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Research article

INTEGRATION OF MULTI-SOURCE DATA IN A GEOGRAPHIC INFORMATION SYSTEM (G.I.S.) FOR THE DIAGNOSIS OF DEGRADED SOILS IN THE WATERSHED OF WADI MINA - CASE OF SUB-WATERSHED OF WADI YELLEL - NORTH WEST ALGERIA

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ABSTRACT: Integration of multi-source data in a Geographic Information System (G.I.S.) for the diagnosis of degraded soils in the watershed of wadi Yellel - North West Algeria. The objective of this work comes in the context of an ecological and agro-pedological study of degraded soils in the watershed of wadi Yellel, the main tributary of the Wadi Mina, which drains an area of 15 000 ha. this one is mainly composed of Tertiary marls, justifying the name of marl zone. The study area suffers the Mediterranean climate conditions with 5-6 dry months' and interannual variation of 305 mm. Vegetation covers only 7.20%, which leads to early degradation. The establishment of Geographic Information System (GIS) allows the knowledge of the spatial variability of wadi Mina water shed physical characteristics. The results show that soils in the southern part of the water shed are often clayey (36-50% clay) unsalted and those of the north are sandy clay soils unsalted, characterized by a rate of sand varies between 7 and 44% and with a very high content of salts. These soils are either used for agriculture or abandoned and colonized by the halophytes. The product of this study is firstly a database and also a tool for decision making regarding the development of marly semiarid areas.

Keywords: GIS – Pedological factors - semi arid - degradation - soils - Wadi Yellel - Relizane – Algeria

INTRODUCTION

The study of soils is essential in many fields of planning to enable better management of space. Thus, it is necessary to have information on soil properties and their spatial organization. The Yellel Wadi sub-watershed, part of the Mina Wadi watershed, particularly damaged, requires priority interventions in land protection and development.
Despite various studies (Kouri, 1993; Gomer, 1994; Touaïbia, 2000) [1,2,3] the study area remains insufficiently known. The random and irregular morphological characteristic and spatio-temporal discontinuity of the scope complicate its study [3]. In this work, the approach is based on the use of digital maps to better define the different potentialities of the study area.

MATERIALS AND METHODS

The study area

The Mina Wadi watershed is located approximately 300 km west of Algiers (0°20' to 1°10' East and 34°40' to 35°40' North). Its total area is 20 000 ha [2] and drains an area of 4900 km^2 down to the Sidi M'Hamed Ben Aouda dam [4].

Wadi Mina is one of the main tributaries of the Cheliff Wadi, it runs across 135 km between Bakhada and Sidi M'hamed Ben Aouda dams in a South-East – North-West orientation. This watershed belongs to the mountainous relief class (landforms ORSTOM classification) [5]. The region is characterized by a Mediterranean climate with semi-arid bioclimatic level with mild winter. The average annual rainfall is estimated at 305 mm with a marked irregularity [6], precipitation is concentrated between November and March. From a geological point of view, the watershed of the Mina Wadi is characterized by the predominance of Jurassic in the north and the west of area.

The rest of the region shows Cretaceous outcrops of limestone and sandstones. Agricultural soils generally consist of alluvia and colluvia where very diverse cultures are practiced. Analysis of the spatial distribution and diversity of vegetation in the basin showed two clearly distinct parts [1,7]: the northern zone purely marly, highly eroded and devoid of vegetation except some islands of reforestation and fruit trees plantations in the valley ; and the southern zone less eroded of which approximately 50% of the surface is covered by vegetation with varied and very scattered density, ranging from forest (of Aleppo pine) to the very sparse scrub. It should be noted that subsistence farming prevails with overexploitation of soils, permanent land clearing and intensive overgrazing.

Methodology

The used mapping methods allowed to define by the combination of some of the environment characteristics factors (vegetation, soil salinity, pH, organic matter, etc...), a set of risk-prone areas of degradation in the studied watershed. To this end, we need a concept of watershed geomorphology improved by digital mapping techniques.

Sampling

To obtain representative stations, the no stratified sampling method was adopted based on the land use at the tributaries of the Wadis, and this after determining homogeneous zones. The sampling depth is 50cm. The following figure shows the 38 selected stations.

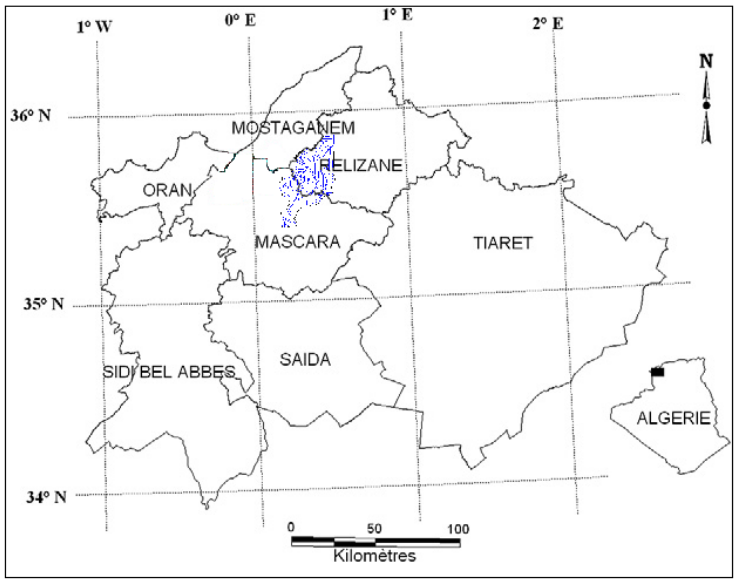

Fig. 1. Location of the study area.

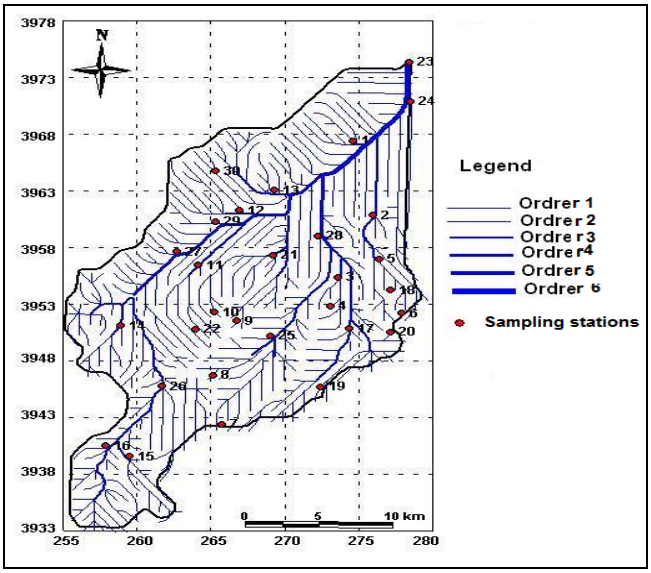

Fig. 2. Location of sampling stations.

RESULTS AND DISCUSSION

The treatment results of analysis of the main soil parameters (texture, pH, OM, $CaCO_3$, EC) shows:

Soil texture

This parameter is determined by the USDA diagram textures [8], we identified three types of textures in the study area:

Clayey soil (A), located in the southern part of the basin (Bordj El Kelaa, Sidi Saada) Soil with sandy clay texture (AS), located north of the center (Yellel El Matmar, Relizane and Belhacel). Sandy textured soils (S), located in the center of the study basin (Aïn Errahma, Ouled Bouali). The distribution of soil textural composition in the watershed is characterized by the predominance of the clay fraction with an average of 45%, a rate of sand varying from 7 to 44% and, as an average 9%, for the stringers.

pH

The study area is characterized by alkaline soil with an average pH of 7.83. This is illustrated in Figure 3, which shows the spatial distribution of pH values in the sub-watershed of Yellel Wadi. It appears that the majority of the watershed is characterized by a neutral pH due to the presence of limestone. By cons in the south-west, the pH is acidic. This acidity is partly explained by the Aleppo pine presence.

Organic matter

Figure 4 shows that the soils are irregularly filled with organic matter. Very poor soils represent 7% of the total area, with grades ranging from 0.11 to 0.98%. In the southern part, 13% of the soils are low in organic matter (1.06 to 1.98%), while 36% are rich. This can be explained by the contributions of runoff laden sediments.

The total limestone

In the study area 50% of soils are moderately calcareous (10-22% of $CaCO_3$), due to the nature of the limestone bedrock. However 17% of the southern part is characterized by very low rates of limestone (0.42% and 1.70%). In the center area (32% of the total area) $CaCO_3$ contents range from 0.42% to 1.70%.

The electrical conductivity

Figure 6 shows that the soils of the northern part of the watershed (lowland areas) are very salty and savory with values ranging from 1.27 to 6.6 mS/cm. These are either occupied by cereal or abandoned and colonized by halophytes. Several factors may be responsible: the quality of irrigation water (salty groundwater), low slopes and poor drainage. However, the soils of the southern zone (mountain areas), subject to water erosion phenomena, are unsalted.

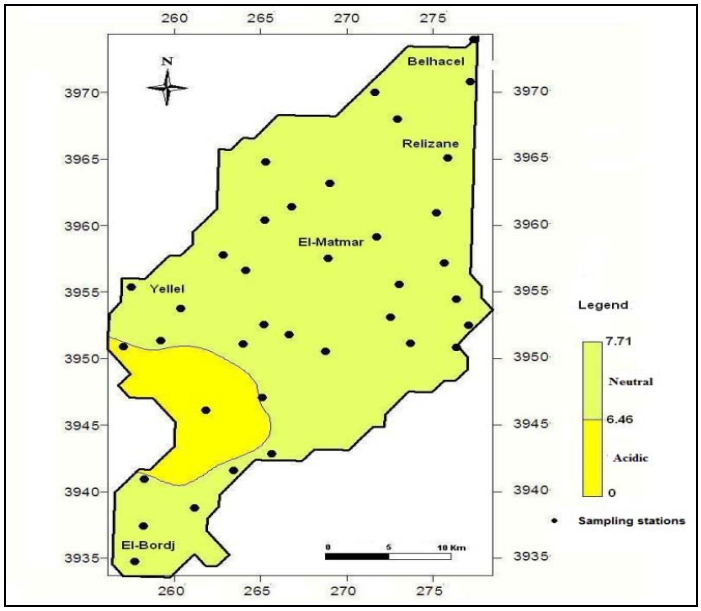

Fig. 3. pH Distribution in Yellel Wadi sub-water shed

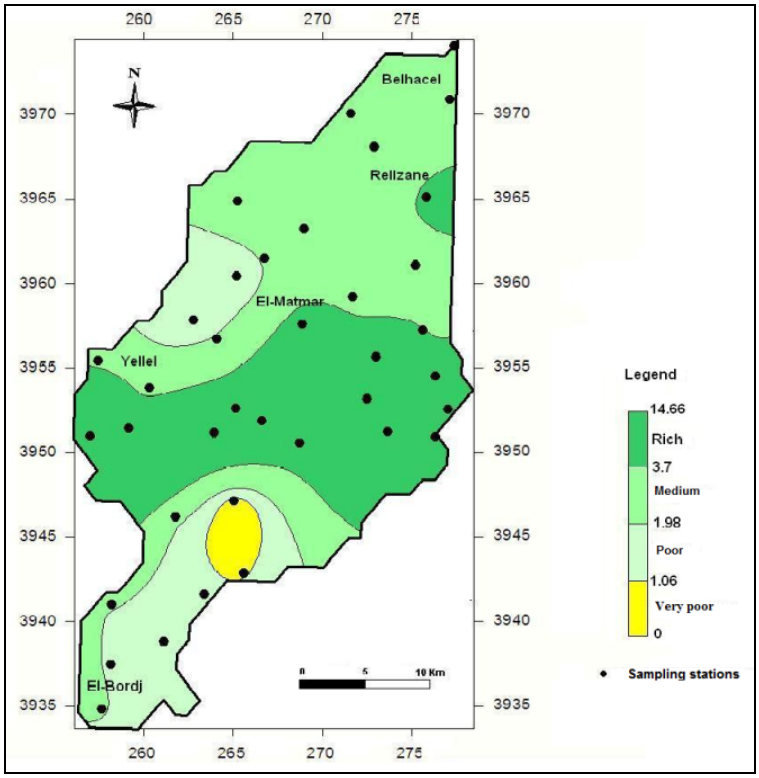

Fig. 4 Distribution of organic matter in Yellel Wadi sub-water shed

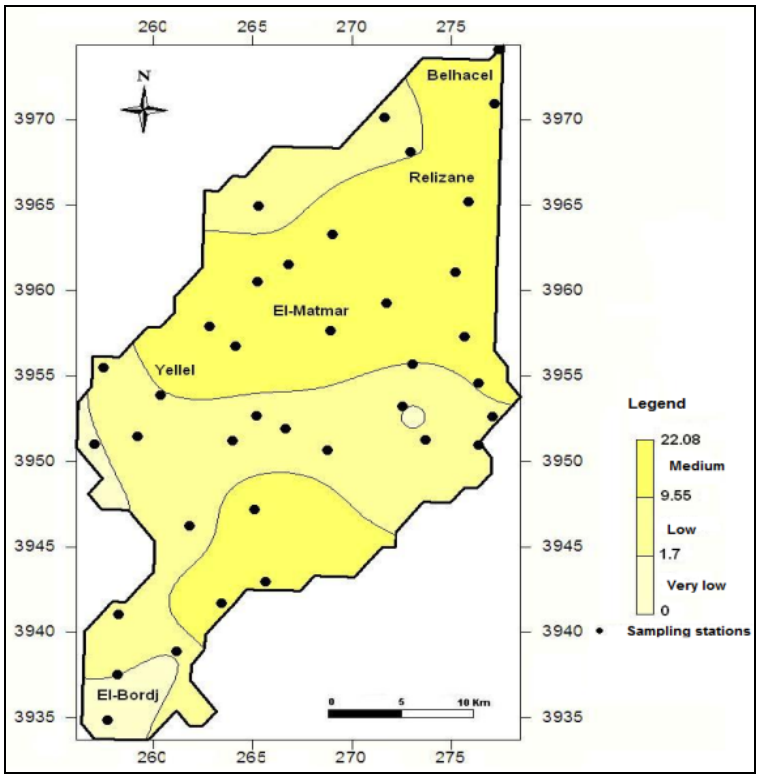

Fig. 5. The spatial distribution of $CaCO_3$ values in Wadi

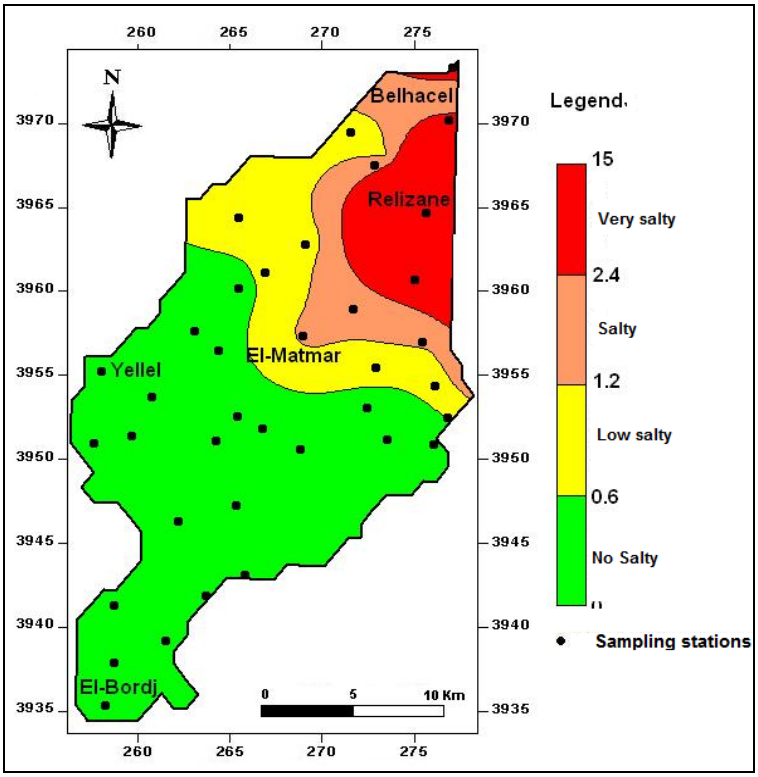

Fig. 6. Salinity map of the Yellel Wadi sub-watershed.watershed.Yellel

CONCLUSION

The study area (sub-watershed of yellel wadi) is facing a serious problem of soil degradation, as virtually the entire region of western algerian tell.

Given the complexity of the problem of land degradation and the number of parameters that contributes, we adopted a methodology based on the use of geographic information systems to scan, map and analyze data from the field study.

In addition, this work has allowed us to characterize the soils in the watershed and highlight the spatial distribution of some soil parameters (pH, OM, $CaCO_3$ and EC).

The results show that the study area has the following soils characteristics:

- Clayey and sandy clay;
- Neutral pH;
- Average to low organic matter levels;
- Moderately calcareous (10-25% $CaCO_3$);
- Salty in the northern part.

In fact, these results contribute to the study of the soil conditions in the Yellel Wadi watershed, to better know its physicochemical characteristics and to determine its hydro-agricultural potential. This will help to show the different constraints and propose solutions regarding the rational and sustainable exploitation.

The purpose is also to provide decision-makers with easily exploitable maps that provide clear and accurate information for the enhancement and development of the study area.

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