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From theory to the complex geospatial ground-truth of contaminated soils

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Characterization and subsequent reclamation of contaminated sites require detailed knowledge of the geospatial distribution of contamination. In Italy, a potentially contaminated site is an area where the concentration of one or more contaminants in soils is above land-use legal limits (CSC according to Italian law 152/06). Four main phases have to be followed to assess contamination and then reclamation: 1) preliminary conceptual model, 2) characterization plan, 3) site specific risk analysis (by Risk-net software) setting the contamination threshold concentration (CSR), 4) assessment of contamination and therefore reclamation action by comparison between CSC and CSR. The geospatial distribution of contaminants is considered in the characterization plan. It is mandatory to sample at least three samples for each surveyed point (one sample in the 0 to 1 m depth, one sample in the capillary fringe zone and one in between). There aren't clear indications on the sampling strategy and spatial density. According to Italian law (D.M. 471/99), it is usual to identify 5 to 15 sampling points for areas of 1 to 5 hectares.
In this work we attempt to answer the question: "After more than a decade from the introduction of law 152/06 and considering the progress of scientific knowledge, are these soil sampling criteria suitable for assessing the spatial and volumetric distribution of site contamination?".
We considered the analytical and spatial dataset obtained from two rural and industrial potentially polluted sites of south Italy, formerly interested by past disposal of industrial sludge and wastes.
In both sites results showed that: (i) the geospatial variability of contamination is always much more complex than expected and depends by the history of the contamination; (ii) the sampling of the first meter - as a single body - is not satisfactory because it does not take into account the real vertical distribution of pollutants and the soil stratigraphy (such as the presence of centimeter horizons).
The work illustrates the use of proximal sensing sensors, such as EMI, ARP, portable gamma-ray spectrometers and portable XRFs to obtain detailed mappings for homogeneous areas identification, where to address subsequent pedological and chemical investigations.
Moreover, the pedological observation - guided by these technologies - often provides essential information to understand the process of emplacement and possible migration of pollutants towards other environmental sectors. The applied integrated approach, which was found very relevant for the site characterization, can assume even greater importance in the subsequent phase of reclamation.