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Lab and modelling tests to develop a geoelectric monitoring system for municipal solid waste landfills

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Although the indications contained in the European New Green Deal aim to inhibit the opening of new waste disposal sites through a circular economy of waste materials, the management of an extremely large number of municipal solid waste landfills (MSWLF) at different stages of their life cycle is a highly topical issue. Recent national regulations in Italy require the operators to monitor subsoil conditions for 30 years, but do not define clear and unambiguous guidelines.

According to analyses carried out at various landfill sites in northern Italy, monitoring activities were often found to be set up with wells equipped with piezometers. This approach is not optimal because when any contaminants are intercepted by the wells, the conditions of the subsoil may already be compromised. Therefore, the goal of our work is to develop methodologies to test and define an effective monitoring protocol that allows to mitigate the environmental and ecological risks associated with the subsurface propagation of pollutants at MSWLF sites.

The analysis of the subsoil conditions involves the design of monitoring methodologies and the interpretation of the obtained results, exploiting geological, hydrogeological and geophysical knowledge and skills. Accordingly, we rely on a research methodology based on the mutual and continuous exchange between the involved disciplines, starting from the initial geological assumptions that will be used to define a physical model of the subsurface. We mainly resort to indirect non-invasive techniques, in particular to the direct current (DC) electrical resistivity tomography (ERT) that on the one hand is indicated for identifying conductive anomalies associated with the propagation of pollutants, but on the other hand constitutes a complex ill-posed numerical problem. The major issues are related to the spatial resolution and the penetration depth of the technique that in turn control the capability to detect presence and the conditions of the extremely thin high-density polyethylene (HDPE) membrane used to isolate the landfill waste from the surroundings.

To tackle the abovementioned issues, we decided to perform properly downscaled laboratory experiments in order to test the effectiveness of DC methodology in controlled and well-known settings. Processing and interpretation of the collected geoelectrical data are supported by a new modelling code in Python programming language that is being developed.

We deem that the integration of lab and modelling tests is necessary to propose a sound standard approach to address complex and multidisciplinary problems related to landfill risk management.