

## Abstract

In 1985, the collapse of the tailing dam in Chenzhou lead/zinc mine (Hunan, southern China) led to the spread of mining waste spills on the farmland along the Dong River. After the accident, an urgent soil cleaning up was carried out in some places. Seventeen years later, cereal (rice, maize, and sorghum), pulses (soybean, Adzuki bean, mung bean and peanut), vegetables (ipomoea, capsicum, taro and string bean) and the rooted soils were sampled at four sites: (1) the mining area (SZY), (2) the area still covered with the mining tailing spills (GYB), (3) the cleaned area from mining tailing spills (JTC), and (4) a background site (REF). Metal concentrations in the crops and soils were analyzed to evaluate the long-term effects of the spilled waste on the soil and the potential human exposure through food chains. The results showed that the physical–chemical properties of the soils obviously changed due to the different farming styles used by each individual farmer. Leaching effects and plant extraction of metals from some soils were quite weak. Certain soils were still heavily polluted with As, Cd, Zn, Pb and Cu. The contamination levels were in the order of GYB>SZY>JTC showing that the clean-up treatment was effective. The maximum allowable concentration (MAC) levels for Chinese agricultural soils were still highly exceeded, particularly for As and Cd (followed by Zn, Pb and Cu), with mean concentrations of 709 and 7.6 mg kg<sup>-1</sup>, respectively. These concentrations exceed the MAC levels by 24 times for As and 13 times for Cd at GYB. Generally, the edible leaves or stems of crops were more heavily contaminated than seeds or fruits. Ipomoea was the most severely contaminated crop. The concentrations of Cd and Pb were 3.30 and 76.9 mg kg<sup>-1</sup> in ipomoea leaves at GYB, which exceeded the maximum permit levels (0.5 mg kg<sup>-1</sup> for Cd and 9 mg kg<sup>-1</sup> for Pb) by 6.6 and 8.5 times, respectively. Taro (+skin) could accumulate high concentrations of Zn and Cd in the edible stem, and rice and capsicum had high Cd concentration in the edible parts. However, the toxic element concentrations in maize, sorghum, Adzuki bean, soybean and mung bean remained lower than the threshold levels. The bio-accumulation factors (BAFs) of crops were in the order: Cd>Zn>Cu>Pb>As. BAF was typically lower in the edible seeds or fruits than in stems and leaves. The accumulation effect strongly depends on the crop's physiological properties, the mobility, of the metals, and the availability of metals in soils but not entirely on the total element concentrations in the soils.

Even so, the estimated daily intake amount of Cu, Zn, Cd, and Pb from the crops grown in the affected three sites and arsenic at SZY and GYB exceeded the RDA (Recommended dietary allowance) levels. Subsequently, the crops grown in Chenzhou Pb/Zn mine waste affected area might have a hazardous effect on the consumer's health. This area still needs effective measures to cure the As, Cd, Pb, Zn and Cu contamination.