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Editorial

Editorial of the Special Issue Digital Soil Mapping, Decision Support Tools and Soil Monitoring Systems in the Mediterranean

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In the digital era, the role of soil surveyors has evolved significantly. With legacy soil data now being recognized as valuable assets, thanks to the increased computational capacity of geographic information systems, the potential of soil spatial assessment has been greatly enhanced [1]. International calls have led to increased collaboration between scientists, and national research projects have been instrumental in advancing innovation in the soil-mapping domain [2].

Soil mapping in the Mediterranean region involves contributions from various authors and institutions [3]. Several prominent research institutions, governmental agencies, and academic organizations are known for their contributions to soil mapping and related research in the Mediterranean region [4,5]. These includes universities with agricultural or environmental, geology and natural science departments, geological surveys, research centers specializing in soil science, and regional or international organizations focused on environmental conservation and land management.

In terms of individual authors, there are numerous experts and scholars who have made significant contributions to the field of soil mapping in the Mediterranean [6–9]. Several other scholars and researchers have authored key publications, research papers, or reports that have advanced our understanding of soils in the region [10–15].

To identify the main contributing author or institution for a specific project or study related to soil mapping in the Mediterranean, it is recommended to analyze the peer-review research literature, being as comprehensive as possible (e.g., by including SCOPUS and Web of Science databases) [16]. This can provide insights into the key contributors and institutions that have played a significant role in advancing soil mapping efforts in the Mediterranean region [17–20].

The abundance of soil information available today presents an opportunity to integrate and leverage both legacy and new soil data to gain insights into soil properties and their temporal changes, thereby enhancing our understanding of earth processes and informing better soil resource management [21]. The operational use of digital soil mapping (DSM) for precision farming has emerged as a critical activity in modern agriculture, benefiting from technological advancements such as remote sensing [22], decision support systems [23–25], web-based soil modeling and mapping, and cloud computing [1,26]. This aligns with the new European soil mission [27] aimed at addressing climate change [28] and environmental challenges, emphasizing the importance of soil maps in supporting sustainable development and climate mitigation efforts [29,30].

The dissemination of soil knowledge and data is crucial to meeting the needs of the broader soil user community and safeguarding soils. In line with these developments, this Special Issue (SI), "Digital Soil Mapping, Decision Support Tools and Soil Monitoring Systems in the Mediterranean", has received seven contributions focused on various aspects

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of soil mapping and data management, including smart soil data management, legacy data reuse, and the extraction of spatial knowledge from soil survey data and remote sensing. The articles in this SI report on the results of field experiments and literature reviews, mostly within central European territories (Italy and Croatia), covering several assessments of and methodologies for soil properties.

The aims of the SI were to foster discussions and showcase advancements in leveraging digital technologies to enhance our understanding of soil properties spatial distribution and support sustainable soil management practices, and these objectives were partially achieved.

In recent years, the application of machine learning models in the field of soil science has revolutionized the way we understand and map soil properties. This editorial aims to provide an overview of seven abstracts from recent studies that highlight the innovative use of machine learning in digital soil mapping and the assessment of soil properties. Among the DSM studies, Agaba et al. (2023) [31] present a comprehensive analysis of the spatial distribution of soil organic carbon stock in an alpine valley in northern Italy using machine learning models. The authors employed different machine learning algorithms, including multivariate adaptive regression splines, random forest, support vector regression, and elastic net, to predict the soil organic carbon stock at different depths. The results demonstrated the effectiveness of the random forest model in mapping the spatial distribution of soil organic carbon stock with high accuracy. Similarly, Adeniyi et al. [32] utilized linear and nonlinear machine learning models to map soil properties in an agricultural lowland area of Lombardy, Italy. The study focused on predicting and mapping soil properties such as sand, silt, clay contents, soil organic carbon content, pH, and topsoil depth. The findings provided valuable insights for sustainable land use and management in the region. In another study, Vittori Antisari et al. [33] assessed pedodiversity and soil organic matter stock in soils developed on sandstone formations in the Northern Apennines of Italy. This research highlighted the influence of vegetation, topographic factors, and lithology on pedodiversity and soil organic matter content, emphasizing the importance of preserving soil resources in mountain regions. Conforti and Buttafuoco [34] investigated the effects of the study area size and soil sampling density on the prediction of soil organic carbon using visible and near-infrared diffuse reflectance spectroscopy in south Italian forest areas. This study emphasized the need for further research to fully realize the potential of spectroscopy in predicting soil organic carbon. Kaya et al. [35] focused on the predictive mapping of the soil Electrical Conductivity and assessments of the potential soil salinity in a Western Türkiye alluvial plain using machine learning models. This study underscored the importance of monitoring soil salinity to ensure sustainable soil management in irrigated areas. Trevisani and Bogunovic [36] conducted a diachronic mapping of soil organic matter in eastern Croatian croplands, comparing soil organic matter content from the 1970s to that from the 2010s. The study revealed a trend of soil organic matter depleting over time, highlighting the need for soil conservation and restoration actions. With the latest accepted review paper, Adeniyi et al. [37], conducted a systematic review of digital soil mapping application in lowland areas, emphasizing the growing recognition of the pivotal role of digital soil mapping in understanding soil properties in agricultural lowlands. These studies collectively demonstrate the capacity of machine learning models to advance our ability to assess spatial distribution of soil properties (e.g., electrical conductivity soil organic carbon content and stocks), thereby providing valuable insights for sustainable land management, agricultural productivity, and environmental conservation strategies. The integration of machine learning models in soil science has opened up new frontiers in digital soil mapping, enabling researchers to unravel the complex relationships between soil properties, environmental factors, and land use management. As we continue to dig deeper into soil research, these innovative approaches hold immense promise for improving soil management and fostering environmental sustainability.

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