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Taxonomic and environmental implication of pedotechnique in large scale farming

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ABSTRACT

Human activities that involve deep modifications of the soils and a substantial deterioration of their features are numerous and very diverse. Such activities are considered as pedotechniques and, in large-scale farming, are used only under the boost of significant economic returns. In these last decades, the pedotechniques used to tailor soils suitable for table vine cultivation in the Acate valley (Sicily, Italy), not only led to objective difficulties in the classification of these deeply transformed soils but also, to several environmental hazards. In this work after considering the pedotechniques used in tailoring suitable soil for table vine cultivation, we propose to introduce Anthrosols as a new taxonomic soil Order in Soil Taxonomy stressing that a correct soil classification of these deeply modified soils allow for a correct understanding of their features and of the environmental hazards that their management could originate.

1. Introduction

Man, traditionally jealous keeper of soil's capability in supplying goods and services, in recent years has acquired an increasingly importance as a pedogenetic factor (Dudal, 2004). His influence on soils has become so effective and intense that in many systems of soil classification the need to introduce a new group of soils was felt. These are Anthrosols (CSTC, 2001; IUSS Working Group WRB, 2015) o Anthroposols (AFES, 1995; Isbell, 1996; Florea & Munteanu, 2000), o Antropozem (Němeček, 2001) o Anthropic soils (Hewitt, 1998). Human activities that involve deep modifications of the soils and a substantial deterioration of their features are numerous and very diverse. Some of these are very showy and occur for instance during the construction of structure and infrastructure. Others, less flashy but equally dangerous for pedodiversity conservation (Lo Papa, Palermo, & Dazzi, 2011; Lo Papa & Dazzi, 2013) and for the environmental resources safeguard, concern the creation of soil in burying wastes from various origins and nature, as happened along the slopes of Vesuvius (C. Buondonno, personal communication) in Italy.

Pedotechnique, is a term introduced in soil science in the 1980s (Fanning & Fanning, 1989), to indicate human activities affecting soil formation and soilscapes morphology. Pedotechnique can be considered as a new interdisciplinary branch of soil science, which tries to understand and integrate the effect of soil handling on the soil qualities (Van Ouwerkerk & Koolen, 1988) and classification (Dazzi, Lo Papa, & Palermo, 2009).

Man's activities in pedotechnique may vary widely. For instance in the selection and evaluation of suitable materials for "building soils" suitable for specific purposes, such as in the field of agronomy or for waste disposal, or in mining operations, in the artefacts production, etc.

Over time, the concept of pedotecnique was extended to all those human actions that link the soil to social, industrial and economic activities. In the 1990s, concepts and methods of pedotechnique were expanded (Fitzpatrick, 2009) to:

- environmental systems (desertification, soil and water quality, animal and human health);
- industrial systems (mines, quarries, new settlements);
- forensic system (the fight against crime and terrorism);
- conflictual systems (military operations, reclamation of minefields); and
- social systems (telecommunications, sports facilities, recreational areas).

In few words, pedotechnique methods were expanded to most of the human activities carried out with the soil or on the soil that, unfortunately, continues to be considered as a crypto-resource.

In agricultural management, pedotechnique is used only after the boost of significant economic returns, but in so doing, farmers often do not take into account a very important aim: i.e. satisfying

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human needs avoiding any undesirable environmental threat that might occur during the handling of earthy materials. Following such premises, in this work we wish to stress two particular aspects concerning the application of pedotechnique in large-scale farming for vine cultivation in Southern Italy: in particular: (i) those linked to the classification of these deeply disturbed soils and (ii) those linked to the environmental implications.

2. Study area

The study area we considered is located in the Acate river valley, in southeast Sicily, Italy (Fig. 1). Climate is Mediterranean, with maximum average monthly temperatures in August (25–26 °C) and minimum average monthly temperatures in January (10–11 °C). Average annual rainfall is around 450 mm. From a morphological point of view, the landscape is characterized by a gentle hilly morphology. Rock outcrops, dating back to Pleistocene and Holocene. They, consist of clay and sandy-clays, fossiliferous yellowish sandstones, fine quartzitic sands, weakly cemented sands, lacustrine and fluvial deposits and marly limestones. These environmental characteristics allowed for the development of soils with different evolution (Entisols, Inceptisols, Vertisols, Alfisols and Mollisols), but at present, most of them show anthropogenic features.

In this area during the late 1970's, vineyards spread copiously. Such huge land use change (Lo Papa et al., 2011) has allowed not only a significant increase in per capita income (up to 400% according to Lo Verde and Italian (1995)) and the almost complete disappearance of unemployment but, give rise also to several environmental hazards that, till now did not shown their dangerousness.

3. Materials and methods

To highlight pedotechniques used to tailor soils suitable for table vine cultivation in the Acate valley, we must premise that the motivating factor determining a huge land use change in the study area, was the farmers' certainty that high contents of calcium carbonate in soils increase the quality of the table vine.

Maps of land use change (from 1955 to 2010) (Lo Papa et al., 2011) highlighted:

1. that arable lands completely disappeared at the end of 1990s;
2. a huge development of trellis system vineyards at the beginning of 2000s;
3. a continuous increase in urbanized areas, reservoirs and artificial lakes; and
4. the huge decrease of woodlands and semi-natural areas.

Using former soil surveys and aerial photo interpretation, we had the possibility to survey the soils in two adjacent fields: a never cultivated field suitable as test area to survey the natural soils and a nearby area to survey the anthropic soils.

4. The pedotechnique used

Original soils showed A–C or A-Bw-C horizons in the profile; a loamy texture (clay content between 16.5% and 38.5%); a sub-angular blocky structure; $pH_{(1:5\ soil/water)}$ values range between 7.5 and 7.9. The amount of total carbonates in the soil solum ranges between 1.6% and 51%. Active carbonates (from 0.7% to 17.7%) and organic carbon (from 0.5% to 1.0%) in general decrease with depth. Interpretation of aerial photos and interviews from landowners indicate that the first intervention for planting trellis system vineyards on these soils was made in 1982 and consisted in ploughing them (about 90–100 cm depth) with a mouldboard one furrow plough, which provided complete overturning and deep stirring up of the soil horizons. After a first cultivation cycle, vineyards were explanted and the field surface was covered with a 50–70 cm layer of marly limestone, i.e. a soft rock made up of limestone and clay (approx. 70% and 30%, respectively). The surface moulding aimed at making a gentler slope and at increasing the amount of carbonates in the soils that as previously outlined, have a positive effect on the quality of the fruits because (R. Di Lorenzo, personal communication) of increase in both the crunchiness of the grapes (the vineyards are used to produce table grapes) and the soil albedo (with positive effects on the content of sugar in the fruits). After one year, the soils covered with the marly limestone (Human Transported Material – HTM) layer, were ploughed up to a depth of 100 cm with a mouldboard one-furrow plough, obtaining soils whose most striking feature is a double sequence of horizons at an oblique angle to the soil surface (Fig. 2a–c). Regarding the features of these soils, it should be noted that they show an anthropogenically disturbed deep profile (Fig. 2) with a loam to clay-loam texture and a fine and medium subangular and angular blocky structure. Furthermore the colour of the topsoil is consistently very light (from light grey, 10YR 7/2 to white, 2.5Y 8/2); the amount of carbonates, both total (from 41.5%

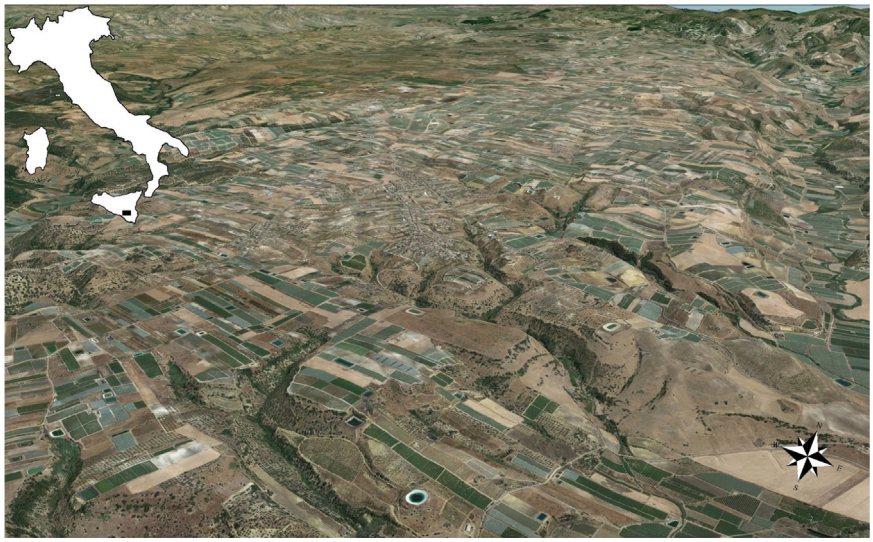

Fig. 1. 3D Satellite image of the Acate valley (29/07/2013). Vineyards fields are clearly visible.