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Effects of land use history on heavy metals concentration in agricultural soils

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Intensive agricultural management can have significant impacts on soil properties. Such effects and their degree are often related to the history of land use and to the agronomic practices. When legacy soil data are missing, historical land use maps can help to describe how crop management might have changed the concentration of certain elements in soils. In this study, we prove how permanent crop management (vineyards and apple orchards) influenced heavy metal concentration in agricultural soils in South Tyrol, Italy. We selected areas where land-use change was unidirectional going from forests, grasslands and arable lands to apple orchards or vineyards. We hypothesize that the heavy metal accumulation in the soil starts when a parcel is converted to intensive permanent crops. This hypothesis allows us to see if there are any significant differences between parcels with a longer or shorter intensive agriculture history. We used approx. 6000 soil samples analyzed between 2006 and 2016 and coupled them with historical land use maps dating from the 1850s until today. Soils that have been cultivated as apple orchards or vineyards since the 1850s are characterized by higher concentrations of Cu. The oldest vineyards have much higher soil Cu concentrations than apple orchards of the same age with a median content of 342 mg kg^{-1} and 212 mg kg^{-1} of Cu respectively. Similar patterns, but with smaller extent can be described also for Zn concentration. Comparing the age of vineyards with today's concentration we estimate an accumulation rate of 2.4 mg kg^{-1} $year^{-1}$ of Cu. We conclude that historical land use maps are extremely helpful in understanding today's soil characteristics especially with not degradable pollutants such as heavy metals. High concentrations of Cu in vineyards reveal the widespread and abundant use of this metal in viticulture for plant defense programs through time. The accumulation trend proves that further research and monitoring is needed to understand spatial and temporal pattern of Cu and Zn pollution in intensively managed permanent crops and to estimate their impact on taxonomical and functional fungal and bacterial diversity. These aspects are of pivotal role in determining the soil fertility levels of our cultivated soils.