Integrated Methodology for the Environmental Risk Assessment of an Abandoned Uranium Mining Site.

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The large volumes and solutions manipulated in the extraction and processing operations of radioactive ores generate huge rates of useless by-products, solid wastes, liquids and or gaseous effluents which have been disposed in open air areas for many years. Wind, rainfall and biological processes tend to provoke the dispersion of these materials in the environment interfering in their release and transport processes through the atmosphere, superficial aquatic systems or through subsoil leading to the contamination of new environmental sub-compartments. The radionuclides transport in the ecosystems, characteristics of the systems where there was former uranium ore production, still has not been sufficiently investigated and documented.

It was our objective to apply mathematical models with phenomenological basis to the release, the dispersion and the intercompartimental transfer of low level radioactive substances. Multicompartment models were developed and adapted with the purpose to predict the activity concentration in predefined exposition points located in each one of the compartments.

Our research works ensue essentially in the development of models concerning to the release mechanisms, to the radionuclides transport, its intercompartimental transfer and fate, consolidating the bases to an exposure assessment to which may be exposed the selected components from the local ecosystem. To validate the developed models it was used, whenever it was possible, the obtained information referring to the surrounding areas of the Urgeiriça mine wastes disposal.

A systematic analysis was performed in order to consider the integrated analysis of the following points: i) **sources** (tailings piles, ore processing wastes disposal with and without cover system,...); ii) **release mechanisms** (for instance: leaching, decay with gaseous radioactive products,…); iii) **transport mechanisms** or dispersive vectors (air and water); iv) **transfer mechanisms** between the environmental compartments (sorption, absorption, partition,…); v) **concentrations estimative in each environmental compartment** using dispersion models with spatial variation, whenever it was possible; vi) consideration of **privileged exposure points** (wells, biota, irrigation water, inhabited areas,…) and vii) consideration of the **exposed receptors** (flora, selected trophic levels from the food chain, resident's consumers of contaminated water, population,…).

The important routes of contamination have been identified as a basis for determining the modelling approach. The radionuclides of major concern were also identified in each one of the compartments based on their chemical, physical and radiological properties.

It was also incorporated a radionuclide transfer model through the food chain having been included in a more complete version of the conceptual model, the radionuclides distribution within an organism for a relevant trophic level (pasture animals) adapted from the biokinetic models present in the specialized literature.

For each sub-model at least one simulation was done. The necessary parameters were adopted from different sources: some parameters were adopted from measurements referring to the particular contaminated site, the Urgeiriça uranium tailings piles; others were adopted from published data. The unknown parameters were estimated from available data or from literature references in cases where on-site data were not available.