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Accumulation of potentially harmful elements in soils and forage plants in the Industrial area of Estarreja, Portugal

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The industrial municipality of Estarreja, located in littoral north central of Portugal, one of the most important poles of the Portuguese chemical industry, is operating for more than seven decades. The industrial Chemical Complex of Estarreja is composed of several chemical industries, which are recognized as important sources of heavy metal inputs into the environment. The most important input in environment is chiefly related to past industrial activities, namely with the production of sulphuric acid from arsenopyrite roasting (e.g. As, Cu, Ni, Pb and Zn) and from chloralkali plant (e.g. Hg). Other plant like CIRES (PVC) and DOW (polymeric isocyanates) are also present in this area.

This study reports levels of some heavy metals and arsenic in soils and forage plants from Estarreja and from a reference site (Ouca, Vagos).

Composite samples of topsoil (0-15 cm) were collected at 90 sites and 27 forage plants (gramineae). In Ouca were collected 20% of this numbers. The soil samples were dried at 40ºC and passed through a 63 [U+F06D]m sieve. All plants were carefully washed separated into roots and green shoot material and ground to a fine state of subdivision. Both soils and plant were analyzed in the same way, extraction with aqua regia and the multi-element analysis was done by ICP/ES & MS. In addition, the availability of the four metals in these soils was evaluated using ammonium acetate as the extracting solution. Data were assessed for accuracy and precision.

In Estarreja area the maximum concentrations found in the soils are, for example, above 100,000 mgkg-1 for As, 1,540 mgkg-1 for Cu, above 100 mgkg-1 for Hg, and 3,573 mgkg-1 for Zn. The spatial distribution of these metals shows a typical anthropogenic pattern, with the highest values near the factories and sewage outlets and decreasing to background values with the distance away from these contaminating sources. In Ouca, the reference area, located approximately 30 km south of Estarreja, with the same general characteristics (geology, pedology, etc.), this potentially harmful elements show concentrations close the national background [1].

In surrounding area of Chemical Complex of Estarreja, the maximum concentrations found in green shoots are 255 mgkg-1 for As, 30 mgkg-1 for Cu, 5 mgkg-1 for Hg, and 523 mgkg-1 for Zn. The maximum contents in roots are 1774 mgkg-1 for As, 80 mgkg-1 for Cu, 12 mgkg-1 for Hg and 919 mgkg-1 for Zn. For almost the investigated elements, the accumulation occurs in roots. The biological absorption coefficient was calculated for these four potentially harmful elements the two areas.

The elements investigated in forage plants are preferentially accumulated in the roots. The roots seem to act as a barrier for the uptake of these metals, thus attenuating the impact of high metal contents in soils of green areas often used as pasture land and agriculture.

At the present perception studies are ongoing and in the future all these data should be complied and correlated to investigate possible relationships to public health problems.

(1) Inácio M, Pereira V, Pinto MS. 2008. Journal of Geochemical Exploration; 98: 22-33.