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Heavy metals fluxes and speciation in the surface layer of urban soils in the province of Brescia (Italy)

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For the last forty years (1974–2015), a ferroalloy industry has been working in Bagnolo Mella, a municipality nearby the city of Brescia (Northern Italy), producing particulate emissions enriched in heavy metals: manganese (Mn) in particular, but also lead (Pb), iron (Fe), aluminum (Al) and arsenic (As).
Although some of these metals are required trace elements for most living organisms and can be largely found in natural environments (e.g. Mn being the fifth most abundant metal in the Earth crust), they all lead to toxic effects when they contaminate work and life environments of the exposed population.
Aiming at contributing to quantify the exposure of the population to environmental pollution near the factory, as well as the heavy metals possible tendency to migrate through the considered soil matrix, in this work we investigated metals speciation and fluxes within the Earth Critical Zone.
The factory is located near residential areas in a plain characterised by little wind and shallow water table with a great number of water resurgences.
Three test sites were identified among the pronest ones to particulate matter deposition, on the basis of data collected during a previous experimental field campaign and of the local wind rose. One more site was selected upwind to the factory as a reference site minimally prone to particulate matter deposition, on the basis of the previous investigations.
Sites where lawns have been maintained at least for the last forty years where selected in order to avoid agriculture—induced effects on the metals movement.
Total soil metal concentrations were measured by means of a portable X-Ray Fluorescence (XRF) device along the soil profiles, down to the depth of 40 cm from the soil surface.
Four loose soil samples were collected at each site, at depths ranging from 5 to 30 cm, and they were later subjected to sequential extractions procedure and ICP—MS analyses, in order to investigate differences in heavy metals speciation along the considered soil profiles.
The XRF metal total content profiles show an accumulation of metals in the subsurface soil layers, around 5 cm under the soil surface (this feature is highlighted in the normalized profiles). They also give evidence of the plant activity consequences, with the closest downwind site showing values which are for all metals at least one order of magnitude –two for Mn– higher than the ones in the test site.
The speciation profiles, besides describing loosely the same pattern, show how the amorphous oxides species is always prevalent for Mn and Pb along the whole profile, while for As the species associated with crystalline oxides is always the prevalent one.