

Advanced Numerical Tools Applied to Geo-Environmental Engineering - Soils Contaminated by Petroleum Hydrocarbons, A Case Study

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Contaminated soils can be considered as a heterogeneous, anisotropic and discontinuous geo-system, whose properties vary in time and space. Aiming the remediation of an active contaminated site (a refinery located in the north of Portugal) we performed laboratory studies with soil samples contaminated with petroleum hydrocarbons.

The experimental results concerning the kinetics of degradation led to the development of a MIMO (multiple input multiple output) model describing simultaneously the time evolution of biomass and the contaminant degradation. Several phenomena were simultaneously considered in this model: the volatilization, a fast kinetics component, a slow kinetics component and the refractoriness of some hydrocarbons for the time scale used in the experiments.

As part of the research programme we used the continuous respirometry of the contaminated soils which is a relatively unexploited subject. This procedure generated a huge amount of data as the measurements of the oxygen and carbon dioxide concentrations, as well as the temperature, are done at intervals of a second. Several mathematical tools were used for treating this data. Time series and system identification was chosen to analyze data interpreted as biological signals allowing for the detection of particularities related to daily cycles of activity, and also to analyze the temporal relationship between variables through the autocorrelation and the cross-correlation functions. The cyclic behavior of respirometric variables was analyzed using wavelets.

The combination of this set of tools, systems of ordinary differential equations, time series analysis, systems identification, Fourier analysis and wavelets theory allowed us to characterize and predict the behavior of the main variables of a geo-environmental system in progress.