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Spatial evolution of morpho-pedological characters in Ziban soils

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Abstract:

The study area is located in Algeria's northern Sahara, in the Ziban region. The stations selected are defined on the basis of a well-established sequence, enabling us to highlight the main spatial lines of pedological evolution. We have established two sequences of soil which have different morphological characteristics. Soil samples were taken from downstream to upstream geomorphological levels. For each level studied, one representative soil profile is analyzed. The differences are mostly caused by the terrain's geomorphological position and favorable hydrological aspect in the first sequence, which favors the production of gypsum soils over the second.

On the basis of the data collected from the geomorphological and pedological studies, the main spatial lines of pedological evolution in our study area are distributed over distinct territories.

Key words. Ziban, Sahara, Geomorphology, gypsum soil, calcic soil.

Introduction

The climatic characteristics of Saharan regions result in a persistently dry period throughout the entire year. Flows, superficial (oueds) or hypodermic, are most often temporary. They reach areas of concentration which are the privileged places of saline manifestations in water and soil. The extreme environmental conditions of these regions pose significant constraints on soil formation processes. (Rognon, 1994)

The processes of valorisation of the grounds used, do not take into account all the factors (climatic, edaphic, hydrological etc.) which ensure and perpetuate this production. On the other hand, developing the land means above all taking into account all the factors cited above in order to assess the current capacities and meet the maximum requirements for increasing the intrinsic quality of the land and ensuring, in a sustainable manner, a yield qualitative and quantitative (Benadji, 1998).

The aim of our research is to define the links between the pedogenetic traits that can explain the distribution of soils within the same level and from a level to another, to conclude with a general synthesis that will take into account all the particularities that make up the complex structure of the Ziban.

The acceleration of agricultural development to meet immediate and urgent demands can have harmful long-term effects on soil reserves and groundwater resources region of Ziban one of the most productive agricultural where Palm-growing occupies an area of 42 thousand hectares, i.e., approximately 4.5 million palm trees, and greenhouses cover an area of around 25 thousand ha (DSA Biskra, 2020)

2. Materials and methods

2.1 Geography of the Ziban region

Biskra region is located in southeastern Algeria at 425 Km of the capital Algiers (Figure1).

It is bounded in the north by the Saharan Atlas, which represents a SW – NE directional relief.

It extends to the Chott Melghir area in the southeast and to the Eastern erg in the southwest.

Biskra region constitutes a transition zone between two different morpo-structural domains, the folded domains in the north and the flat and desert expanses of the Sahara in the south

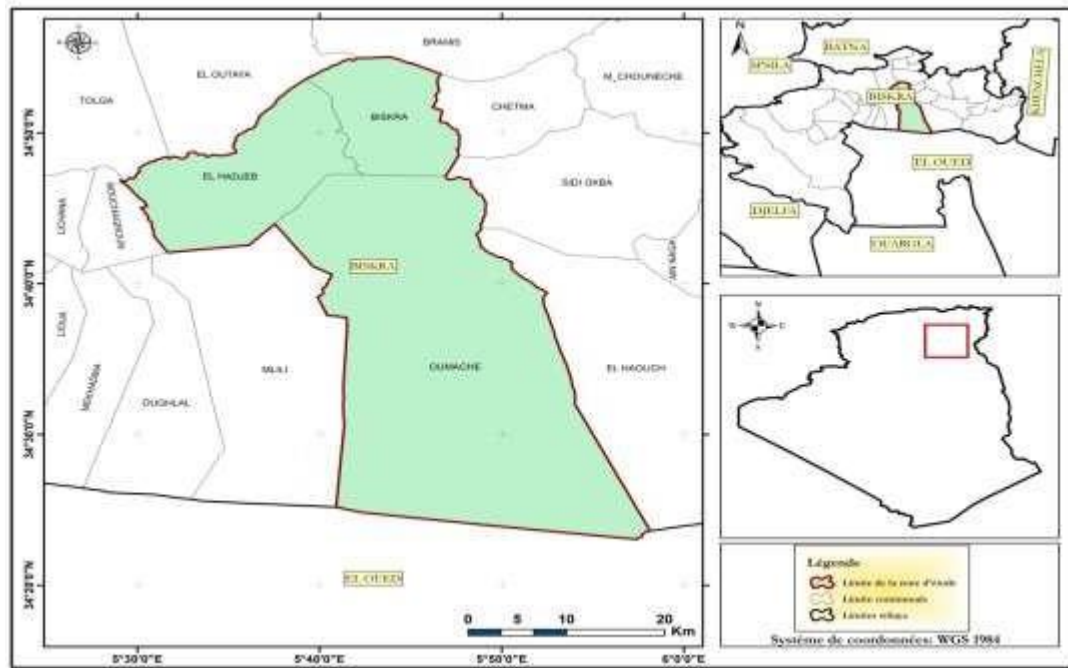


Figure 1 Geographical location of the study region

2.2 Geology and hydrogeology of the Ziban region

The Biskra region is part of the transition between the folded Atlas domain of the North (Saharan Atlas), and the flat and desert expanses of the Sahara. The latter characterized in particular by the very flat regions corresponding to the great western and eastern Erg, to the plateau of Mzab, Tadmait, Tinrheret as well as to the relatively depressed region of Gourara, Touat, Tridklet, south Tihert (Boumaraf, Bensaid, & Marre, 2014) (Figure 2). The northern part of the region is in the form of a chain, roughly oriented North-East - South-West of the Jura type and to the south, the Saharan plain is presented by a whole series of erosion glaze shaped by run off and where oases are located (Chebbah, 2007). The region is characterized by sedimentary terrains ranging from the Barremian at the base to the calcareo-gypsum Quaternary with sandy and clayey alluvium. It is an environment very marked by mechanical and water erosion. The hydrographic network is dense.

The Biskra region has several aquifer reservoirs that belong to the Quaternary, Miopliocene, Lower Eocene and Upper Senonian (Maastrichtian) and Albian (Bouziane & Labadi, 2009).

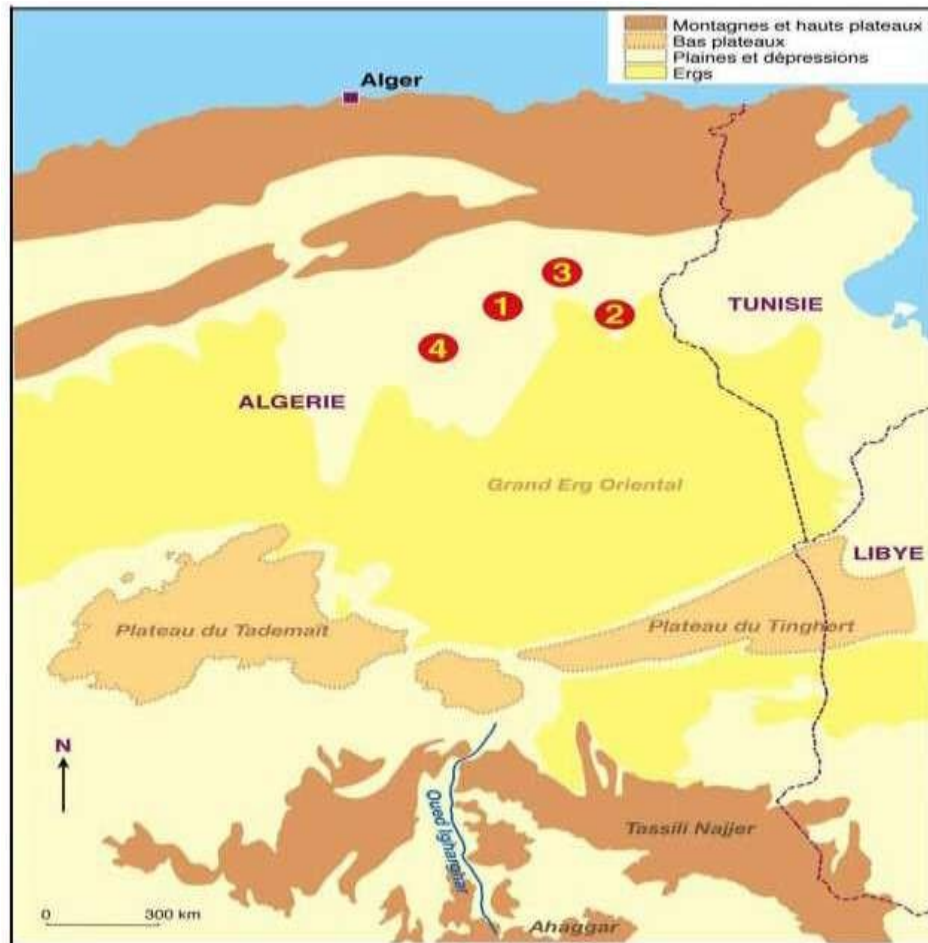


Figure 2 - Carte générale du Bas-Sahara. (Ballais, 2010)

1 : oued Rhir. 2 : oued Souf. 3 : Ziban. 4 : oued Mya.

GEOMORPHOLOGICAL MAPPING

The prospecting methods

After a general reconnaissance of the Biskra Valley, using basic documents (topographic, geological map and aerial images), it was in the southern part that we focused the field surveys, because it offered the bottom of the Chott Oumach, many forms of landscapes that contemplate a distribution of varied and multiple soil types (Boumaraf, Saadi, & Marre, 2016). The geomorphological study is based on systematic mapping (Gueremy & Marre, 1996; Marre, 2007; Boumaraf, Bensaid, & Marre, 2014; Boumaraf, Saadi, & Marre, 2016). It made it possible to show the existence of different morpho-pedological levels, from level zero the bottom of the Chott Oumache to the Ziban Mountains.

3. Results and discussion

The bottom of the sebkha of oumache the lower level A0

This level corresponds to the current settling pit with pseudogley soils., with an absolute absence of vegetation, it offers a remarkably flat topography. It is characterized by a carpet of white salt crystals, of different types (sulfate and chloride).



Figure 3. The Sebkha of oumache.(Laouar, 2023)

Level of chotte level lower A1

with a transition that is sometimes not very visible, an extremely short concavity, and where the density of halophilic plants in the form of nebkha become more numerous. It is located in a silt saturated with salts, and which marks the passage to the chott. It is characterized by silty-sandy soils sometimes dune it is a fringe of the sebkha.

The Medium Glaze A2

The surface of this level has a greater area than that of the neighboring levels. This level appears a few meters equipped with the previous one. It is presented as a glaciis with a greater extension towards the southwest, with a very slight slope. It is characterized by soils with gypsum accumulation, characterized by crusts and encrustations of gypsum at varying depths. Invaded by the nebkas, there are favorable conditions for their formation due to their proximity to groundwater (the water table) (Mostephaoui, Saker, & Bensaid, 2013) which is too salty and loaded with sulphates. This sheet varies between 0.80M and 1.5M depending on its piezometric position and the season. These chemical characteristics, particularly its content of soluble salts, are accentuated largely due to irrigation and the excessive use of chemical

fertilizers. The drainage water from the palm groves upstream and occasional floods are the principal sources of water table maintenance (Abdelhafid, Rechachi, & Halitim, 2019).

The Medium Glaze A3

This level appears to the northwest of the Oumache depression, towards the Aurès Mountains and the plain of the Faidjet El Hammam valley. It is characterized by alluvial-colluvial clay-silty soils with high total limestone content (from 30% to 45%). These are unstructured soils with a very diffuse transition between the underground horizons. Located on the foothills of the Aurès mountain range, our landscape is presented as an accumulation of glaçi entangled with the last level with pronounced erosion escarpments, sometimes giving rise to moors degraded in its upper part by more active watercourses. The surface appearance of this level presents characters of vertisms with very characteristic shrinkage slots.

The High Level A4 Glaze

It is an erosion glaze defined by certain inclined surfaces and others very sandy. The presence of sands on this level is due to the dominant wind current in this region and which blows from the Nod West to the South East. This flow of sands and gypseous dusts existed several times during the Upper Pleistocene and the Holocene. It is materialized by veneers of dunes and more or less indurated gypsum accumulations on the side of the Ziban reliefs. Deposits from arid periods alternate with deposits from wet periods (paleosols, alluvium).

A variable slope of 5% to 15% for the swallow with a reduced spatial extension, very variable compared to the previous level. The piedmont becomes slightly concave giving the appearance of a perched glacier. Hydrographic network and more pronounced downstream by ravines 20 to 40 cm deep, more pronounced downstream. On the surface, breccia is very regularly observed, probably developed on Miopliocene materials (Ballais, 2010).

The Very High Level A5

This layer is characterized by a vast glacier. These formations, which follow the contours of the topography, appear as encrustations. They are observed on surface debris in holes of various sizes and are covered by a thin layer of sandy, loose material, with xerophytic plants rarely exceeding 50 cm in height. This layer shows minimal signs of flow, reduced to a few centimeters of erosion. The upper crust consists of crumbly clods and nodules adhered to a harder gypsum-limestone layer, with a consolidated marl substrate at its base.



Figure4. The variation in glaze levels observed in Ziban region (Laouar, 2023)

Conclusion

All the factors that preside over the formation and evolution of soils induce a double differentiation in the vertical organization of the profiles and in their lateral distribution. By analyzing the variations of the analytical and morphological results obtained from the sebkha of Oumach towards Djebble Boughezal, it clearly appears to us that the landscape of the Biskra region is part of a region that evolves as part of the endorheic system. The evolution of the landscape of this region depends for the structural part on the conditions defined by the lithology and the tectonics and also on the systems of erosion subjected to paleoclimatic aspects inherited from the Quaternary, of which the crusts are the testimonies in the first section.

The series of soils located on the sequence going from the Djebel Bourehezal to the depression of Oumache, the sulphated layers, contribute to the accumulations of gypsum in the form of cuirasses and encrustations. This sequence is largely subject to the progressive accumulation of sulphates in the colluvial material, this is the domain of gypso-morphy. This precipitation results from the upward movements of the saline solutions of the water table very close to the surface (Bouselsal & Hakim, 2022). This aquifer is fed by rainfall, floods, diffuse flows, drainage water from agricultural activities in this region.

The formation of these soils is influenced by many factors: the gypsum-limestone material, the topographical position, and the presence of the water table. The topography plays a role in

differentiating between Calcids and Gypsids, while the presence of Aquisalids is closely linked to the water table.

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