the chott and the sebkha the existence of nebkas and micro nebkas of pseudo sand to excessively saline, characterized by a fine texture with clayey particles, constituent of the aggregations of pseudo sands with crystals of the common salt (Na Cl) individualized or under shapes of heaps or discontinuous horizontal layers. The accumulations of salts are excessive to the surface of soil or the conductivity reaches 106mho/cm².

- Biologic origin, the content raised in sodium (Na) and of it (Cl) in some plants of the Hodna as the Djell (*Salicornia Arabica*) and Gtaf (*Atriplex halimus*) encourages the increase of the content in salts of soils. Some analyses foliaires has been done at the time of the Project Hodna showed that the horizons immediately below vegetation (*Salicornia Arabica*) present a conductivity of 30 to 35mm ho/cm², while the horizons under a bare surface present a conductivity of 20à 28 mmho/cm², the conductivity being function of the concentration in salts. However the constraints of the middle hodneen, we materialized them on the face -3 -.

4) The main factors governing the choice of the irrigable soils:

The starting point of the development of all planning diagrams undertook in the pan hodnéenne, is the availability of water and soil. But, he/it was never question to lead scientific studies retailed in order to determine the faculty cultural of such or such soil and the measures to take for an enhancement rational and really integrated of the perimeters and zones chosen. The secondary salinization due to the irrigation to been multiplied by six in the perimeters of the south of the chott or the enhancement has been led excessively [8]. In the perimeter of the Ksob or one wanted to reconvert the cereal culture to arboriculture [that asks a lot of water], the salinization to been multiplied by six in three years. It is for this reason that

in the majority of the perimeters irrigués, the salinization has and one of the reasons of the failure. I made the observation personally on the land. How? The first enhancement of the land, first year or some fruit trees have been planted died from the third year, because dice that the roots arrive in the middle part or the concentration in salts is big (layer of salts and water tables salty meadows of soil). The salts asphyxias the roots because tolerance level is passed extensively. What pushed the agriculturists to abandoner their earths, what has contributed to the desertification [9] again more, the same thing for the market cultures, especially the watermelons practiced culture excessively? One noticed that the output the first year is very good; the second is middle, the third year the watermelons grow, but harden. It was never question in all these perimeters the least trace of drainage.

It is of can be it has a reconcentration of salts by a badly conducted irrigation or has a weariness of soil, because here one only makes the monoculture. Besides according to the research of Mimoune. S in 1994, he put in evidence that the setting in culture had an impact on the saltiness of soils and that this one has been multiplied by ten. It never noted the least trace of drainage. The Rmel before 1978 was one of course, but from 1975 he has been chosen like pilot zone for the projects of the agrarian revolution. Without study, his/her/its projects contributed a lot more has the deteriorations of soils by 1 wind erosion and the salinisation.

However to valorised to best these soils, it is necessary to take in consideration the main factors that govern the choice of the irrigable soils [10]: the climate, the quality of the available waters, the survey of soil, and the possibilities of drainage. Once these factors determined in detail, he/it remains the choice of the culture to practice, that becomes the third factor of the trilogy: water. Soil. Plant.

Conclusion :

The salinisation of soils is a problem that arises in all arid and semi-arid zones of the world, but every zone has its particularities. To this effect the pan of the Hodna, as we showed it is a well individualized natural entity, but varied in the detail. It is a zone of accumulation of salts, whose Chott plays a major role, that is the remarkable, pedological and plant zonalité, that the chott confers has this endoreic pan. The geographical configuration and the topography are the determining factors of the phenomena and process pédogénétiques that permitted the formation of soils, in inherited majorities, in a pan of remblaiement. Again it is necessary - to insist that these factors that impose the coercive climatic conditions and helping towards the salinisation of soils.

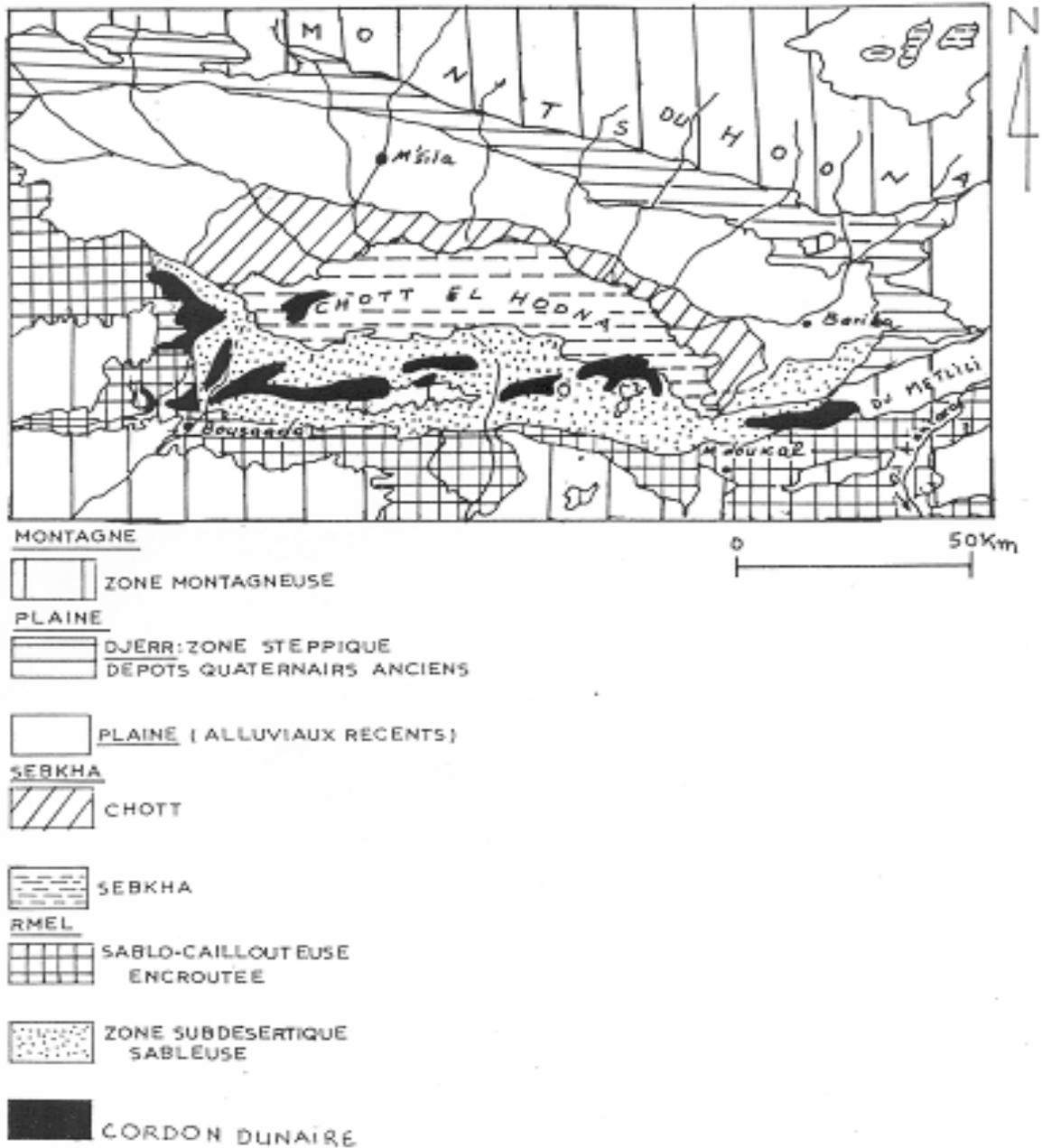
The intervention of the public powers by actions of amenities to enhance this pan to the profit of the farming populations, didn't give resulted them waited. These actions have been led without scientific studies that permit to know the natural habitat with his potentialities and these constraints. However, the salinization, the blinding and the lack of water will probably be the spiny problems to solve in the future

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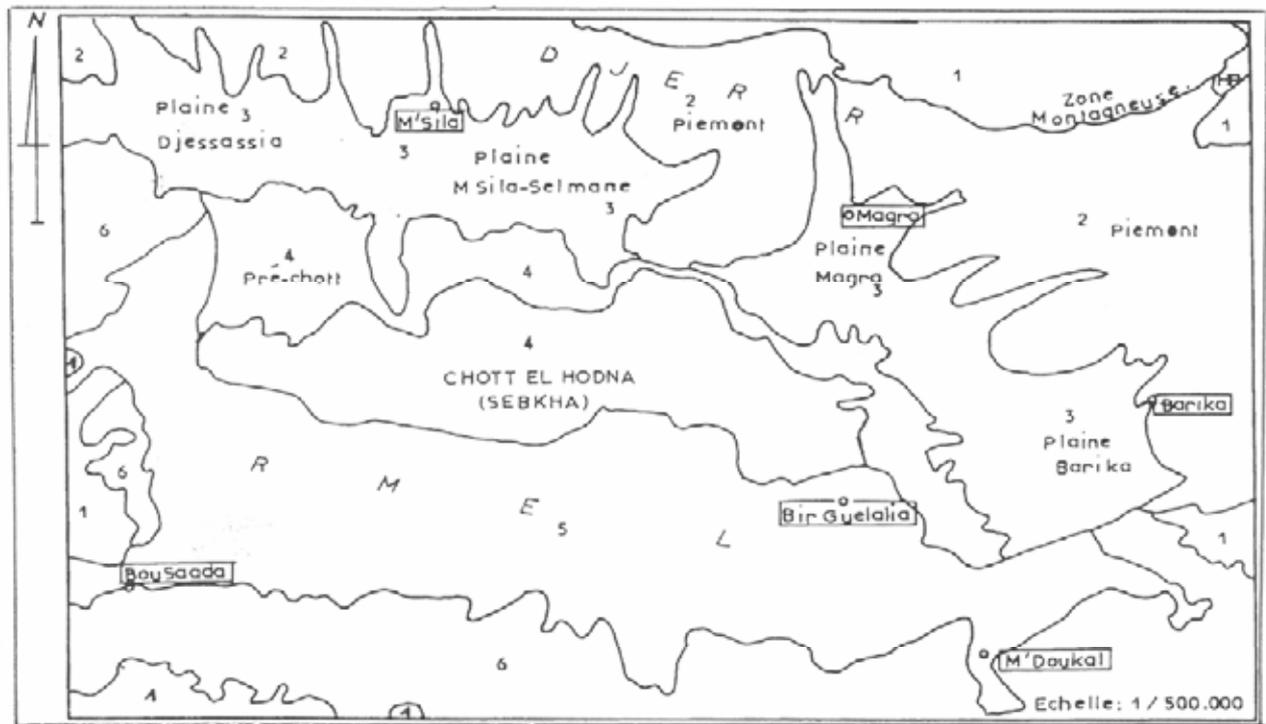
- LE RELIEF : UNE VARIETE DE PAYSAGES



Subdivisions pédologiques du Hodna (Mimoune , 1995) :

MILIEU	ZONE	Extension et Limites	SOLS	Aptitudes Culturales
MONTAGNES	Zone montagneuse xerique	Mont du nord du Hodna Longueur ouest-est = 150 Km Largeur = 15 km	Sols bruns calcaire en association avec regosols et lithosols	- Sur pente: reboisement - Sols de dépression aptes aux cultures annuelles en sec
MILIEUX STEPPIQUES	Zone steppique de dépôts quaternaires anciens et moyens	Entre le sud de la zone précédente et la route Tarmounte-M'Sila-Selmane. Puis Magra-Barika. Largeur = 12 km	- Sierozems sur croûte calcaire Q ₅ - Sierozems à encroûtement calcaire (Q ₄ et Q ₃) - Sierozems à nodules calcaire (Q ₂) - Sols gypseux - Sols minéraux brut et sols peu évolués regosoliques - Sols peu évolués d'apport alluvial	- Céréaliculture en sec - Reboisement et pâturage - Pâturage, céréaliculture en sec - Pâturage en irrigué - Pâturage - Reboisement avec banquettes
	Zone steppique de dépôts alluviaux récents	Entre le sud de la zone précédente et le chott avec une limite méridionale ondulée. Elle est liée surtout aux cones de déjection des oueds.	- Sols peu évolués d'apport alluvial * peu steppisés * calciformes * hydromorphes - Sols peu évolués halomorphes - Sols sodiques	céréaliculture en sec Arboriculture Maraichage Culture Industrielles Cultures fouragères Quelques cultures maraichères
MILIEUX SUBDESERTIQUES	Zone subdésertique argileuse du chott et de la sebkha	Longueur = 90 km Largeur = 20 km	Sols très fortement à excessivement salins	Aucune aptitude sauf dans la périphérie de la zone (C<30 mmhos/cm) où le pâturage pour camelin est possible
	Zone subdésertique sableuse avec dunes de sable	Elle est limitée au nord par le chott, à l'est par Barika, au sud par une série de collines appartenant à l'atlas saharien Longueur = 110 km Largeur = 5 à 25 km	- Sols minéraux bruts xériques inorganisés d'apport - Sols peu évolués d'apport éolien - Sols peu évolués d'apport alluvial - Sierozems modaux	- Pâturage - Bons pour les cultures irriguées. - Bons pour toutes les cultures - Bons pour toutes les cultures
	Zone subdésertique sablo-caillouteuse	Partie septentrionale de l'atlas saharien	- Sols sur croûte et encroûtement calcaires - Sierozems à nodules calcaires - Sols minéraux bruts d'érosion	- Pâturage et alfa - Pâturage, céréaliculture en sec, maraichage - Aucune utilité

Les zones pédologiques.



LEGENDE

- | | | | | | |
|---|---|---|---|---|---|
| 1 | Zone montagneuse xérique | 3 | Zone stéppique de dépôts alluviaux récents | 5 | Zone sub-désertique sableuse de formation dunaire |
| 2 | Zone stéppique de dépôts quaternaires anciens et moyens | 4 | Zone sub-désertique argilo-halophile du chott et de la sebkha | 6 | Zone sub-désertique sablo-caillouteuse encrautée |



Le Hodna : Sols et contraintes.

