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The effect of abandoned mining ponds on trace elements dynamics in the soil-plant system

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In semiarid climate regions lack of vegetation and dryer climate contribute to erosion of abandoned mining surface areas making them up important potential sources of metal pollution into the environment. The objectives of this study were to determine the influence of mine ponds in agriculture and forest soils, and identify the dynamic of metals in the soil-plant system for native plant species (Ballota hirsuta) and crop species (Hordeum vulgare) in two ancient mining districts: La Unión and Mazarrón. To achieve these objectives, wastes samples from mine ponds and soil samples (rhizosphere and non-rhizosphere soils) from natural and agricultural lands were collected. In addition, six plants (Ballota hirsuta) from natural area and 3 plants (Hordeum vulgare) from crops were collected. Physicochemical properties and total, water soluble and bioavailable metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) and arsenic were measured in waste/soil samples. The chemical speciation of metals in soil was estimated by a sequential extraction procedure. For plants analyses, each plant were divided in roots, stem and leaves and metal content measured by ICP-MS. Results indicated that mine, natural and agricultural soils were contaminated by As, Cd, Cu, Pb, and Zn. Chemical partitioning revealed higher mobility of metals in mine ponds than natural and agriculture soils while only Fe and As are completely bound to the soil matrix due to the mineralogical compositions of soils. The accumulation of metals in Ballota hirsuta in La Union decrease as Fe>As>Cr>Ni>Cu>Zn>Cd>Mn>Co>Pb while in Mazarrón did as As>Fe>Cr>Pb>Cu>Ni>Co>Mn>Zn>Cd. Ballota hirsuta showed high ability to bio-accumulate Cu, Cr, Fe, Ni, and As, transferring a large amount to edible parts without exceeding the toxicity limits for animals. Results for barley plants (Hordeum vulgare) showed the ability to absorb and accumulate As, Fe, Mn, Pb and Zn, although the transfer ability of As, Cd and Pb was lower. Although the behavior of metals reflects a root barrier effect, the amount of Pb in grain overreached the permissible limit in aliments.