GEOPHYSICAL CHARACTERIZATION OF MEDITERRANEAN SOILS IN A TUNISIAN HILL RESERVOIR SYSTEM

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Introduction

Water scarcity, owing to low and erratic rainfall, always posed problems to farmers and herders. In the last century, worldwide population has tremendously grown increasing the pressure on water resources. To secure water supply and intensify agricultural production, water harvesting are traditionally used under varying rainfall rates and population densities. In Tunisia, the Government has undertaken since the early 1990's the implementation of the "National Strategy of Surface Runoff Mobilisation" which aims at building numerous large dams, small earth dams and other works for irrigation and water table recharge (1). For some reservoirs, the water balance is highly negative and suggests a water loss by infiltration leading to a reservoir leakage and an alluvial aquifer recharge.

Based on a geochemical approach, a recent study permits the determination of the groundwater inflow and outflow rates (2, 3). However, for modelling the groundwater pathways, there is a lack of knowledge in the structural pattern of the weathering formations. The goal of our study consists in using the geophysical approach to characterise the soil and subsoil structures in the vicinity of an infiltrated reservoir.

Study site

The El Gouazine watershed (35°55'N - 9°45'E) is about 50 km north-west of the city of Kairouan. A steppic vegetation and rain fed cereals cover the 18.1 km2 watershed area. The mean annual rainfall is 339 mm (estimated from 1994 to 1998) and class-A pan evaporation is in order of 1,775 mm yr^{-1} during the 1996-1998 period.

The El Gouazine watershed resides at the east boundary of the SW-NE orientated Ousseltia syncline. Pedological formations developed on the Tertiary sedimentary deposit (marly calcareous and gritty deposits), highly raised by tectonic movements in the eastern part of the watershed with a south-eastern and nearly vertical dip.

Most soils are highly calcareous and clayey and locally calcreted. On the hillslope, colluvium is found with a high stone content. The main soils include calcrete calcisols and Calcaric Camisoles. Camisoles are mainly formed from marl deposits and locally from limy sandstone deposits.

Materials and Methods

Applied geophysics is a useful tool for preserving the structure and the functioning of soils, and providing a spatialized and well sampled information. Based on surface measurements using a current

injection, the principle is to determine the physical properties of a soil volume, and the vertical and horizontal variations.

Along three toposequences (T1, T2 and T4) located in the vicinity of the El Gouazine reservoir, 12 1-D soundings were performed using a Wenner array. On each site, 14 apparent resistivity measurements (ρ_a, in Ω m) were recorded from the subsurface to the nearly 7.5 m depth using an electrode spacing ranging from 0.2 m to 10 m. An inversion model transformed the ρ_a values in terms of soil thickness. The 1-D geophysical method was constrained by field observations (pits, groundwater level) and soil analysis.

To determine the ρ_a variation along the toposequence, an electromagnetic survey was carried out using the EM-31 and EM-38 devices with a 10 m measurement spacing.

Results

The marly formations are more conductive in depth and are covered by resistant structures, either a sandy layer for the T4 sequence (Figure 1), or a calcareous deposit for the T2 sequence (partly or totally encrusted colluvium).

For the T4 sequence, the lowest ρ_a values in depth are attributed to the effective presence of a groundwater flowing throughout the sandy soil which was formed by sandstone weathering. This aquifer crossing the reservoir sediments and the dam base joins the alluvial aquifer and partly explains the reservoir infiltration.

Conclusion

The 1-D geophysical method provides accurate structural data completing the hydrological and geochemical data sets and defining a more precise model of the reservoir functioning. However, the discretized and insufficient measurements along the toposequence does not allow a lateral interpolation and recent geophysical methods, such as the 2-D imaging approach, could be provided a more spatialized information of the vertical formation structure. Applied geophysics could be extended to the other infiltrating hydrosystem encountered in the Tunisian water management project.

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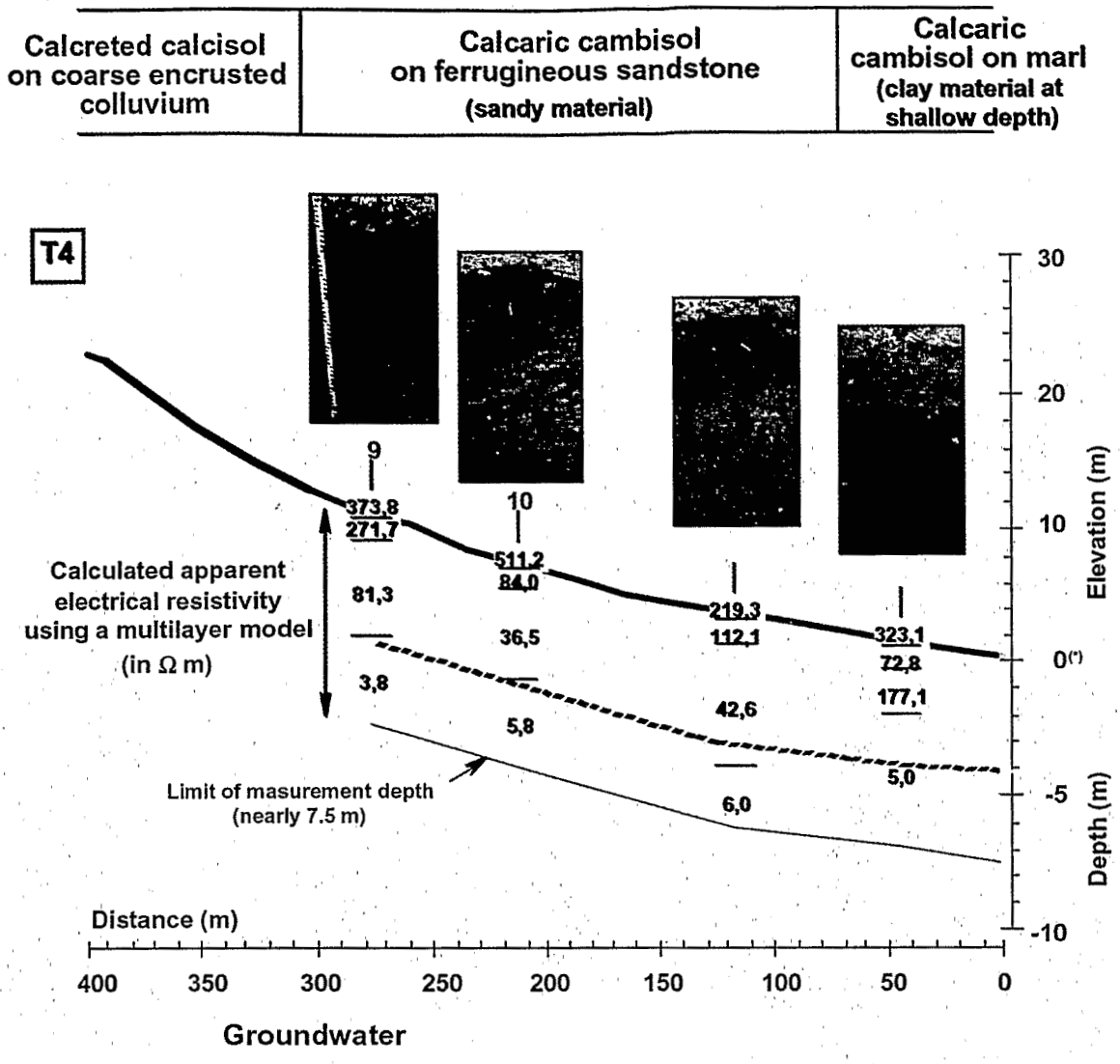

Figure 1

Soil apparent electrical resistivity along a toposequence in the vicinity of the El Gouazine hill reservoir.

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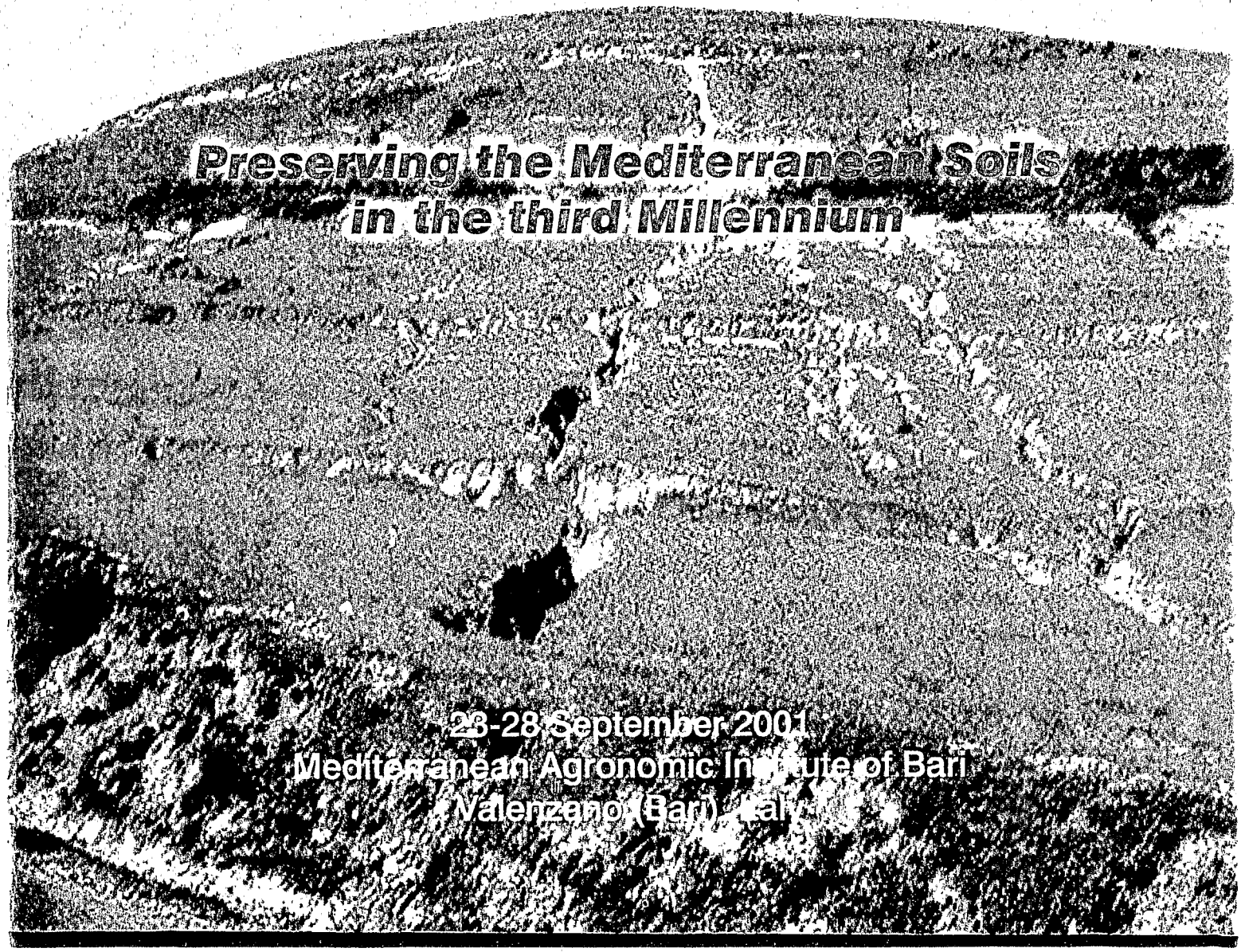
EXTENDED ABSTRACTS

7th INTERNATIONAL MEETING ON SOIL WITH MEDITERRANEAN TYPE OF CLIMATE



EXTENDED ABSTRACTS

7th International Meeting on Soils with Mediterranean Type of Climate

Preserving the Mediterranean Soils in the third Millennium

23-28 September 2001

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INTRODUCTION

On behalf of the Organising and International Scientific Committees along with the International Working Group on Sols with Mediterranean Type of Climate (WGSMTC), we are very pleased with your participation to the 7th Meeting, this time in Valenzano, Bari, Italy. It gives us a great pleasure to see so many of you coming from different parts of the world with a common goal to exchange ideas on the subject matter. We are extremely grateful for the Staff Members of the Mediterranean Agronomic Institute for their acceptance and the sacrifice to organise this meeting in a wonderful atmosphere. Italy is in the centre of the Mediterranean region and Italian scientists have made important contributions for our understanding of the soil development, use and management under Mediterranean climate in the past and present time. In addition to other duties, the Institute is also serving as the centre to educate young scientists from Mediterranean countries with common goals for better co-operations among the nations.

The Mediterranean region has extremely diversified environment, climate, geomorphology, soils, and agro-ecological zones. The typical red colour of many soils has attracted the attention of many scientists around the world for a long time, which continue to fascinate our attention even today. Vegetation and biota are strongly correlated with soil characteristics. Historical long-term use and widespread deforestation have influenced the soil evolution and quality. Special patterns of soil erosion and land degradation have created unique opportunities, to deal with their sustainable use and management. Soil use on sloping lands has been a challenge and will continue to be a matter of concern for farmers and policy makers.

Forestation and crop diversification is now a widespread exercise. Fertilisation and irrigation are practised on high quality soils and these practices have changed the characteristics of the soils considerably. A new challenge has emerged after the introduction of pesticides and organic amendments. Soil pollution is an important issue for the sustainable use and management of the soils. The new issues, such as soil quality, conservation tillage, crop diversification, carbon cycle, sequestration, and restoration of degraded and polluted lands are now the new challenges for today and perhaps many centuries to come.

This is the 5th meeting in a row, since the establishment of the International Working Group in Adana, Turkey and the 7th of its kind after the last one held in Spain. Surely we are making progress, perhaps the greatest of all is to bring scientists every two years to discuss our common goals. We are extremely pleased to notice the presence of so many scientists in this meeting. The interest is growing and will continue to grow. We are all very pleased to see the great success continuing here in Italy. The diversity of the subject matters is likely setting new goals and strategies for the future meetings. We want to express our sincere appreciation and thanks for your participation and contribution to this meeting.

A. R. Mermut
Chairman, International Working Group
WGSMTC

TOPICS, GOALS AND PURPOSES OF THE MEETING

The main theme of the 7th IMSMTC is "Preserving the Mediterranean Soils in the third Millennium". Within this context, it is necessary to continue efforts for better understanding the interacting soil ecosystem of the Mediterranean environment. This requires providing many better and scientifically proven answers to the extreme diversity of these soils: their formation, relation to parent material, effects of past and present climate, biota, and human influence. Moreover, preserving these soils now has become a priority as land degradation and desertification continuously threatens them.

Main topics:

- Soil ecosystem;
- Organic fertilisation and organic agriculture;
- Soil quality indicators;
- Mediterranean soils use and management;
- Soil genesis, classification and cartography;
- Soil fertility and plant nutrition;
- Soil degradation and conservation;
- Soil physics;
- Soil pollution and environmental protection.

Purposes and the goals of the Meeting:

- Bring together scientists from different parts of the world;
- Communicate research results and new developments;
- Strengthen existing contacts and create the necessary condition for further co-operation;
- Networking;
- Encourage close collaboration;
- Increase public awareness on soils and their impact on the quality of environment and human life;
- Cope with new challenges for sustainable use of soil resources.

MEETING OUTLINE

Session 1: ***Opening ceremony***
Session 2: ***Soil quality indicators in Mediterranean environments***
Session 3: ***Soil pollution and environmental protection***
Session 4: ***Mediterranean soils use and management***
Session 5: ***Soil genesis, classification and cartography***
Session 6: ***Soil fertility and plant nutrition***
Session 7: ***Soil degradation and conservation***
Session 8: ***Soil management and agronomy***
Session 9: ***Soil activities in the Apulia Region***
Session 10: ***Organic fertilisation and organic farming in the Mediterranean***
Session 11: ***Closing ceremony***