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From conceptual model to remediation: bioavailability, a key to clean up heavy metal contaminated soils.

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Processes of metal bioavailability in the soil
To know the bioavailability processes at site specific levels is essential to understand in detail the risks associated with pollution, and to support the decision-making process, i.e. description of the conceptual model and choice of clean up technologies. It is particularly important to assess how chemical, physical and biological processes in the soil affect the reactions leading to adsorption, precipitation or release of contaminants.

The measurement of bioavailability
One of the main difficulties in the practical application of the bioavailability concept in soil remediation is the lack of consensus on the method to be used to measure bioavailability.
The best strategy is to apply a series of tests to assess bioavailability, since no applicable method is universally valid under all conditions. As an example, bioavailability tests for phytotechnology application should consider two distinct aspects: a physico-chemical driven solubilization process and a physiologically driven uptake process. Soil and plant characteristics strongly influence bioavailability.

Bioavailability as a tool in remediation strategies
Bioavailability can be used at all stages in remediation strategies: development of the conceptual model, evaluation of risk assessment, and selection of the best technology, considering different scenarios and including different environmental objectives.
Two different strategies can be followed: the reduction and the increase of bioavailability.
Procedures that reduce bioavailability aim to prevent the movement of pollutants from the soil to the living organisms, essentially by: i) removal of the labile phase of the contaminant, i.e. the fraction which is intrinsic to the processes of bioavailability (phytostabilization); ii) conversion of the labile fraction into a stable fraction (precipitation or adsorption); iii) increase of the resistance to mass transfer of the contaminants (inertization).
Procedures that aim to increase the bioavailability of pollutants are used in technologies which remove or destroy the solubilized contaminants. These procedures can increase mass transfer from the absorbed phase by means of sieving in order to decrease the diffusion processes (soil washing), by increasing the temperature (low temperature thermal desorption), or through the addition of chemical additives, such as chelating agents (Phytoextraction Elektrokinetic remediation).

Concluding remarks
Bioavailability should be a key component of the exposure evaluation in order to develop the conceptual model and to select the technology, in particular when:
• only some chemical forms of contaminants are a source of risk for the site;
• default assumptions regarding bioavailability are not suitable because of the site's specific characteristics;
• the final destination of the site will not be modified at least in the near future.