MASTER THESIS PROJECT

DERIVATION OF SOIL SCREENING LEVELS FOR ARSENIC USING A PORTUGUESE REGOSOL

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Abstract

Soil Screening Levels (SSL) for potentially toxic elements (PTEs) are critical for the preliminary risk assessment of polluted sites. The Portuguese Environmental Agency has recently proposed screening values for soil depending on their usage, but no consideration was given to the soil type. However, it is consensual the importance of this latter aspect given the importance of soil characteristics in contaminant mobility and bioavailability. Therefore, SSLs should be specified for natural soils or at least allow for readjustments based on the target soil's organic matter and clay content. This present work aims at deriving a screening value for arsenic (As) using the dominant type of soil in the Estarreja region (centre of Portugal), where the Estarreja Chemical Complex caused historical problems of soil contamination.

A battery of ecotoxicological tests focusing on seedling emergence and seedling growth (fresh and dry mass) of terrestrial plants [two dicotyledons (*Lactuca sativa* and *Solanum lycopersicum*) and two monocotyledons (*Triticum aestivum* and *Avena sativa*)], reproduction of invertebrates (*Folsomia candida* and *Eisenia fetida*), soil microbial parameters (dehydrogenase, CM-cellulase, acid phosphatase, arylsulfatase, urease, and nitrogen mineralization), and soil elutriate tests with standard aquatic species: (*Allivibrio fischeri*, *Raphidocelis subcapitata*, *Lemna minor* and *Daphnia magna*) were performed to test both a Portuguese natural soil (regosol) spiked with a range of As concentrations and corresponding elutriates of the spiked soils, following standard protocols (ISO and OECD). The NOEC, LOEC and ECx, values were obtained or estimated to show the concentrations that cause no effect, that started to cause a significant effect or that cause a x% effect (ECx) to the tested organism and endpoints assessed, respectively. According to existing guidelines, a probabilistic method (species sensitivity distributions) was used to estimate the HC_x – hazard concentration for x% of the species of the ecosystem, to be proposed as a SSL for As.

In all the tested soil biota, As significantly inhibited the activity of the parameters as the concentration increased, with total inhibition noted at ≥ 281 mg As kg^{-1} soil$_{dw}$ for seed

germination and growth of the terrestrial plant and ≥ 91 mg As kg^{-1} soil$_{dw}$ for the number of juveniles produced by the invertebrates. The elutriates prepared with As were also very toxic to all the aquatic species tested. Arsenic also inhibited the overall metabolic activity of the soil microbial community and the phosphorus cycling processes. The EC$_{50}$ values estimated for all the tested parameters range from 2.00 to 467.16 mg As kg^{-1} soil$_{dw}$, with *S. lycopersicum* (fresh mass) having the most sensitive effect concentration. HC$_{20}$(EC$_{50}$ - SSL) of 11.01 mg As kg^{-1} soil$_{dw}$ was proposed as SSL and HC$_{50}$(EC$_{50}$) of 29.23 mg As kg^{-1} soil$_{dw}$ was proposed as the immediate remediation value. These soil guideline values will be a valuable tool for the risk assessment of the soils surrounding the Estarreja Chemical Complex.