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Portable XRF analyzer: a powerful tool for multiscale assessment of soil contamination

Florindo Antonio Mileti¹, Antonietta Agrillo², Piero Manna³, Langella Giuliano², Fabio Terribile^{1,2}, and Simona Vingiani^{1,2}

¹Napoli Federico II, CRISP, Portici, Italy

²Department of Agricultural Sciences, University of Napoli Federico II, Portici (NA), Italy

³CRN-ISAFOM, Portici (NA), Italy

All around the world, a wide range of rural and industrial areas contaminated by PTE (potentially toxic elements) is affected by general lack of ex-ante information on type, quantity and location of potentially hazardous substances, hence the increasing request of proper investigation tools enabling preliminary screening of soil environment. Besides, spatial understanding of soil contamination is a prerequisite for the achievement of both proper site characterisation and reclamation.

Continuous acquisition in field of physical soil properties (such as apparent electrical conductivity by means of EMI equipments or natural gamma-ray dose rate by gamma-ray spectrometer) is of great importance to follow soil short range spatial variability. However, when the key parameter to be monitored is the soil PTE concentration (to assess, for example, exceeding of the established screening values - CSCs), a different tool is required.

In a farmland of South of Italy, confiscated by the Italian Judiciary due to past illegal burial of industrial wastes, a portable handheld XRF analyzer (pXRF) was used at field scale to measure PTE (As, Cd, Cr, Ni, Pb) content on soil samples collected on a regular sampling grid of 20x20 m, at three depths (0-20, 30-60, 70-90 cm). On the basis of the contaminant content, distribution maps were outlined and "spatial pollution hot spots" revealed.

In correspondence of the most contaminated areas, 8 soil trenches and 5 profiles were dug. In one of the most representative soil trenches, a large (depth/height = 200 cm and width = 500 cm) wall was in situ analysed with high detail by using the pXRF at pedon scale (measurement distance of 10 cm vertically and between 20-35 cm horizontally). The use of the software Surfer 12 enabled the spatialization and mapping of the in depth contamination. Results showed a moderate but diffuse and homogeneous Cr contamination in the topsoil (400 mg/kg), a higher but point-source (2-3%) contamination in the subsoil and uncontaminated soil (40 mg/kg) below 2 m of depth. Most contaminated soil/wastes were then morphologically described and collected, bulk samples for chemical analyses and undisturbed samples for micromorphological thin sections.

pXRF analyzer was also used at microscopical scale on soil thin sections, using a small spot

collimator (analysis area of 0.07 cm²), to preliminary detect and select contaminated micro-pedofeatures, to be further sub-microscopically (SEM-EDS) analysed.