Developments in the modeling approach for radiological safety assessment of ^{238}U-series radionuclides in waste disposal.

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Human and environmental exposures doses from radioactive substances need to be quantified as part of the risk assessment process and for developing long term remediation strategies. In most radiological assessment models, simplistic, empirical ratios are used to simulate contaminant transfers between environmental compartments are favoured because of the pragmatic ease with which they facilitate modelling. Their use, however, significantly increases the uncertainty of model predictions because they do not account for the underlying processes that govern spatial and temporal variation. On the other hand, the migration of radionuclides in the ^{238}U decay series in soils and their uptake by plants is of interest in various contexts, including the geological disposal of radioactive waste and the remediation of former sites of uranium mining and milling.

The structures of models used to assess doses in the biosphere for long-term waste disposal assessments have not changed significantly in the last twenty five years or so. Several aspects of the model representation of the biosphere are currently being debated in international forums, and these would benefit from further investigation. These include biogeochemical zonation of radionuclides in the sub-surface, caused by changes in the redox characteristics in response to a variable water table. It has been proposed that traditional model structures are not able to represent this problem adequately.

Major improvements are needed to make models more process-based and capable of simulating the kinetics of contaminant transfers. A major challenge is to identify where the greatest advantages can be gained in reducing model uncertainty and understanding variability, developing a criteria to identify when a research is required to parameterizing dynamic-mechanistic models, and identifying the level of model complexity needed for specific exposure scenarios.

This work describes a top-down review of the FEPs (features, events and processes) required for ^{238}U-series radionuclides by long-term assessment models for waste disposal and proposes an alternative model structure which is used to investigate the potential impacts of variable conditions in the calculated soil and plant radionuclide concentrations. This work looks also at the potential for the inclusion of spatial-temporal resolution in models for the long term dose assessment.