3D time-lapse imagery of leachate and biogas behaviors in a landfill bioreactor by electrical resistivity monitoring

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The continually growing volumes of household waste and their long degradation times under normal conditions put landfill owners in an environmental, financial and logistic dilemma. Over the past decades, the concept of bioreactors has been developed to accelerate waste biodegradation with the result of aftercare cost reduction, space gain for new deposits and energy generation through biogas production. Bioreactors consist of sealed cells where degradation mechanisms are enhanced through leachate infiltrations (waste wetting) pumped at the cells bottom. Special attention should be paid to the homogeneous wetting of waste material, while preferential flow paths of the injected leachate allowing to bypass large parts of targeted waste should be avoided.

This work studies the leachate circulation during injection into a landfill cell of the Bistade landfill (France). The main goal was to monitor the proper functioning of the bioreactor and to detect eventual preferential paths considering its multiple structural challenges, such as a biogas pumping well and an overlaying geomembrane. We conducted a 3D electrical resistivity survey consisting of 4 profiles around an injection drain and the biogas well; two consecutive 5-hour injections of leachate were carried out at 20 hours intervals. All along the experiment, electrical resistivity was measured every 30 min using the 3D ERT setup. The collected data were then analyzed and inverted using the pyGIMLi open-source code.

The analysis of the spatial and temporal variations of the electrical resistivity allowed the identification of several preferential leachate pathways as well as the accumulation of biogas in certain zones of the waste cell. The results of the study can be used by the site owner to optimize the leachate recirculation in existing waste cells and to improve the design of future cells.