



## **Affects of wastewater discharge from mining on soil heavy metal pollution and enzyme activities in northern Hunan province, Central South China**

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Hunan province, Central South China, is rich in mineral resources and also a well-known nonferrous metal base in China. Mining and ore processing there, however, are mostly conducted in indigenous methods, and thus causing heavy metal pollution of abundant farmland. Situated in northern Hunan province, Y county has antimony, manganese, vanadium, and pyrite mines, but still belongs to a region of rice cultivation, of which, paddy fields make up 84.5% of the total farmland. Our investigations found that irrigation water is threatened by the release of mining wastewater in the county. For example, a stream used for irrigation turns dark-red after long-term receiving wastewater discharged from a pyrite company at HS Town of the county. Concentrations of Cu, Zn, Cd, Fe and Mn in the stream water reach 0.03 mg kg<sup>-1</sup>, 2.14 mg kg<sup>-1</sup>, 0.02 mg kg<sup>-1</sup>, 96.0 mg kg<sup>-1</sup> and 11.5 mg kg<sup>-1</sup>, respectively; these in the paddy soils nearby are 67.3 mg kg<sup>-1</sup>, 297 mg kg<sup>-1</sup>, 4.0 mg kg<sup>-1</sup>, 33.1 mg g<sup>-1</sup> and 463 mg kg<sup>-1</sup> on average, respectively, with a maximum of Cd reaching 16.8 mg kg<sup>-1</sup>. Microbial biomass and activities are significantly reduced by metal toxicity in the soils. The counts of fungal, actinomycin and bacterial colonies in the polluted soils are 8.8×10<sup>3</sup> /g (Fresh soil), 4.9×10<sup>5</sup> /g (Fresh soil) and 6.4×10<sup>5</sup> /g (Fresh soil), respectively, which are only 4.68%, 10.3% and 20.9% of these in non-polluted soils in Y county, respectively. Likewise, the microbial biomass (MB) – C and MB – N of the polluted soils are only 36.8% and 50.3% of these in the non-polluted, respectively. The activities of dehydrogenase, urease, catalase, acid and neutral phosphatase and sucrose in the polluted soils are only 41.2%, 49.8%, 56.8%, 69.9%, 80.7% and 81.0% of these in the non-polluted, respectively. There are significant negative correlations between Cu, Zn and Cd contents and the activities of dehydrogenase and catalase, suggesting that the two enzymes are the most sensitive to heavy metal toxicity in the soils. The rice grain produced in the polluted paddy fields are highly contaminated by heavy metals, with concentrations of Cu, Zn, Cd, Fe and Mn being 14.1 mg kg<sup>-1</sup>, 21.4 mg kg<sup>-1</sup>, 0.55 mg kg<sup>-1</sup>, 16.3 mg kg<sup>-1</sup> and 38.5 mg kg<sup>-1</sup> on average, respectively. According to our investigations, the rate of rice with Cd exceeding the national allowable limit (0.2 mg kg<sup>-1</sup>) reaches 59.6% of the total in the county; that with Cd higher than 1 mg kg<sup>-1</sup>, called as Cd Rice, reaches 11.1%. This suggests that wastewater irrigation caused by indigenous mining has led to the severe heavy metal pollution of farming land in Hunan province. Moreover, toxic metals in the soils have been accumulated in rice grain and do harm to human health.