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Detailed soil mapping and relationships between soil characteristics and tree growth in an alluvial plain (Lombardy, Italy)

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The study area is located in an abandoned meander of the Oglio river (southern Lombardy, Italy), with young soils of alluvial origin (Calcaric Fluvisols). During 2002, in an area covering 20 hectares, a tree plant for wood production was realized (oak, hornbeam, ash, alder, and walnut; poplar only in the first part of the growth cycle).

Objective of the study was to verify the existence of correlations between tree growth and soil characteristics. In 2004, the soil was sampled at 126 points, according to a regular grid, taking the surface soil horizon (Ap). The collected soil samples were analyzed in laboratory, measuring pH in H_2O and KCl, texture, total carbonates, soil organic C (SOC), available P (Olsen), and exchangeable K.
The pH in H_2O varies between 7.7 and 8.1; the pH in KCl varies between 7.2 and 7.7; the more frequent particle-size classes are loam and sandy loam; SOC varies between 0.4 and 1.1%; total carbonates from 23 to 45%; exchangeable K between 0.01 and 0.25 $cmol_{(+)}$ kg^{-1}; available P between 1.2 and 16.8 mg kg^{-1}.
At a distance of 12 years, in 2014, diameters at breast height of all the trees (2513 in total) were measured and their height was estimated on the basis of empirical equations obtained for each species, in order to calculate the tree volume.
Spatial variability of soil properties was evaluated and mapped using multivariate geostatistical techniques. The analyses revealed the presence of different scales of spatial variation: micro-scale, short range scale (about 80 m for texture) and long range scale (about 220 m for texture). The spatial pattern of most soil properties (mainly texture and total carbonates) was probably associated with fluvial depositional processes.

To evaluate soil-plant relationships, soil characteristics were collocated into the plant data set by estimating specific soil properties at each individual tree location. Soil spatial variability was reflected by the differences in plant growth.

Statistical analysis of the collected data highlighted a number of statistically significant correlations between tree growth and soil features: clay content and total carbonates were almost always negatively correlated with tree growth; sand content, pH in KCl, available P and exchangeable K were almost always positively correlated; SOC content was negatively correlated, but only for oak.