Bioaccessibility options for detailed quantitative risk assessment of metals

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The United Kingdom has adopted a risk based approach for the assessment of contaminated land and human health impact. As part of this approach, Soil Guideline Values (SGV) and Generic Assessment Criteria (GAC) have been developed by DEFRA, the Environment Agency and private industry to enable Generic Quantitative Risk Assessment (GQRA). These assessment criteria have been derived using a set of assumptions based on the potential exposure pattern of human receptors in a series of standard land uses. One of the main assumptions in the derivation of these assessment criteria is that 100% of the contaminant present in the soil will be bioavailable or bioaccessible. Although this cautious assumption may be necessary in the preliminary stages of risk assessment to ensure the protection of human receptors, it may result in overly conservative risk assessment where the exposure of the receptor is over estimated. Recommendations for remediation may subsequently be made in situations where remediation is not appropriate.

Over recent years the potential for bioaccessibility data to be incorporated into Detailed Quantitative Risk Assessment (DQRA) has been increasingly recognised. However, its application by industry and acceptance by regulators is not currently widespread and is limited to a small number of contaminants.

To investigate the potential for the application of bioaccessibility data in DQRA, GAC which incorporate published bioaccessibility data (GAC_{BIO}) have been derived using the Contaminated Land Exposure Assessment model (CLEA). GAC_{BIO} have been derived for selected metals; arsenic, cadmium, mercury, nickel and vanadium for standard residential, commercial and allotment land uses. By comparing GAC_{BIO} to typical contaminant concentrations encountered in UK soils we explore the options for the future application of bioaccessibility data in DQRA by UK industry.

A risk evaluation of the need to remediate based on the use of literature estimates of bioavailability or of GAC that invoke generic bioavailability values would be difficult to defend. GAC_{BIO} can however be useful in deciding whether to incur the cost of site specific

studies of bioavailability. The applicability of GAC_{BIO} can be determined by considering three lines of evidence: history of contaminant formation (natural or anthropogenic); geochemical sequential extraction and physiological based tests. The natural or anthropogenic geochemical processes that led to the formation and current disposition of the contaminants of concern (CoC) at any specific site will give an indication of the likely chemical instability and therefore bioavailability of such CoC. Sequential extraction testing can give an indication of the mineral species with which different fractions of the CoC are associated and hence their likely availability. Finally empirical physiologically based tests can give an insight into the material specific chemistry.

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