Geogr. Fis. Dinam. Quat.,
16 (1993), 153-157, 2 figg., 1 tab.

SALVATORE MADRAU (*)

PRELIMINARY OBSERVATIONS ON THE PEDOLOGICAL CHARACTERISTICS OF AN AREA INSIDE THE FAIYÛM DEPRESSION IN EGYPT

Summary: MADRAU S., *Preliminary observations on the pedological characteristics of an area inside the Faiyûm depression in Egypt.* (IT ISSN 0391-9838, 1993).

The author has made a preliminary description of the soils in an area of the Faiyûm Depression (Egypt). The study shows that irrigation causes a progressive salification of the soils and the necessity of an more detailed study on their taxonomy and suitability for irrigation.

KEY WORDS: Soil, Faiyûm, Egypt.

Riassunto: MADRAU S., *Prime osservazioni sulle caratteristiche pedologiche di un'area sulla depressione del Faiyûm (Egitto).* (IT ISSN 0391-9838, 1993).

La depressione del Faiyûm rappresenta una delle aree di maggior interesse agricolo per l'Egitto. Nell'area in studio, limitata a nord dal lago Qârûn e che ha una superficie di circa 5000 ha, sono stati riconosciute tre unità di paesaggio. I tipi pedologici riscontrati sono stati attribuiti secondo la Legenda Fao-Unesco della Carta Mondiale dei Suoli a otto differenti unità di suolo, a loro volta ascritte a sette unità cartografiche.

Il plurimillenario ricorso all'irrigazione per soddisfare i fabbisogni idrici delle culture agrarie ha causato il progressivo accumulo di sali nelle acque di falda e nei suoli causandone una diminuzione della fertilità. I rilievi di campagna e i *field tests* eseguiti hanno evidenziato la necessità di raccogliere un maggior numero di dati analitici sia per verificare la tassonomia di alcuni tipi pedologici, sia per valutare la suscettibilità all'irrigazione di questi suoli in funzione della qualità delle acque disponibili.

TERMINI CHIAVE: Suoli, Faiyûm, Egitto.

INTRODUCTION

From the Summer of 1986 the author was working on the Faiyûm Pilot Project for Re-use of Drainage Water for Agriculture and had the opportunity to study the pedology of the Faiyûm Depression over a surface of about 5000 ha adjacent to the Birket Qârûn.

These notes, which have been based on observations in the field and often incomplete geological literature, give a short illustration of the pedological characteristics of the Faiyûm region, which has always been very important to Egyptian agriculture.

GEOGRAPHIC PICTURE AND GEOLOGICAL, MORPHOLOGICAL AND CLIMATIC CHARACTERISTICS OF THE AREA

The Faiyûm Depression is a strip of land on the N.E. of the Sahara (fig. 1), it is surrounded by small limestone, sandy limestone and marly limestone hills of the Oligocene, and it surrounds the Birket Qârûn Lake.

The surface of the lake is about 43 m below sea level, and it is 10 m at its deepest point. The present surface of this lake is about 200 sq Km.

During the Pliocene, the salt water from the Mediterranean Sea flowed into the Delta and the River Nile and it reached the Faiyûm Depression.

Hydraulic interventions of the Pharaons in the XIIth Dynasty, caused the natural canal between the Nile and the Faiyûm to be made deeper and wider. They also built dams, which lead to the formation of a new freshwater lake, which they called Moeris. It was more than 700 sq Km, and was used for thousands of years as a regulator of Nile flooding.

The geological substrate of the depression is made up of eolic olocenic sandstone covered by a series of partially terraced alluvial deposits, both old and recent. They are mixed with and covered by ancient and recent lacustrine deposits.

The Faiyûm Depression is surrounded by a series of small limestone, sandy limestone and marly limestone hills and its sides descend towards the lake in small terraces.

The two main irrigation canals, the Wadi Drain and the Batts drain (the latter outside the area), have excavated fluvial forms in the alluvial and lacustrine quaternary covering. Due to the reduced flow rate, these forms must be considered fossils.

(*) *Dipartimento di Ingegneria del Territorio, Facoltà di Agraria, Università di Sassari.*

This work is part of the Faiyûm Pilot Project and executed for the Project «Structural Geomorphology and Landscape evolution in Italy and in Mediterranean aereas» (Head: prof. P.R. Federici).

FIG. 1 - Localization of the Faiyûm depression.

The two big canals already metioned, and the dense network of irrigation and drainage canals connected to them, carry huge quantities of very fine suspended material towards the Birket Qârûn, gradually reducing its depth. These waters are subject to very strong evaporation and this, together with the very highly saline irrigation run-off water, has caused a gradual increase in salinity and that is why these lake waters, which were fresh in Herodot's time, are now salt. The area studied is of about 5000 sq ha ([1]), and is intensively cultivated. It is from 6 to 43 m below sea level, and is in form of an irregular triangle with the NW apex in the direction of the city of Qârûn.

The Birket Qârûn forms the northern boundary and to the east, there is the Wadi Drain (fig. 2). From SW to the NW there are a succession of canals: Bahr el Nazia, Bahr Misharrak and the Misharrak Drain.

Readings from the rainfall station at Schakschuk, a riverside village halfway between Auberge Faiyûm and the Wadi Drain, are available for a definition of the climatic characteristics of the area.

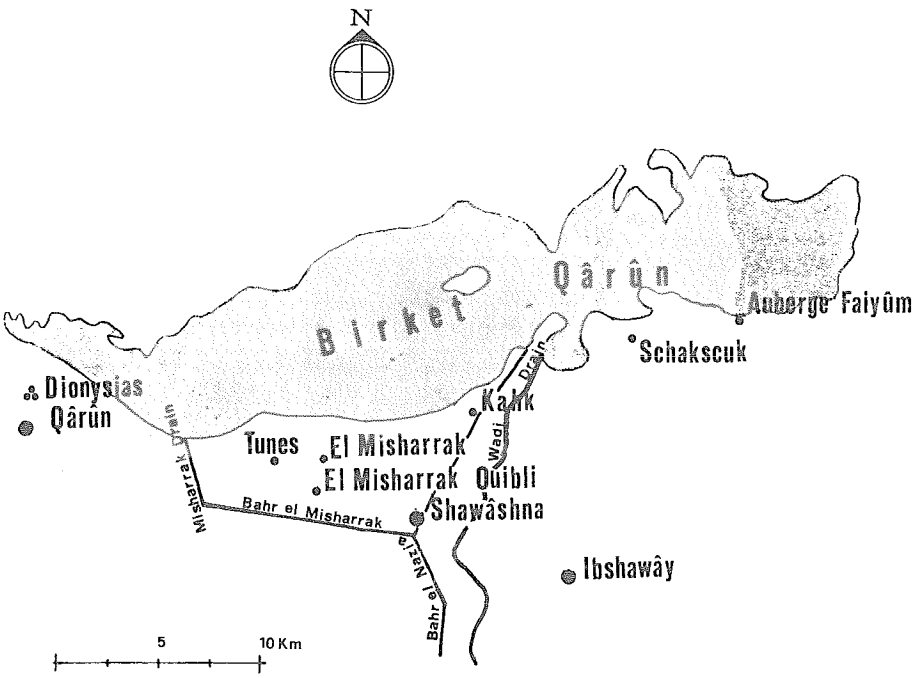

FIG. 2 - Sketch map of the study area.

These are readings for the years 1965-69 and 1979. Average monthly evapotranspiration calculations were made on the basis of these data, according to Thornthwaite and Mather, using NSM software (rel. 1991), of Cornell University.

([1]) The total land surface abscribed to Faiyûm is about 312000 ha of which a little less than 132000 ha are used for agriculture.

The soil water balance with AWC values of 100 and 200 mm was calculated using the same software, to take in to account its possible variations with regard to the texture, porosity and organic substances etc. of the soils.

The elaboration of the data from the rainfall station are as follows:

i- Hipothermic soil temperature regime (Soil Taxonomy, USDA, 1975).

TABLE 1 - Mean monthly rainfall, temperature and evapotranspiration at Schakschuk station for the years 1965 to 1969 and for 1979 (source Meteorological Dept. Cairo).

		J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall	mm	1.3	1.7	0.7	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.1
Temperature	°C	12.9	14.9	17.3	21.9	25.1	29.0	29.1	28.9	26.7	23.7	19.9	14.5	21.9
Evapotrans-piration	mm	19.1	26.6	46.3	88.6	137.9	180.3	184.9	171.4	139.1	99.6	58.2	25.3	1177.3

ii- Aridic soil humidity regime (Soil Taxonomy, USDA, 1975).

iii- number of cumulative days in which the moisture control section (MCS) is dry, - 365 days.

iv- number cumulative days in which the MCS is dry with soil temperature higher than 5 °C, - 365 days.

v- number of consecutive days in which the MCS is dry after summer solstice, - 120 days.

According to the authors of the NMS software, these climatic conditions can be classified as *extreme aridic.*

The Faiyûm Depression with its 132000 ha cultivated hectares is of fundamental importance to Egyptian agriculture, as it is the only large cultivable surface away from the narrow river band of the Nile and the Nile Delta.

The many villages, some of which have been occupied since the first Dynasties, bear witness to its intense utilization. Of these villages, Khak, El Shawashna, El Misharrak Quibli and Tunes are inside or near to the area being studied. Between the villages there as a continuous succession of little fields measuring up to 20 ares. They are all irrigated and produce crops all the year round. The main crops are cotton, maize, sugar cane, onions, garlic and medicinal plants. There are date palms everywhere and small, carefully tended gardens of citrus fruits and mangoes. There is hardly any mechanization and all the tilling operations and often the transport of water to the fields from the canals is carried out manually with the help of simple tools and animals.

Climatic data indicates quite clearly the impossibility of satisfying the water requirements of the crops, which grow only thanks to irrigation.

In 1986 it was estimated that about 2300 million cubic metres were taken from the Nile through the Bahr Youssef and Bahr Hassan Wassef canals, to the Faiyûm to satisfy an estimated annual requirement of 1400 million cubic metres.

The irrigation pratices carried out over thousands of years, have gradually rendered the groundwater found near the Birket Qârûn saline. The re-use of the refluent water for irrigation has caused in the soils in these areas to become even more saline with a progressive loss of their productive potential.

The local authorities are well aware of the problem and, since 1986, they have been seeking a solution through studies and interventions.

PEDOLOGICAL TYPES

The maps avalaible were limited to two at 1:25 000 scale, a cadastral map and topographical one.

As it was impossible to carry out a preliminary aerial photographic study, the survey began in the field.

Three fundamental types of landscape were found.

- limestone and sandy oligocenic limestone landscapes
- landscape with predominantly lacustric quaternary deposits
- landscapes with predominantly fluvial quaternary deposits.

Initially, observations were made using a hand auger, to discover the main pedological types, at the same time locating and marking the boundaries on the unit map in which the number of soil types present was reduced to a minimum.

After that, a sufficient number of profiles to describe all the main pedological types were taken. The pedological types were classified according to the FAO-UNESCO Soil Map of the World ([2]).

1 - Limestone and sandy oligocenic sandy-limestone substrate landscapes

- *map unit A: complex of Lithic and Eutric Leptosols.*

This unit be seen on high slopes between the village of Tunes and the Misharrak Drain, near the most western point of the area. The substrate is composed of limestone and oligocenic sandy-limestone.

The soil profile is A C with an average depth of less than 30 to 40 cm. Stony and rocky with richly textured tracts. The texture varies from loam to loamy clay. The structure is subangular blocky, fine and medium, moderate. The soils are subject to moderate to severe water erosion. They cannot be used for agriculture.

2 - Landscape with predominantly lacustric quaternary deposits

- *map unit B: Eutric Cambisols*

These surfaces can be seen on slight to moderate slopes and on substrate of very dark grey compact lacustric

([2]) These notes are based on the revised Legend (1988).

deposits, which are sometimes mixed with fine or medium sandy alluvial deposits a few centimetres wide.

The soil profile is A Bw C, with a depth of 60-100 cm. It is almost uniformly moist and dark greyish-brown (10 YR 4/2), throughout the profile. The rocks and mineral fragments are few and minute. The texture is silty clay or varies from silty clay to clay. The structure is subangular blocky, medium, strong. There is marked effervescence.

Near the edge of the lake, from 60 to 80 cm, these soils often have a ground water table. They are also intensively farmed.

- *map unit C: Vertic Calcaric Cambisols*

This unit was seen on slight or medium slopes in non-continuous tracts of small terraces. The substrate is chiefly dark grey lacustric deposits.

The soil has an A Bw C profile, 60 to 70 cm deep. When moist it is very dark greyish-brown (10 YR 4/2), and more or less uniform. There are no rocks or mineral fragments. The texture is silty clay or varies from silty clay to clay. The A horizon structure is prismatic, coarse and strong. The A horizon and part of Bw horizon have cracks which are wide, but do not exceed 40 cm in depth. On the soil surface there is an abundance of self-mulching and on the ped faces there are very slight slickensides and pressure faces. On the Bw horizon, small, very fine, whitish secondary carbonate in soft powdery forms, can be seen. There is marked effervescence. A ground water table is present at a depth which varies, according to the distance from the edge of the lake or from the irrigation canals and which, in any, is case never less than 50 cm. It is also intensively farmed.

It should be underlined that the vertic properties can be seen only on surfaces which are resting between crops or which have not been worked or irrigated for some time.

- *map unit D: Haplic Solonchaks* ([3])

This map unit can be seen generally on narrow surfaces. The surfaces are flattened or slightly depressed an drains poorly to imperfectly. They are spread irregularly in the previous unit. The soils differ from the Eutric Cambisols in that they have a saline crust several centimetres thick, which is often accompanied by a whitish non effervescent saline efflorescence at the bottom. The A horizon structure is friable when moist and very hard when dry. In the Bw horizon there may be black or bluish mottles a few centimetres thick. The ground water table starts at about 60 cm.

These surfaces cannot be used for agriculture.

- *map unit E: Calcaric Regosols*

This is on moderate slopes with substrates of medium to coarse sandy deposits.

The soils have an A Bw C profile with an average depth of 60 cm. The colour varies from yellowish brown (10 YR 5/4 or 10 YR 5/6), to greyish brown (10 YR 5/2). There are no rocks or mineral fragments. The structure is subangular blocky, medium, weak to structureless. There is marked effervescence. A ground water table or bluish, greyish, or dark mottles can be seen at 50 to 60 cm. They are also intensively farmed.

3 - Landscape with predominantly fluvial quaternary deposits

- *map unit F: Calcaric Fluvisols*

This can be seen on flat land with very fine alluvial deposits, having very slow drainage and distributed along the sides and the mouth of the Wadi Drain.

The soil profiles are A C or A C 2A 2C, often deeper than 100 cm. It is greyish brown (10 YR 4/2) and more or les uniform throughout the profile. There are very few rocks and mineral fragments. The texture varies from sandy clay to clay silt. The structure is subangular blocky, medium and moderate to strong. There is a marked effervescence.

There is a C horizon locally which is about 50 cm deep and made up of very fine sand. Under this there is a very dark greyish brown (10 YR 4/2), fine textured 2A horizon (profile A C 2A 2C). The nearness to the edge of the lake and the presence of ground water which is definitely more salty than that in the previous unit, puts severe restrictions on its use for agricultural purposes.

- *map unit G: Salic Fluvisols*

This soil, which has an A C profile, can be seen on slightly depressed and weakly drained surfaces near the edge of the lake or at the mouth of the Wadi Drain on medium to fine alluvial deposits.

The soils are similar to the Calcaric Fluvisols. However they differ from them because they have a medium to coarse sandy texture, a structure that is very weak or non existent, and an ever present salt bearing stratum from a depth of about 50 cm, which has an abundance of black and grey mottles.

Immediately above the ground water table or the mottles there is non effervescent whithish efflorescence.

These soils are not used for agriculture.

CONCLUSIONS

Knowledge of every aspect of the soils is very important for the correct management of land. As the quality and not the quantity of available water is the main limiting factor, it would be desirable to have an evaluation of the possibilities of irrigating the soils in the area in order to be able to crop them. Evaluation of the saline content of the water used would also be useful. Should there be any carbonates, chlorides or sulphates present in the soil it would be advisable to analyse them in order to be able to carry out correct pratical conditioning.

([3]) These soils and those of unit G have a salinity level exceeding 4 mmhos/cm. I have assign they at the Haplic Solonchaks and the Salic Fluvisols respectevely because in the field it was not possible to determine the amount of Na^+ saturation in the CSC, which is a fundamental requisite for recognizing natric horizon.

From the taxonomic point of view it would be useful if the results of the field tests which have lead us to attribute some pedological types tentatively to the Haplic Solonchaks and the Salic Fluvisols, were supported by freh analisys to either confirm this classification or to attribute them the Solonetz.

BIBLIOGRAFIA

FAIYÛM PILOT PROJECT FOR RE-USE OF DRAINAGE WATER FOR AGRICOLTURE (1986) - *Note e considerazioni sulle caratteristiche, geologiche, idrogeologiche e agronomiche dell'area in studio*. Draft ed.

FAO, UNESCO (1975) - *Soil Map of the World, Vol. 1 Legend*. Unesco, Paris.

FAO, UNESCO (1976) - *Soil Map of the World, Vol. VI Africa*. Unesco, Paris.

FAO, UNESCO, INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE (1988) - *Soil Map of the World. Revised legend.* World Soil Resurces report n. 60, Roma.

FAO and INTERNATIONAL SOIL REFERENCE, UNESCO, INFORMATION CENTRE (1990) - *Guideliness for soil profile description.* 3rd ed. Roma.

SOIL SURVEY STAFF. SOIL CONSERVATION SERVICE U.S.D.A. (1975) - *Soil Taxonomy. A basic system of soil classification for making and interpreting soil surveys.* Agriculture Handbook n. 436, US Gov. Print Off., Washington D.C.

THORTHWAITE C.W. & MATHER J.R. (1957) - *Instructions and tables for computing potential evapotraspiration and water balance.* Centerton.