Assessment of potential health risk for inhabitants of S. Francisco de Assis living near Panasqueira mine (Portugal)

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Abstract

The Panasqueira active mine, in operation since 1896, is located in central Portugal and is recognized as the biggest Sn-W deposit of the Western Europe. The ore deposit is a typical example of a Sn–W hydrothermal mineralization associated with the Hercynian plutonism. The economic exploitation mainly focused on wolframite, cassiterite, and chalcopyrite, the last two as by-products. Mining exploitation and beneficiation processes result in huge tailings with metal rich wastes. The unconfined tailings and open air impoundments are the main sources of pollution in the surrounding area, once the oxidation of sulphides can result in the mobilization and migration of trace metals from the mining wastes into the environment, releasing contaminants into the ecosystem. Barroca Grande, in nowadays, is where the economic exploitation and the beneficiation plant are located. In this setting also exist one of the main deposits of the mining area, a tailing ≈7 Mm^3 and two mud dams ≈1.2 Mm^3 exposed to the atmospheric conditions. Soils, downstream Barroca Grande tailing, will be the major repository of the heavy metals released, being the S. Francisco de Assis village, positioned downstream this tailing, the most affected. The tailing piles at Barroca Grande are also adjacent to the small, but perennially flowing, Casinhas Stream, which drains to the Zêzere River.

In order to investigate the environmental contamination impact on agricultural and residential soils of S. Francisco de Assis, due to the mining activities, and also to understand the geochemical behaviour of a set of chemical elements in this mining region, four sampling media (rhizosphere soils, irrigation waters, street dusts and horticultural plants) were selected.

These media constitute the most important means for the geochemical characterization of an area and for assess the impact of anthropogenic activities on different ecosystems, including the public health of the inhabitants. Vegetables and rhizosphere soil samples define the extent of soil contamination and the metals transfer process from soils to the different parts of the plants. Waters samples explain the influence of soils and human activities in the quality of potable water, for human consumption and for irrigation. Finally, with the road dusts samples is possible to quantify the wind transfer of the contaminants from the tailings and their influence in soils, vegetables and air quality of that area.

The enrichment index (EI), the estimated daily exposure metals from vegetables (EDEM) and the health risk (HR) were computed allowing the evaluation of the contamination degree of multiple elements and the daily intake of metals by humans from vegetables, supported by the classification of the potential health risk of the area.

The results showed, for example, that As concentrations exceed 20 times the Ontario reference value for agricultural soils (11 mg kg^{-1}). The estimated values for EI revealed a high degree of contamination in soils, mainly due to the presence of As, Cu, Cd and Pb. The comparison to the Ontario guidelines indicates that these soils are considered as ‘‘grossly polluted’’. Also the road dusts exceeded the reference acceptable risk values and the maximum acceptable values for As, Cd, Cu and Zn. These concentrations are related to a wind dispersion mechanism, with pronounced expression in this area. The calculated HR for residents, by ingestion these metals, through the consumption of vegetables growing in their yards, put in evidence that the inhabitants of S. Francisco de Assis village probably are exposed to some potential health risks through the intake of As, Cd and Pb.

The overview of the obtained results highlights the need to implement preventive measures and remediation in the area, in order to reduce the risk of this population. This is particularly important not only for this village but for populations worldwide exposed to similar conditions.

This research requires further studies to establish the metals transfer process from soil to the different parts of the plants, to understand their bioavailability, to identify the bioaccumulation patterns based in indicators as, for example, Biological Absorption Coefficient for each element.