Preface

Soil fulfills basic functions for the human society, not only concretely, by providing goods and materials, but also abstractly, by stimulating intellective activity and spiritual wellbeing.

In ancient societies the soil has always had a privileged position, by virtue of its fundamental role of providing foodstuffs. It helped in modeling the lifestyle and way of thinking of these societies. Even today, in various parts of the world, social systems reflect the conditions of soil and environment. The management of soil fertility is still at the heart of this relationship.

Recognition of these functions emerges from the etymological ties between soil and man. In old Hebrew "*adamat*", soil, comes from the same root as "*Adam*", the first man. The same metaphor echoes in the Latin name of the man, "*homo*" which derives from humus, one of the most important soil constituent. Therefore, no wonder that since ancient times, and in all civilizations, man has often attributed a supernatural dimension to the soil, in an attempt to develop a form of knowledge of the life and to explain the world that surrounds him. In the long history of man, when first religions were dominant, soil was conceptualized as part of a world controlled by powerful and invisible entities, being stewards of intangible quality, and became a subject of religious deference and ritual practices, in particular to ensure and continue the fertility.

Passing to the age of "Anthropocene", man has completely forgotten the ancient bond that tie him to the soil, and turning from "*Homo sapiens*" to "*Homo technologicus*" never stops to reflect on how much his wellbeing and the quality of his life are fundamentally linked to the quality of the soil. And today, as never before, maintaining the quality of the soil is a critical objective for sustainable development. Unfortunately, as soil is a crypto resource, only few laypeople recognize its importance in the biosphere equilibrium and, wretchedly, seldom consider it among the environmental resources!

This volume belongs to an international series of books aiming at spreading the knowledge on soils of different European and extra-European Countries. Its ambitious goals are to establish a broad base for the knowledge of the soils of Italy, and to give useful information on (i) their characteristics, diffusion, and fertility, (ii) the main threats whose they are subjected, and (iii) the future scenarios of the relationships between soil science and other disciplines, not traditionally linked to the world of agriculture, such as urban development, medicine, economics, sociology, and archeology. The writing of this book was attended by numerous experts from several Italian universities and research centers, which have taken on the responsibility of editing the various chapters.

A specific characteristic of this book is that it collects scripts of both mature and young soil scientists, who contributed in a decisive way to render the text up-to-date and, hopefully, attractive. A special mention must be given to the information provided by Prof. Fiorenzo Mancini, father of the modern Italian pedology, which was picked up by Costanza Calzolari in Chap. 1 "Research in Pedology: A Historical Perspective". The chapter is a comprehensive history of the pedological research in Italy, spanning more than a century, from the first steps out of agrochemistry and geology to the first complete soil map of Italy, dated on 1928. At that time, the map was based on the geological map published in the late nineteenth century. Further, milestones were the soil map of Italy made by Paolo Principi in 1953 and the soil map published in 1966 by a national committee led by Fiorenzo Mancini. This time the mapping unit limits were based on geomorphology. The chapter also surveys the promising diffusion of pedology in the second half of the last century, fostered by applications in different agricultural and environmental fields, as well as by the setting of some regional soil bureaux. The birth and life of the current three soil societies and associations present in Italy are finally depicted, with the conclusion that a stronger and official coordination could be beneficial for Italian pedology and soil science in general.

In Chap. 2 , the role played by the factors of soil formation in Italy is examined by different authors. Edoardo Costantini, Maria Fantappié, and Giovanni L'Abate explore the potential strong influence of climate on soil nature and distribution. In spite of being placed in the middle of the temperate zone of the boreal hemisphere, the elongated shape of the Italian peninsula, stretching along 11 parallels in the middle of the Mediterranean sea, and the presence of two morphological barriers, the Alps and the Apennines, cause great local climatic variations, to an extent that they are much more important than means. In fact, long-term mean annual air temperature for the whole country is 12.6 °C and total annual precipitation 932.5 mm, but the differences between minima and maxima span 30 °C and 1,800 mm, respectively. Actually, in Italy there are 14 of the 35 climatic regions occurring in Europe. A general climatic change occurred in Italy in the period 1961–2000, with a general reduction of the mean annual precipitations, the number of rainy days, and a general increase of the mean air temperatures. The climate change had some influence on soil organic carbon variations, especially in the meadows and arable lands located in areas where a moderate or high decrease of the mean total annual precipitation value (<-100 mm) and a moderate to high increase of mean air temperature (>0.62 °C) occurred.

In Chap. 3, Claudio Bini concentrates on the main geological and morphological features of Italy, with the aim to examine the role of parent rocks and landforms in soil genesis and evolution. Italy is a geologically young land, with contrasting relief energy and a great variety of lithological types and landscapes. In the western and central part of the Alpine region, crystalline rocks prevail over sedimentary ones (mainly limestone and dolostone), which are widespread in the eastern part. Sedimentary detrital rocks are widespread in the preAlpine fringe, on gently undulating slopes; scarcely developed soils form at these sites. Alluvial soils form in the Po plain and in main river valleys, in strict correlation to corresponding landforms: Luvisols on terraces and high plains, Cambisols and Fluvisols in the low plains, with Gleysols in depressed areas. Three main domains may be recognized in the peninsular Italy: Northern Apennine with large sandstone outcrops, Central Apennine dominated by calcareous formations, and Southern Apennine with prevailing clayey flysch formations. Widespread water and mass erosion rejuvenate soils of these landscapes. Luvisols (*Terra rossa*) from limestone and Umbrisols or Cambisols from granite rocks are the typical soils of Apulia and Calabria, respectively. Peculiar soilscapes are related to particular lithotypes such as ophiolite and volcanic rocks, which outcrop disseminated in various parts of the peninsula, the former with general steep slopes and thin soils and the latter with andic properties. Besides actual Andosols, volcanic materials spread off over the land may contribute to form soils with some andic properties, not sufficient to meet criteria for Andosols, but able to affect significantly soil chemistry and hydrology and, in turn, soil fertility and landslide risk.

Andrea Giordano discusses in Chap. 4, "Vegetation and Land Use", the importance of Italian vegetation in soil formation. Without the human intervention Italy would have been almost everywhere covered by forests, but the course of the very old Italian civilization has greatly changed the original natural vegetation. Currently, one-third of Italy is covered by forest, but the original forest is reduced to some thousands of protected hectares, while the rest is made of secondary, semi-natural, or artificial forests. Since soils have been often influenced by ecological conditions different from the actual ones, they are frequently not in accordance with the vegetation. Nevertheless, in certain cases the vegetation influence on soil is so determinant that soils formed under the same vegetation canopy, but on different lithology, show similar humus forms and superficial horizons, while the deep horizons are different. Forest surfaces are increasing everywhere in Italy, and this is mainly due to the abandonment of marginal agricultural lands, but also to afforestation and reforestation projects. In the present time, reforestation is mainly carried out using mixing conifers and broadleaves, to minimize the risk of fire and avoid soil acidification induced by the use of conifers alone. Coppices largely spread on the Italian mountains are in many places converted to high stands. The recent institution of new natural parks (national and regional) has created the premises for a pedogenesis more in equilibrium with the environment. In agricultural lands, the traditional land uses were for centuries connected with the original soil fertility or with the reconstitution of fertility by means of biomass returns to soil, but nowadays agricultural husbandry does not compensate the losses of organic matter suffered by soils, rather the large use of industrial fertilizers contributes to soil organic matter depletion.

In Chap. 5, Stefano Carnicelli and Edoardo A. C. Costantini examine time as a soil-forming factor in Italy. In most of the country, soil formation never stopped in the last millions of years, while at the same time undergoing constant, and often major, changes in soil-forming factors. This makes Italian soils a huge, and mostly as yet untapped, paleo- and archeo-environmental record. Investigation on soil age suggests that, after the Last Glacial Maximum (LGM), about 18,000 years ago, the soil that most likely forms on the most common, fine-textured, and calcareous parent materials of Italy is a partially decarbonated, fully base-saturated Cambisol. Horizons with clear clay illuviation appear to have formed only in favorable conditions. On the other hand, it is clear that Italian soils developed Nitric, Fragic, Ferric, and Plinthic horizons well within Pleistocene times. The formation of fully developed, carbonate-free but base-saturated Luvisols appears to have generally been possible starting much later than Marine Isotope Stage 5, the last fully fledged interglacial.

In Chap. 6, dealing with pedodiversity of Italy, Edoardo A. C. Costantini, Roberto Barbetti, Maria Fantappiè, Giovanni L'Abate, Romina Lorenzetti, and Simona Magini illustrate the distribution of soil classes, mainly by means of maps. Soil regions on hills are the most lithologically and climatically variable environments, and host the greatest soil variability and endemisms. A vast majority of the WRB reference soil groups (25 out of 32), as well as soil orders of Soil Taxonomy (10 out of 12) are represented in the main Italian soil typological units (STUs), but the clear skewness and lognormal distribution of STUs demonstrate the utmost endemic nature of many Italian soils. In particular, more than a fourth of STUs belong to Cambisols, more than a half to only four reference soil groups (Cambisols, Luvisols, Regosols, Phaeozems), and 88 % to nine RSGs (the former plus Calcisols, Vertisols, Fluvisols, Leptosols, and Andosols), while the remaining 16 RSGs are represented in 12 % of STUs. A similar trend is depicted by considering single soil profile classification, although a larger number of main soil types are represented as soil profiles than as STUs. In particular, there are profiles classified as Albeluvisol, Anthrosol, Cryosol, Plinthosol, and Technosol of WRB, and Gelisols of Soil Taxonomy, which are not correlated to a STU. Consequently, Ferralsols (Oxisols for Soil Taxonomy) and Durisols are the only main kind of soils that have not yet been found in Italy. Likewise RSGs, the distribution of WRB qualifiers shows an evident concentration in relatively few cases, followed by a long tail. In particular, 138 out of the 180 types foreseen by WRB are represented in Italy. Thus, it is possible to say that in Italy there is about three-quarters of the global pedodiversity. Although the most common qualifiers (that is Calcaric, Haplic, Skeletic, Eutric) are all related to the nature of parent material and to incipient pedogenesis, a second group (namely Chromic, Calcic, Stagnic, and Luvic) indicates the main soil forming mechanisms that typify current Italian pedogenesis.

In Chap. 7, Anna Benedetti, Maria Teresa Dell'Abate, and Rosario Napoli focus the attention on all those aspects concerning the soil function and the related ecological services. Stressing that soil organic matter content is widely adopted as soil quality indicator—since it is correlated with various aspects of productivity and sustainability of agricultural ecosystems and environmental conservation—with the aid of several case studies related to the Italian soilscapes, they highlight the way in which the soil microorganisms can provide essential services. In doing this, the AA identify two main causes of erosion of soil microbial genetic resources and consequently depletion in biological soil functions: (i) the impact of anthropic activities on soil (mainly inappropriate agricultural and forestry practices, industrial activity, urban development, soil sealing), and (ii) the natural pressures on soil due to climatic changes and natural disasters.

Carmelo Dazzi and Giuseppe Lo Papa examine in Chap. 8 the several threats that influence Italian soils. Soil threats in Italy started during the Roman period but only after the Second World War, with the transformation of the agriculture and the industrial development, soil degradation and its effects became more and more evident. Nowadays, several degradation processes threaten Italian soils: together with soil erosion, soil consumption, soil salinity/alkalinity, landslides, forest fires, new issues arose, all referable to incorrect relationships between human and soil and all driven by strong economic reasons. Such new threats are: (i) soil consumption by huge diffusion of photovoltaic ground-mounted installations which, as it happens for roads and rails, are preferentially established in flat areas regardless to any aspect on soil quality; (ii) loss of soil diversity by anthropic activity, which has driven pedologists to define new specific soil degradation processes defined as "entisolization" and "anthrosolization".

In Chap. 9, Giuseppe Corti, Stefania Cocco, Giorgia Brecciaroli, Alberto Agnelli, and Giovanna Seddaiu have drawn the attention on soil management. In Italy, soil management has a long story since the story of land use is as old as the occupation of the country by different peoples. The innovations that were concocted during the time depended on the difficulties the peoples encountered in the various places they settled, and on the human history. As a result, the anthropic impact on soil formation in Italy is particularly marked in all the agricultural areas. Besides deforestation, ploughing, liming, manuring, and fertilizing, some practices that particularly characterize Italian soil management have a strong effect on pedogenesis: (i) change of the relief by levelling, terracing, and burying of the previous surface, (ii) modification of the soil moisture regime through irrigation and/or drainage, and (iii) frequent and intensive cultivations, which enhance soil erosion.

Soil management has been frequently driven by policies such as laws and regulations and economic instruments like subsidies and taxes. The European Union (EU) policy instruments have always played a crucial role in shaping agricultural systems and, among them, the Common Agricultural Policy (CAP) contributed particularly to the increase of cropping systems productivity through agricultural intensification and farm specialization. The CAP's original goal was to expand production in order to reduce dependence from imported food as well as to cut down the EU import requirements in terms of energy, raw materials, etc., but the greater specialization toward arable farming systems had frequently meant the end of traditional cropping systems and the intensification of land degradation. The CAP reform in 1992 was designed to reduce production (e.g., setting aside farmland), to encourage greater attention to the environment and to the use of land, and to decrease prices. The subsidies favored the cultivation of some crops (wheat, oil seeds, etc.) even under unsuitable ecological conditions, leading to contrasting impacts on land use compared to the intended goals. The last CAP reforms have put a greater emphasis on environmental concerns by introducing accompanying measures such as agro-environmental schemes and by making direct payments to farmers conditioned to meet the cross compliance requirements, which are supposed to contribute to an improvement of soil quality.

Soils in urban areas are taken into consideration by Franco Ajmone Marsan and Ermanno Zanini in Chap. 10. In Italy, the interest has been directed mainly on the contamination of urban soils. The studies have started in the 1970s and data are now available for a number of cities. The soils of large cities like Rome, Naples, and Turin have been studied in view of their size and the intensity of the polluting sources therein, but also mid-sized cities such as Ancona or Palermo have been investigated. A common trait of all cities is the high spatial variability of their soils together with a high level of contamination. Numerical classification appears then to be preferable to the classic systems for application in urban areas.

Future soil issues are treated by Fabio Terribile, Angelo Basile, Antonello Bonfante, Antonio Carbone, Claudio Colombo, Giuliano Langella, Michela Iamarino, Piero Manna, Luciana Minieri, and Simona Vingiani in Chap. 11. The chapter focuses on country limitations and potentialities, and identifies the most important country-specific contributions by soil science aiming toward the wellbeing of Italy. The authors claim that future soil scientists must give major contributions in the followings aspects: (i) spatial planning of the landscape (oriented to urban planning), (ii) archaeology, cultural, and natural heritage, (iii) agriculture and forestry, combining productivity and environmental protection, (iv) hydrogeological risks, (v) integrated landscape management. In order to get these results, the authors anticipate that soil science requires a novel vision, novel approaches, and most important a novel education combining in-depth specialized knowledge with a very good but broad and basic soil knowledge.

The themes developed in this volume lead to conclude that a reassessment of the relationship between man and soil in Italy is needed. Managing our limited land in an inappropriate way, we are loosing the best, most fertile soil. Even more alarming is that the bill of the way we manage the soil will be paid by our grandchildren and our great-grandchildren. The reassessment of the relationship between man and soil should be based on the full awareness of what soil truly is. And this new awareness should involve the whole Italian society, from the common citizen to the Academy, to the public administrators, and paradoxically also to the scientific community. In most cases, soil is understood as a mere surface, or something in relation to vegetation, or to the geomorphology or geology. Among the consequences more devastating: the most fertile soils are forever subtracted to the agricultural management.

In Italy, during millennia of soil management, the attention toward its qualities has radically changed, passing by phases of intense and devastating exploitation to periods of reclamation and care. The budget is generally negative, as the more self-organized soils were often replaced by less self-organized and less resilient ones, showing sensible limitations to intensive uses. In the recent past, to provide a subsistence agricultural economy even on degraded soil, much confidence was given on the favorable climate and on inconsistent or pseudo-consistent lithologies. However, with the new challenges of the global market, many agricultural soils (but also forestry soils) are no longer competitive and are abandoned, or extensively used. It can be observed in recent years a significant increase of land covered by fodder crops, at the expense of arable land, especially in the central and southern regions of Italy. On the other hand, the high quality soils are more and more exploited, with an increasing widening of areas with horticulture and fruit tree groves. An economic consequence is the fact that land values are decreasing in the marginal areas of central and southern Italy, but are greatly increasing in the most competitive areas, especially in northern Italy. From an environmental point of view, it follows an enlargement of agricultural areas vulnerable to nitrates, which have now reached 16 % of cultivated areas (ISTAT 2010).

It is a common aspiration of the authors that this book could provide interesting information to soil experts and students, so that they can enhance the attention of the general public on this very limited but very economically and environmentally important resource of Italy.

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