Joint Projects

The SeKT Joint Research Project: Definition of Reference Conditions, Control Sediments and Toxicity Thresholds for Limnic Sediment Contact Tests *

Ute Feiler[1]*, Wolfgang Ahlf[2], Sebastian Hoess[3], Henner Hollert[4], Helga Neumann-Hensel[5], Michael Meller[6], Jürgen Weber[7] and Peter Heininger[1]

[1] German Federal Institute for Hydrology, Am Mainzer Tor 1, 56068 Koblenz, Germany
[2] Dept. of Environmental Science and Technology, Technical University Hamburg-Harburg, Eißendorfer Str. 40, 21071 Hamburg, Germany
[3] Institut für Biodiversität-Netzwerk e.V. (ibn), Dr. Johann-Maier-Str. 4, 93049 Regensburg, Germany
[4] Department of Zoology, Aquatic Ecology and Toxicology Group, Morphology and Ecology Section, University of Heidelberg, Im Neuenheimer Feld 230, 69120 Heidelberg, Germany
[5] Laboratory Dr. Fintelmann & Dr. Meyer, Mendelssohnstr. 15, 22671 Hamburg, Germany
[6] ECT Oekotoxikologie GmbH, Böttgerstr. 2–14, 65439 Flörsheim/Main, Germany
[7] NORDUM Umwelt + Analytik GmbH & Co. KG, Am Weidenbruch 22, 18196 Kessin/Rostock, Germany

* **Corresponding author** (feiler@bafg.de)

DOI: http://dx.doi.org/10.1065/espr2005.08.003

Introduction

In current biotest approaches, intact organisms or *in vitro* systems are exposed to sediments using different exposure scenarios. The most important issue in sediment toxicity testing protocols is the question which test phase (solid or liquid) should be used. Whole-sediment exposure protocols represent the most realistic scenario to simulate *in situ* exposure conditions in the laboratory. However, until now there is no agreement in how to acquire and to evaluate the data of the various available sediment contact assays. The SeKT joint research project was initiated with the aim to compare recently developed sediment contact assays by addressing reference conditions, control sediments and toxicity thresholds for limnic sediment contact tests.

1 Background

The European Water Framework Directive (EWFD) pursues the aim to achieve a good ecological and chemical status in the surface waters of European river basins by the year 2015. The necessary reduction of anthropogenic contamination of waters from diffuse and point sources should be attained by setting (i) emission thresholds and (ii) water quality targets that are oriented at the ambient contaminant concentrations (immissions).

While water quality has notably improved over the past three decades through technical water-protection efforts, the – sometimes highly – contaminated sediments in many European river basins remain a heritage from the past era of uncontrolled industrial production and will continue to influence the quality of waters significantly for many years to come (European Network SedNet 2004). Sediment-borne contaminants can be remobilized through bioturbation (Power & Chapman 1992), flood events (Hollert et al. 2000) or dredging and relocation of sediments (Köthe 2003). Thus, contaminated sediments become a secondary contaminant source, posing a threat to organisms for which they are habitat and food source, and might become an obstacle for implementing the Water Framework Directive (Förstner 2002). Taking this background into account, the monitoring and assessment of sediment quality assumes high significance in the implementation of the European Water Framework Directive (Brils 2004).

In this context, there is still a research deficit regarding the application of sediment contact tests: Whereas the available standardised aquatic bioassays, using pelagic organisms, consider the actual bioavailability of sediment contaminants only insufficiently, sediment contact tests are highly relevant for an approach to this problem considering the whole ecosystem. Sediment contact tests are biological methods for the determination of the effects caused by whole sediments in organisms, taking into account all possible pathways of contaminant uptake by the test organisms (particle contact, food, pore water).

The complexity of the sediment matrix (particles and water) places high requirements on the biological test methods. For a risk assessment, bioassays have to be suitable to distinguish between anthropogenic impacts (contamination) and the influences of natural factors such as particle-size or organic content. Over the past ten years, successful efforts in development, standardisation and validation of sediment contact assays for routine application were made worldwide, and, particularly in Germany (e.g., Feiler et al 2004, Heise & Ahlf 2005, Hollert et al. 2003, Liss & Ahlf 1997, Traunspurger et al. 1996, Weber et al. 2005). However, the devel-

* This joint project is supported by the German Federal Ministry of Education and Research (BMBF; PT Forschungszentrum Karlsruhe, No. 02WU0598)

opment and the application of the test systems repeatedly encountered fundamental problems that cannot be resolved by further developments of individual tests, but require a comprehensive comparative study.

2 Aim of the Joint Research Project

The studies of the forthcoming joint research project SeKT (German: **Se**diment**K**ontakt**T**ests) aim to improve the interpretability and applicability of sediment contact tests for the quality assessment of a wide range of different sediments. A set of standardised tests which use test organisms of different trophic levels inhabiting the various microhabitats within freshwater sediments are applied: bacteria (*Arthrobacter globiformis*), fungi (*Saccharomyces cerevisiae*), nematodes (*Caenorhabditis elegans*), oligochaetes (*Lumbriculus variegatus*; toxicity and bioaccumulation), fish (*Danio rerio*), and higher plants (*Myriophyllum aquaticum*). With these test organisms also a broad range of contaminant exposure routes is covered.

A key issue of this study is the investigation of the variability of test systems in unpolluted sediments. The definition of reference conditions and standardised control sediments is a prerequisite for (1) the definition of toxicity thresholds (2) the comparability of several sediment contact tests within a test battery as well as (3) the application of sediment dilution series. For this purpose, the test battery is first run on unpolluted natural and artificial sediments to determine the response of the test systems to important sediment properties (e.g. TOC, particle size). The results of this investigation should explain the variability of the different test systems in unpolluted sediments by relating the outcome to sediment properties. Moreover, information about the variability will also help to set reliable toxicity thresholds for the various biotests. Additionally, control sediments (artificial and natural) that can be commonly used for the whole test battery will be defined.

To evaluate the control sediments as well as the defined toxicity thresholds, experiments will be carried out with spiked unpolluted and with polluted sediments. To get information about dose-response relationships for the various test systems, (1) control sediments will be spiked with increasing concentrations of a mixture of contaminants and (2) highly polluted, toxic sediments will be diluted with control sediments.

3 The SeKT Consortium

The SeKT consortium consists of seven partners who are representatives of the German Federal Institute of Hydrology, of two Universities and of four SMEs (small to medium-sized enterprises). The joint research project is made up of seven subprojects:

1. Coordination (Dr. Ute Feiler) and sediment contact test with *Myriophyllum aquaticum*, German Federal Institute of Hydrology (BfG)
2. Sediment contact test in micro plates with *Arthrobacter globiformis* (freeze-dried) and physical-chemical sediment analysis, Dr. Fintelmann & Dr. Meyer Handels- und Umweltschutzlaboratorien GmbH
3. Sediment contact test with *Caenorhabditis elegans* (Nematoda), Institut für Biodiversität-Netzwerk eV (ibn)
4. Sediment contact- and bioaccumulation tests with benthic organisms, ECT Oekotoxikologie GmbH
5. Sediment contact test with *Saccharomyces cerevisiae* (yeast contact test), NORDUM GmbH & Co.KG
6. Sediment contact test with *Arthrobacter globiformis* (DIN 38412-48), TU Hamburg-Harburg (TUHH)
7. Sediment contact test with *Danio rerio*, University of Heidelberg

References

Brils J (2004): Sediment Monitoring under the EU Water Framework Directive. JSS – J Soils & Sediments 4, 72–73

DIN 38412-48: Testverfahren mit Testorganismen, Teil 48. *Arthrobacter globiformis* Kontakttest für kontaminierte Feststoffe

Feiler U, Kirchesch I, Heininger P (2004): A New Plant-based Bioassay for Aquatic Sediments. JSS – J Soils & Sediments 5, 261–266

Förstner U (2002): Sediments and the European Water Framework Directive. JSS – J Soils & Sediments 2, 54–54

Heise S, Ahlf W (2005): A New Microbial Contact Assay for Marine Sediments. JSS – J Soils & Sediments 5, 9–15

Hollert H, Dürr M, Erdinger L, Braunbeck T (2000): Cytotoxicity of settling particulate matter and sediments of the Neckar river (Germany) during a winter flood. Environ Toxicol Chem 19, 528–534

Hollert H, Keiter S, König N, Rudolf M, Ulrich M, Braunbeck T (2003): A new sediment contact assay to assess particle-bound pollutants using zebrafish (*Danio rerio*) embryos. JSS – J Soils & Sediments (3) 197–207

Koethe H (2003): Existing sediment management guidelines: An overview. What will happen with the sediment/dredged material? JSS – J Soils & Sediments 3, 139–143

Krebs F (2000): Ecotoxicological assessment of dredged material from federal waterways by the pT-value method. Hydrologie und Wasserbewirtschaftung 44, 301–307

Liss W, Ahlf W (1997): Evidence from whole-sediment, porewater, and elutriate testing in toxicity assessment of contaminated sediments. Ecotoxicol Environ Safety 36, 140–147

Power EA, Chapman PM (1992): Assessing sediment quality. In: Burton GA (ed), Sediment toxicity assessment, Lewis Publishers, Boca Raton

SedNet (2004): Sediment, a valuable resource that needs Europe's attention. SedNet recommendations for sediment research priorities related to the soil research clusters

Traunspurger W, Haitzer M, Hoss S, Beier S, Ahlf W, Steinberg C (1997): Ecotoxicological assessment of aquatic sediments with *Caenorhabditis elegans* (nematoda) – A method for testing liquid medium and whole sediment samples. Environ Toxicol Chem 16, 245–250

Weber J, Kreutzmann J, Plantikow A, Pfitzner S, Claus E, Manz W, Heininger P (2005): A Particle Contact Assay with the Yeast *Saccharomyces cerevisiae* for the Toxicological Assessment of Limnic Sediments and Dredged Material. JSS – J Soils & Sediments (under review)

Received: July 28th, 2005
Accepted: August 4th, 2005
OnlineFirst: August 4th, 2005