Ecotoxicity evaluation of dredged sediments application on agricultural land with contact soil bioassays

Jana Vaší•ková[1], Jakub Hofman[1], Milan Sá• ka[1], Radim Vácha[2]

[1]Research Centre for Toxic Compounds in the Environment, Masaryk University, Faculty of Science, Kamenice 126/3, Brno, Czech Republic, CZ-62500

[2]Research Institute for Amelioration and Soil Protection, Žabov•eská 250, Praha, Czech Republic, CZ-15627

Phone: +420-549 494 267

E-mail: hofman@recetox.muni.cz

Introduction: High volumes of sediment are removed by water managers from Czech rivers, streams and ponds routinely. The subsequent usage of the dredged sediments is an important environmental topic. Risks of dredged sediments are probably often overestimated - they are often classified and handled as waste, although they may have prevalent positive properties (e.g. high nutrient content, structure and texture). On the other hand, sediments often accumulate high levels of toxic contaminants and when applied on land, they may cause irreversible serious harms to ecosystems. Wise and careful risk assessments and decision making schemes are necessary to analyze and consider all positive or negative consequences.

Dredged sediments have not been legislatively treated in the Czech Republic before 2009. However, novel legislation for the dredged sediments application on agricultural land was ratified in 2009 to enhance risk assessment and to enable clear decision making. It determines the conditions when it is allowed to use sediment on agricultural soils. It also states limit values for the sediments and for soil where they should be applied. It lists also four contact toxicity bioassays to evaluate possible ecological risks: tests with *Enchytraeus crypticus* (ISO 16387) and *Folsomia candida* (ISO 11267) with tresholds 50% for inhibition of reproduction, test of potential ammonium oxidation (ISO 15685) with tresholds 25% for inhibition of activity, test of root elongation (ISO 11269-1) with threshold 30% for inhibition of root growth.

Methods: To verify the utility of novel directive, we evaluated sediments sampled both from bottom of rivers and ponds and from stockpiles of dredged material. They were analyzed for physico-chemical properties and contamination with POPs and heavy metals. Sediments were dried, sieved through 2 mm, and mixed with reference soil in realistic scenario 1:3. Ecotoxicity of mixtures and reference soil was tested according to novel directive on *Enchytraeus crypticus* and *Folsomia candida* (ISO 16387, ISO 11267). Test with nematode *Caenorhabditis elegans* (ASTM E1676) was employed to see if significantly shorter assay (24 h) could replace these directive tests. Test with earthworm *Eisenia fetida* (ISO 11268-2) was performed as well to compare other tests with this classical toxicity bioassay.

Results & Discussion: Results of the tests indicated toxicity of several sediments (i.e. inhibition was above the threshold specified in the novel directive). However, different tests indicated different toxic samples. This confirmed that whole test battery is needed to identify potentially problematic sediments.

The most sensitive test was nitrification assay which indentified majority of sediments as having inhibiting influence on potential ammonium oxidation in agricultural soil. This assay was found to have several issues which should be considered for future use, for example the proper selection of the control soil and its manipulation. From tests with invertebrates, springtails showed surprisingly lowest sensitivity among species.

For samples identified as toxic with bioassays, no reasons for toxicity were found in sediment physico-chemical properties or contamination. No relationship was also found between toxicity and origin of sediments (i.e. forest, agricultural or village ponds). No influence was found if they were sampled from the bottom or stockpiles. This confirms the necessity of biological tests when assessing possible effects in ecosystems, because the effects on living organisms cannot be predicted from chemical analysis of the dredged sediments.

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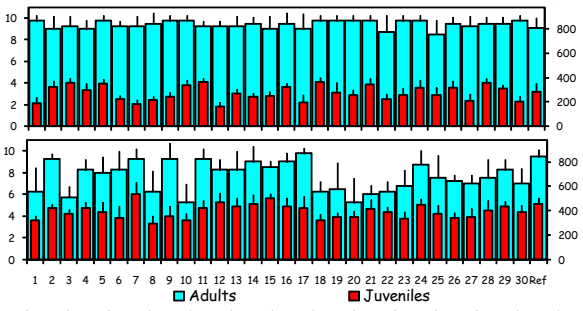

Fig. 1: Example of the results – toxicity tests with *F. candida* (top figure) and *E. crypticus* (bottom figure), the very right column shows control soil.