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Dataset paper

Soil dataset from poplar cultivation sites in northern Italy plains

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ABSTRACT The data pertains to georeferenced soil samples collected from poplar plantations situated in the plains of northern Italy between 1994 and 1996 and targeted areas with poplar plantations that were at least five years old in 1994.
Soil characteristics (texture, NH_4^+, NO_3^-, $CaCO_3$, P_2O_5, pH, organic matter, Soil Organic Carbon - SOC) were documented for every first layer of soil samples, while NIR spectroscopy data for every layer were collected using an ASD Fieldspec instrument. Reflectance at wavelength range 350 – 2,500 nm was acquired. Measurements adhered to the IEEE-P4005 standard on standard sands.
Other useful data like the presence of irrigation was recorded, as well as the depth of the temporary and permanent water table for the topmost layer.
Spectral row data and soil database holds potential for conducting further studies and comparisons with other monitoring soil survey. By utilizing these samples as long-term control points, it becomes possible to identify changes in land use patterns or properties. It would be of interest to investigate the temporal dynamics of organic carbon in the soil or its relation with land management, thus the potential for carbon farming.

KEYWORDS: Soil texture, northern Italy plains, poplar plantations, water table, land use patterns, NIR spectroscopy, soil organic carbon.

Introduction

It is anticipated that by 2050, the agricultural sector will experience a substantial increase in commodity production of approximately 60-70% due to global population growth. Consequently, a shift in land use and agronomic practices aimed at enhancing productivity may result in soil degradation, including erosive processes, compaction, and loss of organic matter (Kaske et al. 2021).

Notwithstanding these concerns, the agricultural sector possesses the potential to significantly contribute to the mitigation of greenhouse gas (GHG) emissions, thereby ensuring that global average temperature rise remains below the 1.5 °C threshold (Martani et al. 2022).

The primary mechanism by which this can be achieved is through photosynthetic processes and subsequent carbon translocation into plant biomass. Consequently, the cultivation of trees, particularly poplar species, can serve as an effective means of long-term carbon sequestration and storage.

Of equal significance is the role of soil, which serves as the most crucial carbon sink on our planet. Hence, agronomic practices play a pivotal role in maintaining a balance between carbon stored in the soil via plant residues and the carbon lost through organic matter mineralization processes (Elbasiouny et al. 2022).

A valuable tool for monitoring local-scale changes in soil characteristics resulting from the maintenance of poplar cultivation areas or shifts in land use involving arable crops and different agronomic practices would be a dataset comprising soil samples obtained from poplar stands.

The objective of this paper is to make accessible soil sample archive from northern Italy, thereby facilitating further investigations and analyses in this field.

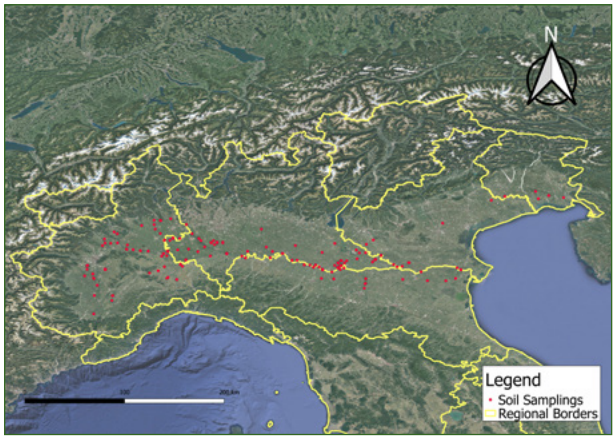
Material and Methods

Study area

The surveyed land consists of the plains of northern Italy, specifically the Po Valley. Data were collected in the administrative regions of Piemonte, Lombardia, Emilia-Romagna, Veneto and Friuli-Venezia-Giulia belonging to 18.8 Soil Region (Costantini et. al 2014).

All records are georeferenced with geographic coordinates in WGS 84, EPSG: 4326.

Figure 1 - The study area map with sampling points depicted as red dots.



Sampling scheme and data collection

The soil sampling activities conducted in the plains of northern Italy adhered to the methodology outlined in the poplar inventory dataset by Rizza et al. (2023a and 2023b). The dataset consisted of 2,322 clusters that were

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georeferenced on a three-kilometre UTM grid, ED50, systematically distributed across an area spanning 4,179,600 hectares. Each cluster comprised nine subunits aligned with the points on a 500-meter square grid.

The soil sampling took place between 1994 and 1996 and focused on sites with poplar plantations that were at least five years old in 1994. The location of the sites is shown in Figure 1. To obtain the samples, a soil profile was excavated, each layer was identified and about 1 kg of soil was collected from each soil horizon.

The instrument LabSpec Pro Spectrophotometer LSP 350-2500P Analytical Spectral Devices, Inc was used and to allow other researchers to use the data deriving from the NIR spectroscopy, measurements were made on standard white, grey, and black sands, respectively from Lucky Bay, Wylie Bay and Ladispoli used in IEEE-P4005 protocol (Dor et al. 2015).

The resulting Vis-Nir soil spectral library was joined with the soil dataset. The variables in the soil dataset represent different characteristics of soil samples. "COD_ELE" is a string variable that refers to the Italian Region and cluster of the soil sample. Specific letters represent different regions, while the first number refers to the cluster and the second one specifies the element of the cluster. The "DATA" variable represents the sampling date and is in the format dd.mm.yyyy. "IRRIG" indicates the presence of irrigation and is a text variable with values "True" or "False". "LAYER" is a numeric variable representing the number of layers. The "DEPTH_X" variables denote the depth of each layer and are measured in centimetres (cm). "MAX_DEPTH" represents the maximum depth of the pedological profile. "WT_TEMP" and "WT_PERM" indicate the depth of the temporary and perma-

Table 1 - Variables explanation of the first Excel sheet: Soil samples.

Field	Description	Field type	Unit of measurement
COD_ELE	The letter refers to the Italian Region code (E= Emilia Romagna, F=Friuli Venezia Giulia, L=Lombardia, P=Piemonte, V=Veneto); the first number specifies the cluster; the second number refers to the element of the cluster	string	
DATA	Sampling data	Data	Dd.mm.yyyy
IRRIG	Presence of irrigation	Text	True/False
LAYER	Number of layers	Numeric	
DEPTH_X	Depth of the X layer	Numeric	cm
MAX_DEPTH	Maximum depth of the pedological profile	Numeric	cm
WT_TEMP	Depth of the temporary water table		
n.d. depth not determined	Numeric/text	cm	
WT_PERM	Depth of the permanent water table		
n.d. depth not determined	Numeric/text	cm	
CLAY_X	Clay in the X layer	Numeric	g/kg
SAND_F_X	Sand in the X layer	Numeric	g/kg
SAND_C_X	Coarse sand in the X layer	Numeric	g/kg
SILT_F_X	Fine silt in the X layer	Numeric	g/kg
SILT_C_X	Coarse silt in the X layer	Numeric	g/kg
$CaCO_3$	Total carbonates	Numeric	g/kg
N_NO_3	Quantity of NO_3^-	Numeric	mg/kg
N_NH_4	Quantity of NH_4^+	Numeric	mg/kg
$P\_P_2O_5$	Quantity of P_2O_5 (Duchaufour method)	Numeric	g/kg
MAT_ORG	Organic matter	Numeric	g/kg
C_SOIL	Organic carbon		
(Anne method)	Numeric	g/kg	
pH	$-\log_{10}[H_3O^+]$	Numeric	
Longitude	Longitude of the collected sample	decimal degrees	geographic coordinates in WGS 84, EPSG: 4326
Latitude	Latitude of the collected sample	decimal degrees	geographic coordinates in WGS 84, EPSG: 4326

Each soil sample was labelled with the region's sampling letter, cluster number, element number and for the Vis-Nir soil spectral library the layer number was added at the end. A maximum of five depths were examined for each sample. The texture characteristics (fine sand, coarse sand, fine silt, coarse silt, and clay) and certain chemical properties (limited to the first horizon) were documented for every first layer, including NH_4^+, NO_3^-, $CaCO_3$, P_2O_z, pH, organic matter, and soil carbon as shown in Table 1. Lately soil samples were sieved to two millimetres and then every layer or every soil sample was scanned with ASD Fieldspec to measure the reflectance for wavelengths ranging from 350 to 2,500 nm, as shown in Table 2.

nent water tables, respectively, and are measured in centimetres (cm). The "CLAY_X" variables represent the clay content in each soil sample and are measured in grams per kilogram (g/kg). Similarly, "SAND_F_X" and "SAND_C_X" denote the fine sand and coarse sand content, respectively. The "SILT_F_X" and "SILT_C_X" variables represent the fine silt and coarse silt content, respectively, in each layer, all measured in grams per kilogram (g/kg). "$CaCO_3$" represents the total carbonates content and is measured in grams per kilogram (g/kg). "N_NO_3" and "N_NH_4" denote the quantity of NO_3^- and NH_4^+ ions, respectively, measured in milligrams per kilogram (mg/kg). "$P\_P_2O_5$" represents the quantity of P_2O_5 according to the Duchaufour method (Duchaufour 2012) and is measured in grams per kilogram (g/kg). "MAT_ORG" represents the organic matter content measured in grams per kilogram (g/kg). Finally, "C_SOIL" represents the organic carbon content according to the Anne method (Anne 1945) and is measured in grams per kilogram (g/kg). The variable "pH" denotes the negative logarithm of the hydronium ion concentration (H_3O^+) and is measured on a numeric scale. Longitude and Latitude indicate the geographic coordinates of the soil sample and are expressed in WGS 84, EPSG: 4326 reference system.

Table 2 - Variables explanation of the second Excel sheet: Vis-NIR.

Field	Description	Field type	Unit of measurement
COD_ELE	The letter refers to the Italian Region code (E= Emilia Romagna, F=Friuli Venezia Giulia, L=Lombardia, P=Piemonte, V=Veneto); the first number specifies the cluster; the second number refers to the element of the cluster, while the third number indicates the layer and increases with depth	string	
350 351 … 2500	Reflectance at wavelength (nm)	numeric	Ra

Data access and metadata description

The dataset can be downloaded using the following reference: Rizza D., Rocci A., Chiarabaglio P. M., & Barbetti R. (2023). Soil dataset from poplar cultivation sites in northern Italy plains [Data set]. Zenodo. https://doi.org/10.5281/zenodo.8182624

The file is provided as a 'Microsoft Office Excel File Format' (xlsx).

Technical validation

The soil database comprises a compilation of soil information encompassing texture, selected chemical properties and the Vis-NIR spectroscopy analysis. Prior to its publication, meticulous scrutiny was employed to ensure the accuracy and integrity of the data from each soil sampling. Precautionary measures were implemented to mitigate the possibility of misspellings or discrepancies in data collected by different operators over multiple years.

Reuse potential and limits

The soil database presented in this study holds significant potential for various research activities.

An essential facet of this dataset lies in its capacity to determine the proportion of soils associated with poplar cultivation areas, offering insights into the spatial distribution and extent of poplar cultivation within the study area. This dataset, enriched with key parameters including carbon content and organic matter in soil samples from poplar cultivation areas, emerges as a crucial resource for comprehending the intricate interplay between soil properties and carbon sequestration dynamics.

Understanding the current status of poplar plantations is important for assessing the impact of land use changes and developing strategies for sustainable land management.

Moreover, the dataset allows for the assessment of changes in land use patterns over time.

By comparing the soil characteristics and properties documented in this dataset with more recent soil surveys, researchers can analyse the dynamics of land use and identify potential shifts in agricultural practices or land management strategies. This information can be valuable for policymakers, land managers, and stakeholders involved in land-use planning and decision-making processes.

It is worth noting that the dataset's reuse potential extends beyond research purposes. It has operational applications as well. For example, the information contained in the soil database can be utilized for practical purposes such as soil quality assessments, land suitability analysis, and land-use planning. Understanding the soil characteristics and their spatial distribution can aid in identifying suitable areas for specific agricultural practices or land-use types. This operational re-use potential of the dataset can contribute to more informed decision-making processes in agriculture and land management.

In summary, the soil database presented in this study offers significant reuse potential for both research and operational purposes. It provides opportunities to investigate changes in land use patterns, assess soil quality, and support decision-making processes. The adherence to standardized protocols ensures data consistency and comparability, reinforcing the dataset's reliability and applicability across various scientific and practical domains.

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