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A GIS for the characterization and mapping of saline soils in semi-arid areas, case of Oued mina watershed (North West Algeria)

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Abstract

The objective of this work comes in the characterization and mapping of saline soils in the wadi Yellel watershed of (700 km²), the main tributary of the Wadi Mina, drains an area estimated 15 000 ha. It is composed mainly of marls tertiary hence the name "zone of marl. The semi-arid climate of the watershed of wadi Mina accentuates the phenomenon of salinization can be classified according to their origin; there are few data on saline areas prior to the execution of irrigation works, which shows common characteristics between the soil and irrigation water. The vegetation covers of only7.20%, which leads to early degradation. We adopted a methodology based on the use of Geographic Information System, the data were selected inventory of soils and vegetation in order to map and integrate them into a database data in order to enhance the information in the environmental sphere. The advantage of this method in of outlook, it is to track spatiotemporal for help characterize changes in terms of salinity and degradation of the physical environment. This will be followed by direct observation in field, laboratory analysis and by using the System Information (GIS). The results show that soils are often clay with a high clay content (36-50%) and salts, they are occupied either by agriculture or abandoned to be occupied by halophytic vegetation. The first results are made available to managers for their decisions and development proposals.

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Introduction

Land degradation is the reduction or loss of land in arid, semi-arid and dry sub-humid, the biological or economic productivity and irrigated cropland, rangeland, forests or woodlands resulting of land use or combination of processes. (M. Jarraud, 2002) It is also defined as a process that reduces the production potential of the soil or the usefulness of natural resources (Barrow, 1991)

Knowledge of soils is essential in many areas of planning, to enable better space management. It is therefore essential to have information on soil properties and their spatial organization. The study area is part of the watershed of wadi Mina particularly deprived requires a top priority interventions for the protection and enhancement of land. It is characterized by the importance of land and saline due to irrigation systems that make the area prone to soil degradation phenomena.

The courses also show a very advanced level of degradation resulting from large eroded areas. To illustrate our study, we will rely on digital maps produced using Geographic Information Systems at (GIS) for a good characterization of different potential in the watershed. It is within this general perspective that we are committed to achieve:

• The overall characterization of these degraded ecosystems in terms of ecological and environmental; conducting a computer-aided mapping.

Materials and methods

The physical framework

Location of the study area

The watershed of Wadi Mina and its extensions is in the lower basin of the Wadi Cheliff. It covers a total area of 20,000 ha. It is situated between 0°10 'and 1°10' east longitude and 35°40' and 34°40' north latitude. It stretches 128 km from north to south, from twenty miles Chott Ech. Chergui Chéliff to the bottom, and about 55 km from west to east, between the massif and the Ouersenis Beni-Chougranne. It consists of the heights of 100 to 1300 m. It offers almost as dissected plateaus, steep slope, leaving only about 12% plains.

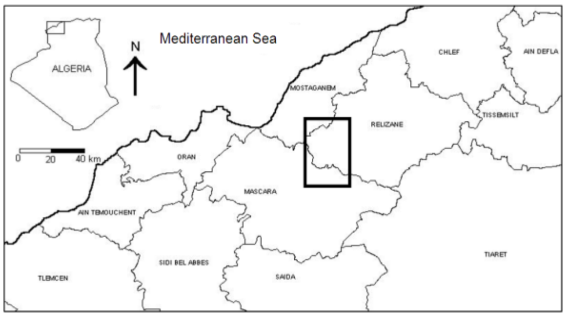

Fig. 1. Location map of study area.

Geologic aspect

The watershed of wadi Mina is a depressed area in the south east and west by mountains. (B. Touaibia, 2000) It has two distinct parts of the geological and lithological point of view:

- The southern part of the Jurassic rocks, consisting of limestone and marl Armed many benches of limestone and sandstone they limit the incision of ravines.

- The northern part north of Oued Mina, with an extension to the south in the downstream, consists of rocks of Tertiary age (Eocene, Oligocene and Miocene): it is thick masses of marl , often chlorinated in which limestone and sandstone are episodic. Gullies may grow freely without litho logical obstacles (after Kouri and Vogt, 1993).

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Geomorphologicala spects

The relief

Topography interferes with other factors training to change the nature of soils. The watershed of wadi Mina is characterized by rolling hills consisting of low altitude. (B. Touaibia, 2000).

The Slope

Class	0 - 3%	3-12,5%	12,5-25%	Total
Area (Ha)	7842	342,7	15,3	8200
%	95,7	4,2	0,2	100

The class of the slopes at more representative of the study area is that of (0-3%), it holds 80.63% of the total area. Table 1area distribution of watershed of wadi Mina area by elevation class.

Overview Soils

From the perspective of soil, the perimeter of Mina is characterized mainly by fine-textured soils potentially salinization. Those are actually already irrigated affected by salinity. Soils are grouped into different classes soil, the most important are: poorly evolved, saline soils, soil calcined magnesium, vertisoils. All these soil types have varying degrees of high fines contents, characters Vertic, high salt content and tasks of excess water in the profile. They are most often low in organic matter, which decreases with depth to become negligible. The pH is usually near neutral to slightly alkaline.

Vegetation

The study of correlations soil vegetation may reflect to some extent the distribution of soils within a given landscape. Salt-resistant species, known as halophiles are abundant while woody plants are very independent of temperature conditions (Gaucher, 1974). Forest cover is composed of halepensispine. It is located in two regions of the basin, tray Frends and the escarpment of the western line of the watershed. In addition to this forest, there is a recent reforestation especially on steep slopes. Cereal cultivation is practiced in the East.

Water resources

The Wadi of Mina drains a watershed of 1268.8 km 2 as major tributaries: wadi of Lanssat, wadi of ansseur, wadi of Bousslit, wadi of Yellel.

Anthropogenic factors

The study of the influence of anthropogenic factor on soil conservation shows: An irregular spatial distribution of population in the region, a density of 290.24 people per km², The total number of livestock, sheep take first place with 214 500 heads implying a degradation of vegetation cover and therefore promotes erosion processes.

Climate

The climate of Algeria is particularly aggressive. Rainfall can be considered dangerous in their consequences in terms of our concern (torrential rain), when they reach or exceed 20 mm in 24 hours (Greco, 1966).

The climate of the basin is semi arid, This area has a continental climate because of its position in basin surrounded by mountains. The average rainfall is around 400 mm. The basin is characterized by a rainy season extending from October to April, during which almost-all rainfall events are observed and produce a cumulative rainfall of about 90% of the annual rainfall. The dry season in turn extends the month from May to September and is characterized by poor rains which rarely exceed 7,2% of the annual rainfall .this is the period where irrigation is essential for agricultural production.

The study area It is also characterized by wind speed which, despite low may pose a threat, given the low plant cover and exposing the plate at the risk of wind erosion. The phenomena of evapotranspiration are not negligible, which will require us to know and take them into account as regards the type of development and selection of crops in climatic requirements.

Data collection

According to the research topic, we will gather all the data you need from digital mapping, field measurements of existing maps and statistics. Data can be analog and / or digital. The processed data are not all similar, both in terms of semantics, as the geometric point of view. Thus the content and container are not the same depending on whether the objects belonging to the natural environment or subject of human behavior. But in both cases, according to the objective of the study and the problems associated with it, it must choose the variables most useful and containers associated (TM GIRARD, 1977).

The available data are:

- Four (4) topographic maps 1:25 000 that covers the study area.
- The geological data: This data are in the form of a geological map of Bosquet Mostaganem at scale of 1/200.000th, published in 1969 by the Department of Mines and Geology of Algeria.
- The file DEM (Digital Elevation Model) of Algeria Downloaded from the World Database site (Shuttle Radar Topography Mission).

The data acquisition will be done by digitizing paper maps (for maps), which requires treatment to achieve the different layers of information by making it usable in digital format.

Methodological approach

The functioning of a watershed with only very little relevant information (as in most watersheds in Algeria) is essentially based on mapping methods. The use of these can be considered as an indicator, by crossing the factors explaining the soil eco-environment, a set of areas involved in the creation of risk beyond land degradation at the watershed of wadi Mina. This is primarily to better reflect the physical and agro-pedological watershed. To this end, it will use a concept of watershed geomorphic improved by digital mapping techniques and understand the importance of spatial discretization in the problem of distributed modeling. To this end, we have established a working methodology that is described in the following flowchart (Fig. 2).

Sampling

The soil samples were collected at each sub-watershed of order 3 of the watershed of wadi Yellel, it is geosystemic sampling based on taking into account the terrain and structure (slope) the lithogeology, hydrology and occupation of soil. 38 profiles were conducted in 16 sub-watersheds (1 to 3 profiles in the basin). The horizon is the basic unit of sampling, the limits of horizons is necessary during the sampling. These are made from the bottom upwards to avoid contamination from one sample to another horizon (Fig. 8.).

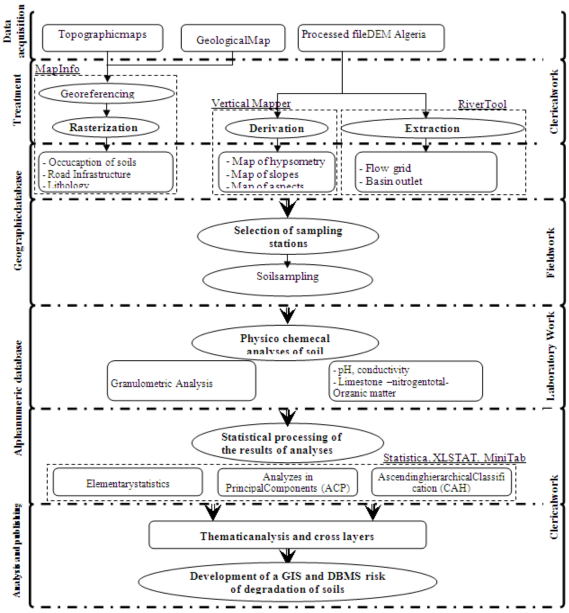


Fig. 2. Methodological approach to the study.

Realization of thematic maps

After scanning maps of Staff and the geological map of the study area available in print, we spent in step georeferencing of these digital files using the software MapInfo Professional 8.0 is a technique to define the projection system and the control points have to position each point in the raster. Rasterization can develop different themes to give a clear characterization of the environments of the study area and can subsequently use in spatial analysis monolayer and multilayer.

The map of occupation of the soils

In the watershed of wadi Mina, most soils are bare, which defines a low retention capacity that promotes rapid runoff that must be considered when assessing a problem due to water erosion. The impact of raindrops can break aggregates and disperse the soil particles. The finest particles, such as fine sand, silt, clay and organic matter, can easily be removed when the splash of raindrops and the runoff of raindrops stronger (dissipating more energy) and a greater runoff will be necessary to move the larger particles of sand and gravel. The vegetation of the watershed is very low, so the risk of erosion is high (Fig. 3.).

Map of road infrastructure

Impervious surfaces play a major role in urban hydrology, they increase the flow of the surface, reduce infiltration and groundwater research. From the map, we conclude that the watershed is characterized by a well developed road infrastructure for national roads, wilaya roads and railways. (Fig. 4.).

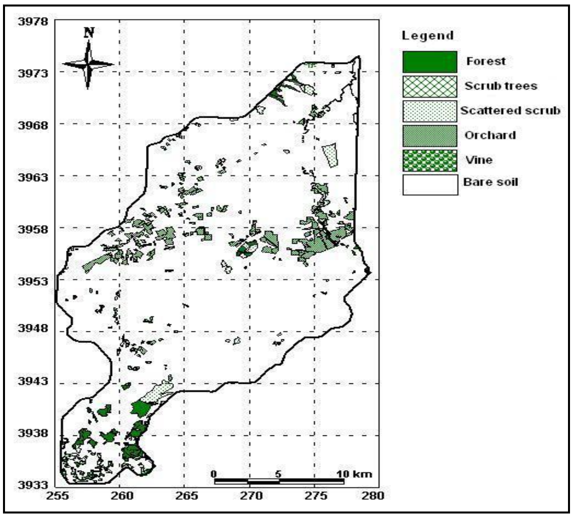


Fig. 3. Map of soils use.

Map hypsometric

This map provides for a given point, the distribution area of the watershed located upstream of the latter depending on the altitude (Fig. 5). According to this map we can see that the majority of land in the watershed is characterized by low altitude varies between 0 and 100 m. and a small southern part is characterized by very high altitudes over 700 m.

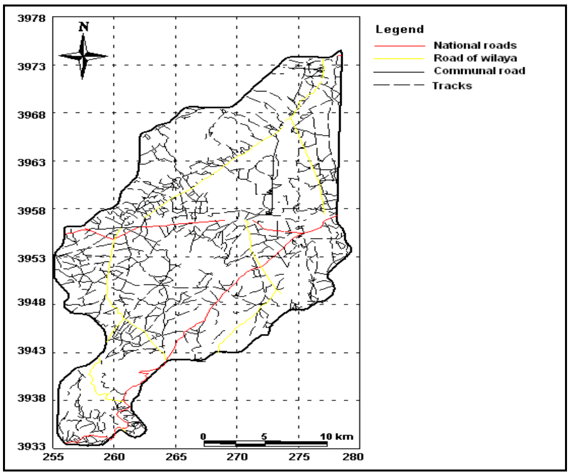


Fig. 4. Map of road infrastructure.

The slope map

The slope map is considered an important layer in the field of regional planning in general and in studies of watershed in particular. Its automatic extraction from the DEM allows the calculation of the slope in each pixel of the basin. The resulting layer is not fixed, it can at all time by a monolayer analysis, to classify slopes as the problem studied. We note from the slope map that most of the lands in the watershed are in the first-class slopes of 0-3%.

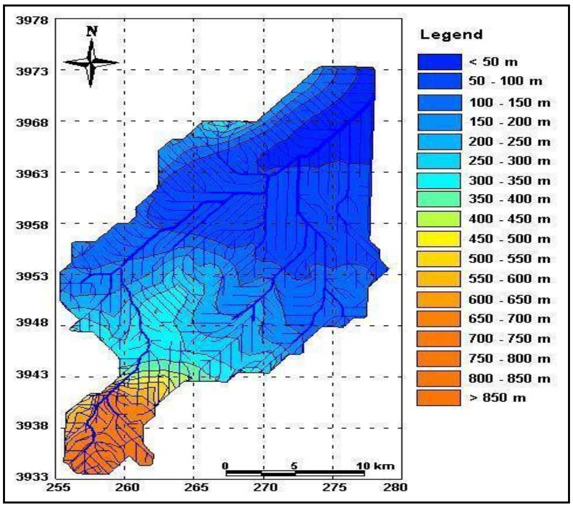


Fig. 5. The hypsometric map.

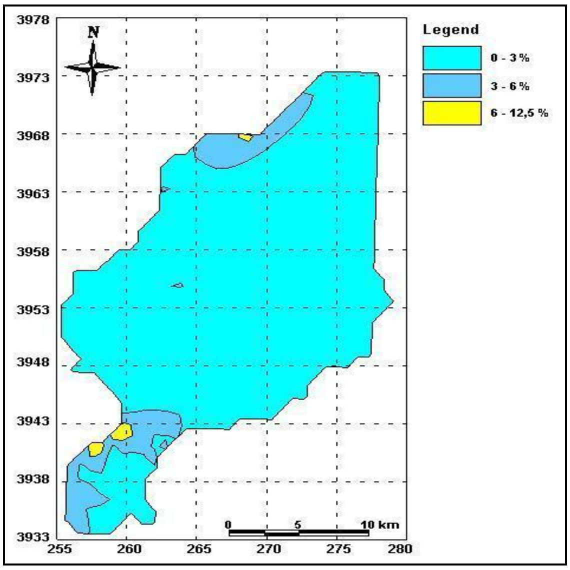


Fig. 6. The slope map.

DEM analysis

From the DEM treated, it is possible to draw a lot of information. According to the methodology of approach, plans to drift are: drainage, watershed boundaries. For this, we will position the outlets on the DEM.

These results will be stratified into layers of information to form a geographic database. We will then export the force capabilities of GIS for spatial analysis an implementation for the mapping of flood hazards in the watershed of wadi Yellel. The parameters are given automatically. They are represented in the following table

Table 2. Morphometric parameters of the watershed.

Watershed area	Hull area	Report Area	Diameter	Shape index	Shape index Hull
630, 732 km²	758,109 km²	0,831980	53,732485 km	0,46739647	0,51242347

The sub-watersheds and their characteristics

The extraction of sub watersheds is with the function "Extract", the results are as follows:

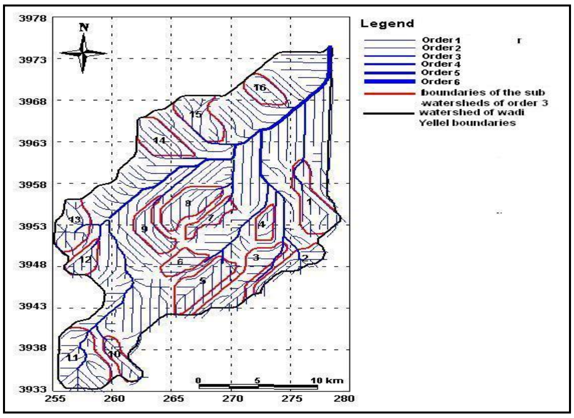


Fig. 7. The sub watershed of wadi Yellel.

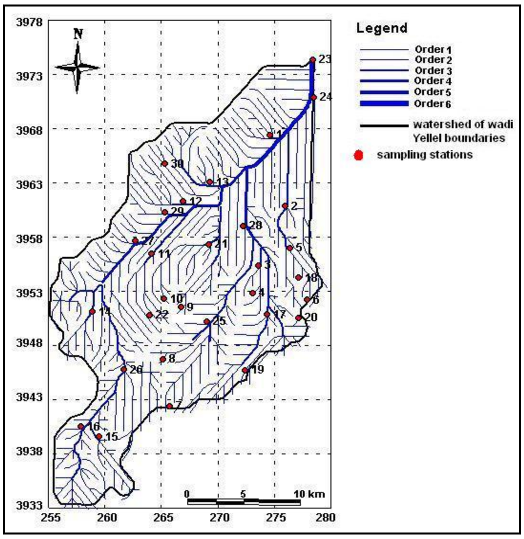


Fig. 8. Sampling stations.

Table 3. Physical and geomorphological characteristics of the sub watershed of wadi Yellel.

N° Watershed	Area	Perimeter	Slope	Vegetation Cover	Lithology	Total length	Drainage density	Shape index
1	33.4072	45.24	0-3%	46.31	Shell limestone	37.399	1.12	0.35
2	18.1132	23.69	0-3%	19.32	Shell limestone	23.45	1.29	0.51
3	27.8722	30.66	0-3%	50.16	Shell limestone	31.87	1.14	0.44
4	11.1404	11.14	0-3%	10.59	Shell limestone	12.331	1.11	0.58
5	24.3903	24.39	0-3%	9.06	Shell limestone	30.917	1.27	0.59
6	13.2367	13.24	0-3%	54.77	Shell limestone	15.734	1.19	0.74
7	13.9245	18.10	0-3%	26.21	Shell limestone	17.15	1.23	0.50
8	22.9720	23.67	0-3%	40.61	Shell limestone	33.224	1.45	0.67
9	20.1926	31.33	0-3%	4.03	Shell limestone	29.977	1.48	0.43
10	15.3467	17.44	0-3%	6.45	Sandy clay	21.024	1.37	0.51
11	34.8804	35.58	0-3%	46.82	Shell limestone	49.365	1.42	0.74
12	13.2362	13.24	0-3%	7.59	Calcareous sand + Shells	15.862	1.20	0.61
13	21.5864	21.59	0-3%	16.45	Calcareous sand + Shells	29.628	1.37	0.70
14	20.8651	20.87	0-3%	11.29	Calcareous sand + Shells	31.507	1.51	0.65
15	22.2490	23.64	3-6%	1.71	Calcareous alluvium + Shells	29.968	1.35	0.70
16	13.9006	13.90	3-6%	6.98	Alluvium	20.067	1.44	0.78

Results and discussion

Granulometric Analysis

The triangles of textures used to classify soils according to their particle size reduced to three fractions (total sand, silt, total clay) whose sum is equal to 100%. Among these triangles of textures include triangles and PAPEG Jamagne (15 classes) most used in France, others more famous around the world such as the FAO (3 classes) and the USDA (12 Classes) (Baize, 1971) we chose to represent our results:

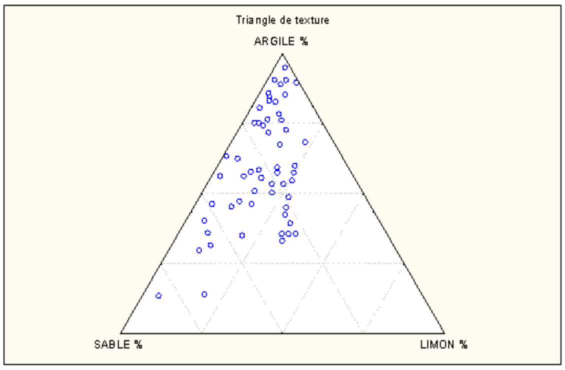


Fig. 9. The texture triangle.

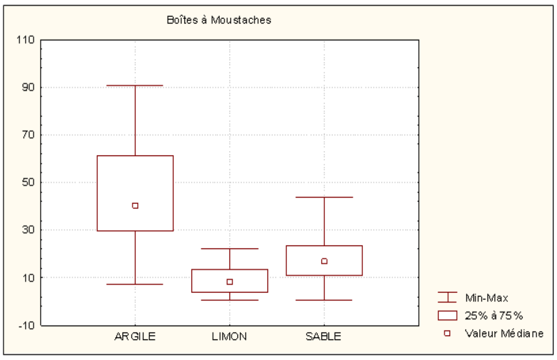


Fig. 10. The variability of the granulometric composition.

The texture triangle (Fig. 9) shows that the profiles have three positions from the dominant texture to texture the least dominant. The texture triangle shows the profiles of our area have three positions from the dominant texture to texture the least dominant.

- A series of profiles of clay texture (A)
- A series of profiles of clay-sandy texture (AS)
- A series of profiles of sandy texture (S)

represented by two profiles.

The variability of the granulometric composition

The diagram of the box plot (Fig. 10) allows us to determine the dispersion of the size distribution. The study area is characterized by the dominance of the clay fraction with an average of 45% and a rate of sand varies between 7 and 44%. For the silt fraction, it is of low average 9%.

Variability of the clay fraction

The theoretical curve of the clay fraction is spread around the average with a standard deviation of 21 and a variance of 444, which explains the heterogeneity of the clay fraction is characterized by a stretch of 83% (Fig. 11)

Variability of silt fraction

It is characterized by a central median, which corresponds to the average value of observations between 9.5 and 10%. The latter divides the box into two equal series of observations classified. There are so many observations before it after her. Ie values above the median are close to the value of 22% and that extends from this value by a vertical line (mustache) to the value of 27.5% which represents the maximum variability not outliers. The values below the median value of this decrease to 6%.

Variability of the sand fraction

This variability of the sand fraction is represented by a series of variables median averages ranging between 44 and 45%. The variables above are close to 46%, mustache higher maximum non-outlier variables grow up to 49% and decrease to the variables below 6%.

Potential Hydrogen pH

The soil pH is very important from the standpoint of power plants since the availability of nutrients depends on it (Bates, 1973). The pH has a neutral medium, almost all the soil profiles are neutral except for profiles 32, 24 and 01 (Fig. 12)

The total limestone

The limestone aggregate is represented in three classes (Fig.13):

- Content trace: 10 profiles are located with a percentage de17%
- Low level: 18 profiles distinguished.
- Content mean represents half of the profiles collected.

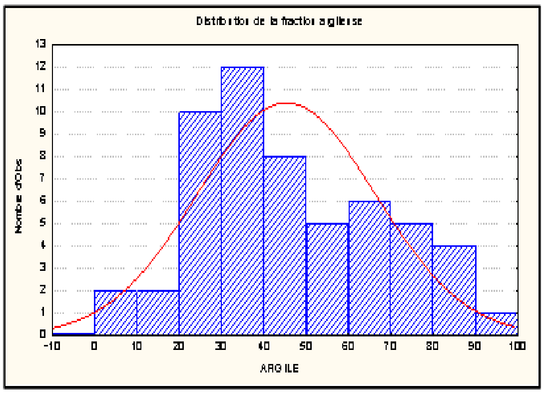


Fig. 11. Variability of the clay fraction.

The Organic matter

The classification of organic matter shows 03 groups (Fig. 14):

- A group of very low organic matter represents 30% of the profiles.
- A group characterized by average values of organic matter accounts for 44% of the profiles.
- An intermediate group with low organic matter percentage of 25%.

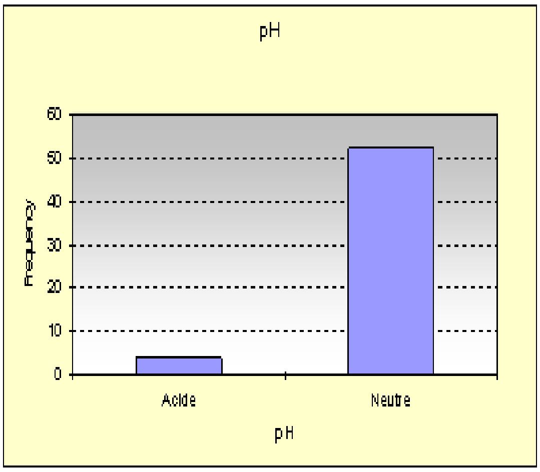


Fig. 12. The soil pH in the watershed of wadiYellel.

Total nitrogen

The profiles are low in total nitrogen but some profiles have a higher nitrogen medium (Fig.15).

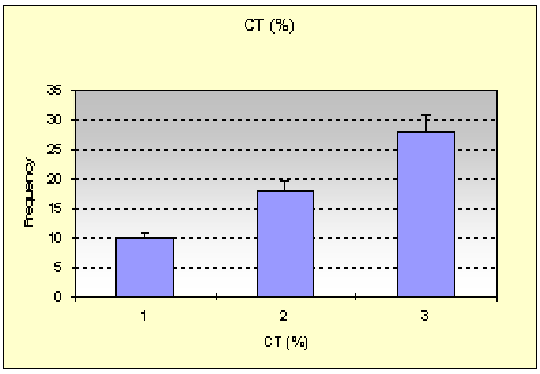
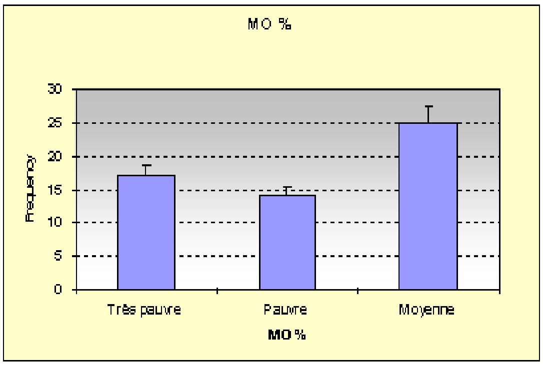


Fig. 13. The total limestone



14. The organic matter.

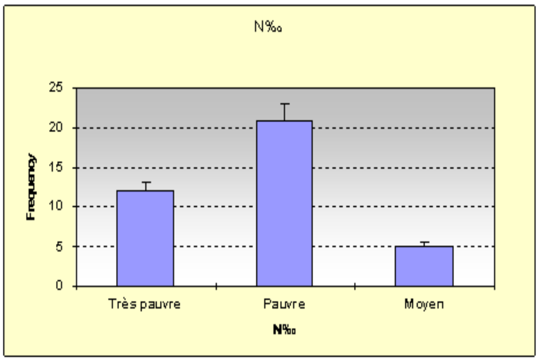


Fig. 15. The nitrogen.

The electrical conductivity

Most soils in the study area soils are unsalted represents 64% of the profiles, they are located in the southern study area while the northern zone is characterized by soil salty and very salty.

After we have integrated these results in Geographic Information System, the results obtained are shown in Fig.. 17.

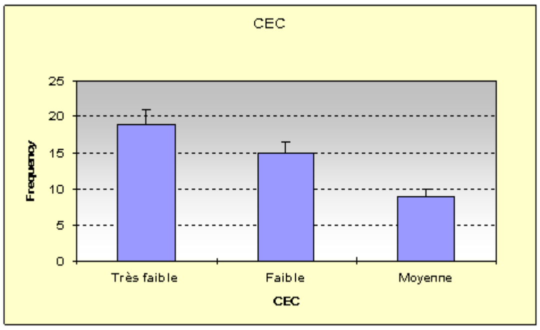


Fig. 16. The electrical conductivity.

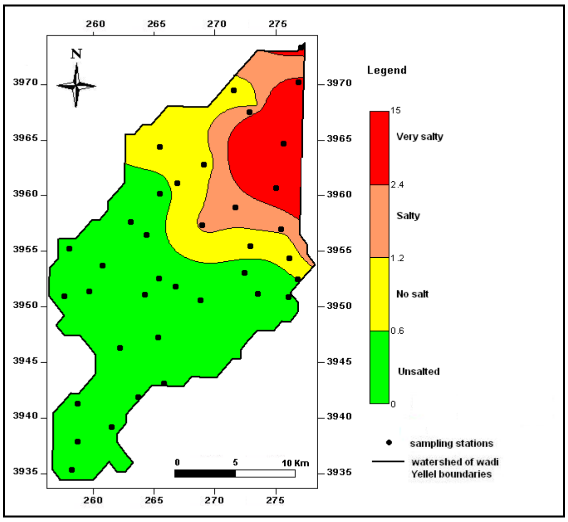


Fig. 17. Map of salinity in the watershed of wadi Yellel.

According to this map, the type of development is chosen in a given situation based on variables such as climate zone, the crop grown, soil factors, economic level and preferences of the farmer. None of these variables were completely independent of the others. In the watershed of Oued Mina, soils of the northern (lowland areas) are affected by the problem of salinity. For cons, the soils of the southern zone (mountain areas) are subject to the phenomena of water erosion. They must be protected by appropriate mechanical and water development as well as to reduce biological risks of this degradation (Fig. 17).

Conclusion

The study agropedological done at the watershed of wadi Mina has allowed us to characterize the physicochemical properties of soil and to identify major constraints acting on different crops in place according to their requirements. Based on field survey and analysis results of different samples, the study area has the following characteristics:

- A moderately deep soil,
- A homogeneous topography,
- Pedogenesis of the soil depends largely on the nature of the bedrock and topography. The main soil processes encountered in the study area is decarbonization and the accumulation of limestone.

Given the complexity of the phenomenon of land degradation and the number of parameters involved, we adopt a methodology based on the use of geographic information systems to enable scanning, mapping and analyzing data by crossing layers.

The results can be a contribution to the study of soil conditions in the watershed of Oued Mina its physicochemical characteristics and the determination of hydro-agricultural potential, in order to highlight the various constraints and propose solutions related to the rational and sustainable exploitation.

And thereafter mapping easily exploitable, these cards provide clear and accurate information in the knowledge of certain aspects of the study area, and take steps to information. They are to make available maps of managers able to assist them in their decision-making or development proposals.

References

BARROW CJ. 1991. Land degradation: development and breakdown of terrestrial environments, Cambridge University Press 295p.

BATES RG. 1973. Détermination of pH.Theory and practice-J.WILEY and Sons. NewYork.

GAUCHER G. 1968. Treaty of Agricultural Soil: The soil and agronomic characteristics. DUNOD. Paris 578 p.

GIRARD MC. 1977. Contribution of remote sensing to map soil herniorrhaphy: Potential, limitations. Proceedings of the 1st conference.

GRECO J. 1966. Erosion protection and soil restoration, reforestation in Algeria (publication of the Ministry of Agriculture and Agrarian Reform, Algiers) 292.

JARRAUD M. 2002. Climate and land degradation on "Soil Science and Remote Sensing, Rome pp. 22l-231.

KOURI L, VOGT H. 1993. Determination of the sensitivity of marl land in gully through geographic information system. Watershed of Oued Mina, Tell Oran, Algeria. Internal report. Algiers.

TOUAIBIA B. 2000. Quantification of erosion from implantation of four dams in the zone of marls W. Relizane Algeria.