



Environmental impact assessment of trace metals in agricultural soil in the rapidly developing area of Hung-yen, Vietnam

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Vietnam has a wealth of fertile agricultural land for food production. However, it is challenging to maintain the land quality and to enforce land-use planning and environmental regulations in the face of rapid economic and industrial development. Many villages have been partially transformed into industrial areas, and industrial pollution has had a negative impact on the quality of agricultural soil. This study investigated the extent of heavy metal contaminants and their mobility and bioavailability. Water and soil samples were collected from different locations in Dai-dong commune (802.96 ha, population 8,476), Hung-yen Province, ~ 30 km east of the centre of Hanoi City. The primary industries are recycling of zinc and crafting of handmade copper goods. This commune provides an excellent area for the study of metal contamination in agricultural soil influenced by a village where these industries play important roles. The mobility and bioavailability of Cu, Cd, Pb and Zn in the agricultural soils were identified by their fractionations using selective sequential extraction. The results indicate that the concentrations of cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) ranged from 0.92 to 2.19, 28.3 to 238.7, 43.6 to 321.8, and 58.2 to 329.9 mg/kg, respectively. Total concentrations of heavy metals varied from location to location. However, they tended to be higher where the zinc recycling and copper goods craft industries are located. The Pb pollution was most severe in soil and water samples at and near the same village. In agricultural soils the highest concentrations were observed in the residual, Fe-Mn oxides fraction or organic-bound, depending on the heavy metal. This indicates the intimate association of heavy metals with clay particles, Fe-Mn oxides and/or organic matter, suggesting the stabilization of heavy metals in agricultural soils. Some agricultural soils had Cu concentrations above 150 mg kg<sup>-1</sup> mostly concentrated in

the organic fraction.