Behavior of toxic elements in agricultural and industrial vadose zone soils of three Ebro and Meuse river basin areas in the context of global climate change

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Objectives of the study are to identify the predominant biogeochemical functions controlling the transfer and bioavailability of four inorganic contaminants (As, Zn, Cd and Pb) in vadose zone soils from small to large-scale agricultural and industrial areas. The idea is to identify numerical functions which relate the partition coefficient (K_d) between soil-water phases, or its variations, to key biogeochemical parameters of the studied systems.

Experiments have been conducted at the laboratory on soil samples representative of the inorganic pollution heterogeneity of three areas of the Ebro and Meuse river basins, contaminated by former agricultural or industrial activities. Experiments have been performed in batch conditions during about 2 months, with regularly aqueous-phase samplings to measure toxic element concentrations in the aqueous phase. An experimental plan has been applied to measure the effect of four main parameters, potentially influenced by the global climate change, on the mobility of the selected inorganic pollutants. These parameters are the temperature (4, 14 and 37°C), the gas phase (air, N_2), the pH (soil pH and ± one-unit modified pH) and the biological activity (abiotic, natural and enhanced biotic conditions). This specific experimental plan has been designed to allow a statistical analysis of results deriving specific regression functions available for integrating the knowledge about the mobility and bioavailability of toxic elements.

For As, results show that high temperature or active biological processes were the most mobilizing conditions. About Zn, inhibited biotic processes, high temperature and pH decrease were the most mobilizing conditions. This can be interpreted as an enhancement of the abiotic release with temperature and acidity. In the case of Cd, all parameters had quite the same slight influence. For Pb, high temperature and active biological processes were the most mobilizing conditions. Anaerobic systems usually induce heavy metals and metalloids solubilization but an oxidizing medium will favour biological degradation of organic complexes inducing Pb solubilization. And finally, in many cases, the effect of the gas phase was not significative. In addition of the main results showing that temperature and biological conditions are the main parameters influencing inorganic pollutants release, this study underlines that soil total concentrations are not relevant to assess the hazard for ecosystems or water resources quality.