MULTIPLE SCALE MOBILITY OF METALS IN SOIL ECOSYSTEMS

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Abstract: Assessment of trace element mobility in soil ecosystems is complex due to multitude of chemical, physical, biological, and systemic parameters. Their combined actions influence trace element behavior. Highlighted factors exerting a strong influence on the mobility of Cd, Cu, Pb, and Zn at different spatial, temporal, and biological scales include hydrology, vegetation type, land use, chemical composition, and biological activity.

Introduction: The integration of concerns about sustainability into the management of contaminated soil calls for long-term thinking. However, predictions about the ecological impacts of metals in soil are complicated by the complexity of the soil matrix and ecosystem. Quantifying the exposure of soil organisms to toxic substances is part of the calculation of impacts according to methods such as LCA and ERA. This poster aims at illustrating factors that determine the long-term mobility of metals in soil ecosystems.

Methods: A literature review has resulted in the identification of key parameters for assessment of metal mobility in soil, with special focus on long-term perspectives.

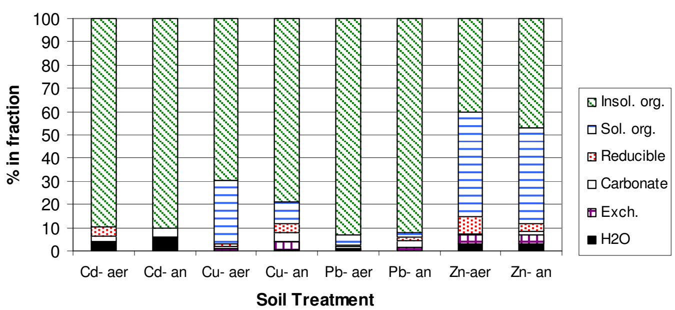
Physico-chemical mobility:

Kd values according to pH and time since contamination (L/kg)

Soil treat-ment	Fresh, sludge pH 4.5	Fresh, sludge pH 6.5	Aged, sludge pH 6.5-7.0
Cd	**9.0**	**89**	**2500**
Cu	**262**	**612**	**360**
Pb	**1313**	**4948**	**> 13000**
Zn	**92**	**589**	**4800**
Ref:	3	3	7

1) As pH decreases, free ion mobility increases
2) For organo-metal complexes and other colloidal fractions, mobility increases as pH increases
3) As length of contamination increases, affinity for the solid phase increases

Hydrological influence on metal distribution in a Dutch peat soil



Source: Van der Welle, personal communication

Anaerobic conditions, which depend on water saturation and soil depth, decrease the soluble fraction.

References: **1**. Bergkvist 1987, *Forest Ecol. and Manage.* 22: 29; **2**. Bergkvist et al. 1989, *Water, Air, and Soil Poll.* 47: 217; **3**. Gao et al. 1997, *Water, Air, and Soil Poll.* 93: 331; **4**. Hunter et al. 1987a, *Jour. of App. Ecol.* 24 (2): 573; **5**. Hunter et al. 1987b, *Jour. of App. Ecol.* 24 (2): 587; **6**. Hunter et al. 1987c, *Jour. of App. Ecol.* 24 (2): 601; **7**. McBride et al. 1997, *Soil Science.* 167 (7): 487; **8**. Stahr et al. 1980, *Soil Science.* 130 (4): 217; **9**. Van der Welle 2007, PhD. Thesis, RU Nijmegen.

Metal mobility at different spatial scales

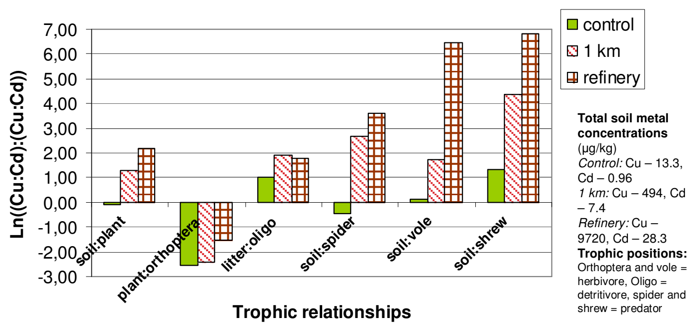
% of yearly input retained

	Cd	Cu	Pb	Zn	Ref.
Watershed	**69**	**61**	**95**	**64**	8
Spruce forest (a)	**-991**	**56**	**91**	**-365**	2
Spruce forest (b)	**-693**	**34**	**96**	**-532**	2
Birch forest (a)	**-118**	**9**	**97**	**170**	2
Birch forest (b)	**-74**	**1.9**	**97**	**58**	2
Grassland (a)	**38**	**35**	**66**	**22**	1
Grassland (b)	**52**	**2**	**35**	**6**	1
Soil top layer*	**77**	**57**	**74**	**62**	7

(a: podzol, b: acidic brown soil), (*Not an annual budget; retention 15 yrs. after sludge application)

Element-specific metal retention behavior is related to: spatial extent of the assessment, vegetation type, soil type.

Differential trophic mobility of Cd and Cu in a grassland ecosystem



Ref: Hunter et al 1987 a, b, c

If y value > 0 the Cu:Cd ratio is higher in the lower trophic level, thus there is enrichment of Cd relative to Cu.
If y value < 0 the Cu:Cd ratio is higher in the higher trophic level, thus there is no enrichment of Cd relative to Cu.
For a given soil, predators will be more exposed via trophic transfer than herbivores; also, element-specific behavior is to be expected.

Biological mechanisms influencing metal mobility in soils:

- Bioturbation (+)
- Microbial activity (+/-)
- Root growth: rhizosphere effects and preferential flow patterns (+)
- Trophic transfer, bioconcentration (+/-)

Conclusions:

- The feeding habits and trophic position of soil organisms are key factors for determining their exposure to metals in soil
- Soil type, vegetation, hydrology, land use, and biological activity influence long-term patterns of metal mobility
- Soil spatial heterogeneity demands specificity in assessment approaches

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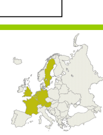

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