Topical Scientific Workshop on Risk Assessment for the Sediment Compartment
7-8 May 2013, Helsinki, Finland

CASE STUDY – SUMMARY FORM

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(Number to be filled by the organisers)

The case studies covering concrete examples of sediment risk assessments for particular chemicals and/or conditions are intended to support the breakout group discussions. All submitted case studies will be distributed to the participants as supporting background material for the workshop and will be included in the workshop proceedings. The Scientific Committee will select some case studies or selected areas of the case studies and will invite the authors to present these cases during the workshop, either at the plenary session or during the break-out groups.

NOTE: By submitting this form, the authors confirm that they have the ownership of the information presented in the case study and that they authorise ECHA to distribute the submitted information to the workshop participants and to publish it in paper and/or electronic format as part of the workshop proceedings.

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Case study details

Case study is particularly relevant for the subthemes:
Note: the case study should cover all three areas, but please indicate if it is particularly relevant/informative for one or more subthemes

X	Problem definition and conceptual model for sediment risk assessment
	Exposure assessment
X	Effect assessment

Authors: Georg Reifferscheid, Dörthe von Seggern, Elke Blübaum-Gronau, Marvin Brinke, Sebastian Buchinger, Ute Feiler, Peter Heininger, Martina Klima, Evelyn Claus

Title: Comprehensive chemical, toxicological and biological analysis of the sediments of lake Rummelsburg (Berlin) to derive measures for a natural repopulation of the aquatic environment with benthic organisms

Keywords: Sediment contamination, bio tests, chemical analysis, multiple lines of evidence, macro zoobenthos, sediment quality guidelines,

Summary:

The sediments of the "Rummelsburger See" a lake-like, partly separated expansion of the river Spree in Berlin have been contaminated due to the discharge of mainly industrial wastewaters for nearly one century. Nowadays, in the course of urban development measures, the territories around the lake are progressively reclassified as residential area. As a consequence of this, divergent claims on utilisation of the lake arise. This leads to the need of a comprehensive risk assessment adapted to the usage of the lake and the area around it.
Since the 1990s there is evidence that the lake exhibits significant deficiencies in biodiversity. This was believed to be caused by the high chemical contamination. Remedial measures did not yield the expected result of a significant improvement of the ecological status.
The main goal of this case study was to characterize the sediment conditions comprehensively by chemical, biological and ecotoxicological analyses. The extent and the nature of ecological stressors had to be explored in more depth in order to recommend possible future measures for a natural repopulation of the aquatic environment with benthic organisms.
Only the integrated view of all lines of evidences provided a coherent picture of the quality status of the lake. Based on the results of this study it can be concluded that both the high chemical contamination with persistent organic and inorganic chemicals, their toxicity, and a poor substrate composition makes a natural repopulation scenario for the improvement of the biological diversity extremely improbable.

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A significant improvement of the habitat could only be achieved by either a very cost-intensive removing of the sludges or by covering the sediments with uncontaminated substrate of appropriate structure or a combination of both.

Poster exhibition
The case study will be presented also as a poster

☐ Yes ☒ No

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SUGGESTED CONTENT FOR THE CASE STUDY: please try to limit the case study to 5 pages (or a maximum of 10 pages for complex case studies) focussing on the elements relevant for a broad general discussion on concepts, methods and approaches applicable to all chemicals or to specific chemical groups.

1. BACKGROUND AND PROBLEM DEFINITION

a. Please include a brief introduction to the assessment aims and goals, the legal and regulatory context if appropriate, the problem definition, and other elements relevant for understanding the assessment

Sediments of the "Rummelsburger See", a lake-like, partly separated expansion of the river Spree located in the metropolitan area of Berlin with an area of some 450 000 square meters have been contaminated due to the discharge of mainly industrial waste water in the course of about one century. Meanwhile the territories around the lake are progressively reclassified as residential area.

It has been suggested that the contamination of the lake with a number of chemicals is the main reason for significant abnormalities of the biological diversity in the lake.

Restorative remediation measures between 1999 and 2001 like recovery of ammunition from the second world war, partial removing of sludge, sediment conditioning by iron compounds and calcium nitrate and the establishment of a pneumatic destratification installation did not improve the ecological status significantly.

In the case study the sediment conditions were comprehensively analyzed by chemical, biological and ecotoxicological analyses. A sediment guideline approach was used to assess the data of the chemical analysis.

The main goal of this project was to analyse the extent and the nature of ecological stressors such as chemical contamination and missing structural diversity in order to recommend possible future measures for a natural repopulation of the aquatic environment with benthic organisms.

NOTE: This case study did not follow the classical risk assessment philosophy. We did not use exposure and effect assessment models as they are commonly used in a prospective risk assessment but

we focused on the assessment of a complex in situ chemical contamination situation.

2. MAIN CASE STUDY DESCRIPTORS

a. Please describe with key words or short sentences the main characteristics of the risk assessment, e.g. generic or site-specific, local/regional/continental, freshwater/estuarine/marine; the chemical(s) or pollution source addressed, targeted to particular areas/concerns, etc.

- Comprehensive analysis of the chemical contamination of an urban lake-like freshwater body severely influenced by mainly industrial effluents over nearly one century
- analysis of the toxicity applying toxicity tests and sediment contact tests
- analysis of the macro zoobenthos
- application of a sediment guideline approach
- derivation of suggestions for measures that could facilitate a repopulation scenario for the improvement of the biological diversity

3. CONCEPTUAL MODEL

a. Please describe the links between the problem formulation (the risk to be assessed), the exposure and effect assessments and its comparisons in the risk characterisation (how the endpoints/receptors were selected and the risk estimated). Include graphical conceptual models, lines of evidence or risk lines (linking the source and/or stressor with the receptors/endpoints for which the risk is estimated).

b. Please indicate if the assessment has followed a particular guidance or recommendation and include the reference and/or link.

The assessment followed partially the Directive for the Handling of Dredged Material on Federal Inland Waterways (HABAB-WSV) 2000. Three lines of evidence described there (chemical analysis, toxicity measured with indicator organisms belonging to the three trophic levels primary producers, primary consumers and destruents, ecological analysis by determination of macro-zoobenthic invertebrates) were complemented by additional biotests for the detection of mutagenicity and estrogen receptor activating potentials. The data of the chemical analysis was assessed by a sediment quality guideline (SQG) approach. Sediment quality guidelines are reference values for the concentrations of chemical substances in sediments, that

were derived effect based e.g. by correlating chemical analyses with the toxicity in direct sediment contact or the change in the composition of benthic communities. SQGs can be specified as threshold effect levels (TEC) or probable effect levels (PEC). SQGs can provide information on the probability of toxicity for benthic organisms.

4. EXPOSURE ASSESSMENT

a. **METHODOLOGY:** Please describe briefly the main elements of the exposure assessment (e.g. release estimation, environmental processes considered, assumptions, use of monitoring data, …)
b. **RESULTS:** Please describe briefly the outcome of the exposure estimation

Representative sediment samples of the lake were taken from the sediment surface in June 2012. One sediment core and one reference sample from the river Spree were taken additionally.

Chemical analysis included: SVOCs, mineral oil hydrocarbons, 7 PCBs, 16 EPA-PAHs, organotin compounds, dioxins, alkyl phenols, and heavy metals.

Chemical and biological analyses as well as ecotoxicological tests were performed with the same material.

5. EFFECT ASSESSMENT

a. **METHODOLOGY:** Please describe briefly the main elements of the effect assessment (e.g. ecological receptors and endpoints, data and assessment principles; PNEC or quality criteria derivation, use of full concentration-response curve, etc. …)
b. **RESULTS:** Please describe briefly the outcome of the effect assessment

A biotest battery consisting of ISO-standardized tests with luminescent bacteria, freshwater algae, daphnids (Daphnia magna), nematodes (Caenorhabditis elegans), lemnaceae (Lemna minor) and higher plants (Myriophyllum aquaticum) was used for measuring the toxicity of sediment pore water and elutriates.
In the case of C. elegans and Myriophyllum auqaticum, test systems were performed as sediment contact tests.

All tests were carried out using concentration-response curves (exception sediment contact tests) to the no effect level. Results were expressed as pT-values which is the negative binary logarithm of the first non-toxic dilution level.

Additionally in vitro tests on mutagenicity (Ames fluctuation test) and endocrine disruption (YES-test) were conducted. Results were expressed as cdr-values (concentration dependent revertant values) or Ethinylestradiol equivalent concentrations (EEQs) (YES-test)

Macrozoobenthos was determined up to the genius or species level. Species and individual density of benthic invertebrates (ind./m2) were recorded. Settlement homogenicity was analysed by cluster analysis. Species diversity was calculated using the Berger-Parker-Index.

Additionally, the incidence of toxicity was calculated on probable effect concentrations (PEC) on the basis of two different chemical data sets.

6. RISK CHARACTERISATION & CONCLUSIONS

a. **METHODOLOGY:** Please describe briefly the main elements of the risk characterisation (e.g. lower/higher tier, risk maps or other geo-referred approaches, deterministic/probabilistic), the metrics (risk quotients, quantitative likelihood estimations, qualitative likelihood estimations, risk expressions indicating the magnitude and likelihood of the expected impact, etc.), uncertainty and variability assessments, how ecological processes such as recovery, re-colonisation, resilience, redundancy, etc. were accounted for.
b. **RESULTS:** Please describe briefly the outcome of the risk assessment including the risk communication phase.

Chemical analyses (<63 µm fraction) revealed concentrations of 400 – 1400 µg/kg PCBs, 80-400 µg/kg p,p'-DDD, 2000-9000 µg/kg mineral oil hydrocarbons, 55-370 mg/kg EPA-PAHs, 500-2400 µg/kg organotin compounds, 9,7-76 ng I-TE/kg dioxin like activity, 80-440 mg/kg Cr, 9-46 mg/kg Cd, 2,2-4,1 mg/kg Hg, 1000-6200 mg/kg Cu, 62-97 mg/kg Ni, 1600-2700 mg/kg Zn, 400-820 mg/kg Pb, and 20-51 mg/kg As.

Whereas sediment pore waters and elutriates showed no toxic effects to freshwater algae and daphnia and a moderate toxicity to

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luminescent bacteria, the samples were moderately to highly toxic to Lemna minor.
Growth of C. elegans was moderately inhibited but the reproduction of the nematodes was severely disturbed in most cases.
The sediments were not toxic to Myriophyllum aquaticum.

Estrogenicity ranged from 5 to 25 ng/l EEQ and was (with the exception of one sample) highly correlated to the concentrations of iso-Nonylphenol (normalized to TOC).

Pore waters were not mutagenic but particle bound mutagenicity was detectable. Mutagenicity increased with the metabolic competence in the test condition. PAHs, nitroarenes and aromatic amines supposed to be responsible for the mutagenic effects.

Surprisingly, the reference sample also showed a considerable chemical contamination and toxicity towards Lemna and C. elegans.

The analysis of macrozoobenthos showed that species diversity was low. Especially such species were found that have low demands on their habitat. Cluster analysis revealed two distinct series depending on the sand / silt ratio of the substrate. SPEAR species were almost absent.

Analysis of PEC-quotients (PEC: possible effect concentration) revealed a high probability of toxicity.

The combination of high chemical contamination with persistent organic and inorganic chemicals, toxicity and poor substrate composition makes a natural repopulation scenario for the improvement of the biological diversity extremely improbable.

The study suggests that either a remove of the sediments or a capping with appropriate substrate can improve the in situ situation significantly.

However, a complete removal of the contaminated sediments would cause costs of more than 1.2 Mio € and would bear the risk of transferring the risk to a different location.

The study was reported to the Senate Department for Urban Development and the Environment, Berlin, Germany for further evaluation of the situation and developing further measures. A summary of the analyses will be made available to the public.