Incorporation of metal Bioavailability into the EU Risk Assessment Framework and Significance of Sediments

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Introduction: Aiming at a more realistic risk assessment of metals, bioavailability is taken into account in a tiered approach which is described in the Metals Environmental Risk Assessment Guidance (MERAG, 2007). This approach has been implemented in the guidance document assisting REACH registrants to perform risk assessments of metals but also plays a role in other legislations such as the Water Framework Directive. Environmental quality criteria are the primary benchmarks against which environmental pollution is measured. Even though aquatic systems are dynamic and there is continuous interaction between solid phases (sediment, suspended matter) with liquid phases (freshwater, groundwater, porewater), regulatory target values have had often considered the water matrix only.
Environmental quality standards (EQS) for sediments are now gain improved attention due to the increased awareness that the goal of a good environmental status can only be achieved if sediment quality is evaluated and integrated in the assessment of environmental quality. Asking for the relevant exposure pathways for inorganic metals to organisms, the compartments water and sediment have been evaluated if existing approaches are suited to answer this main question of bioavailable metals.

Results and Discussion: The metal-specific exposure factors presented here will contribute to the concept of using bioavailable fractions in estimates of PEC and PNEC, which should improve the basis of risk assessments. According to the Figure 1 three exposure scenarios have to be considered, free metal ions, metal complexes, and particle bound metals. Toxicity results when the rate of metal uptake from all sources exceeds the combined rates of detoxification and excretion of the metal concerned.
An important step forward would be to determine the plausibility of the methods applied in existing regulatory guidelines in order to delineate the main uptake routes for metals in different compartments. The goal should be that bulk metal concentrations are adjusted by appropriate bioavailability factors to achieve comparable, actual uptake of metals by organisms.

For sediments a couple of approaches are reviewed and evaluated. It was noted that there is no answer from the SEM-AVS concept to the main question for the main uptake routes of metals to biota in sediments. Important uncertainties in the application of the AVS-equilibrium concept exclude this approach for the prediction of bioavailable metal exposure concentrations as a regulatory tool.

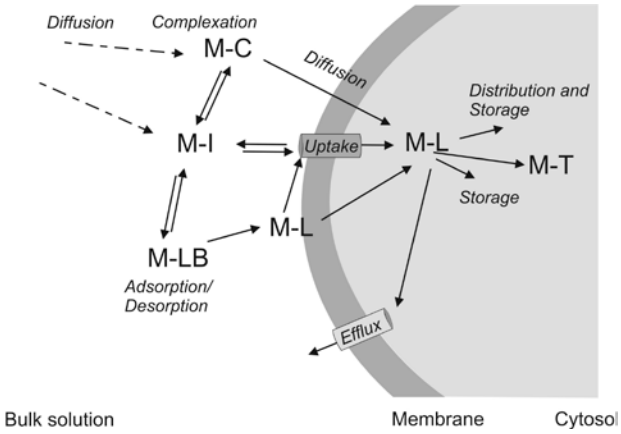

Fig. 1: Uptake routes of metals for organisms

It is a controversial discussion about the importance of diet-borne metals. There is some evidence for organisms with a particular feeding behaviour like bivalves from marine environments that dietary uptake is at least as important as metal uptake from the aqueous phase and in many cases dominates metal accumulation. The value of the methods for measuring bioavailability in sediments can be significantly improved when the species-, metal-, and particle-specific aspects of bioavailability are more accurately taken into account in the design of chemical simulation methodologies. For a risk assessment, direct measurements of bioavailability and bioaccumulation of metals in living organisms could summarize all influencing factors.
Finally the metalloregion concept will be discussed, which based upon the natural background concentration of metals and its suitability to predict the bioavailability of metals.