Contamination of sediments in large riverine systems – assessment and its apprehension

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Introduction: Contaminated sediments are a vital issue in many riverine systems and connecting channels impacted by anthropogenic development and use patterns. Evaluation of temporal/spatial changes of sediment contamination is crucial to answer questions about the state of the system, whether it is improving over time or to determine if sediment remediation activities have benefited the area. However, tracking sediment contamination changes in large systems presents many logistic and technical challenges. Across sediment contamination studies there are typically two main categories of spatial sampling designs used: judgmental designs and probability-based designs [1], while tracking temporal trends is usually limited to trend analysis of time series data (e.g. [2]). The Detroit River (North America) provides an excellent case study for examining such trends of contaminated sediments representative of a large, complex connecting channel. Being part of one of the largest freshwater systems (Great Lakes) gives the study of this river a supra-local perspective, but also acts as a linchpin at bilateral watershed management.

Methods: Two sediment surveys were completed in 1999 (150 sites) and in 2008/09 (65 sites). Sampling sites were selected to encompass the entire boundary of the river using a stratified random design which involved sampling sediments in six strata (upstream, midstream and downstream river reaches, each divided by width into U.S. and Canadian waters). Samples were randomly assigned within each reach in proportion to the surface area a given reach provided to the river as a whole. Surface sediment samples were analyzed for grain size, organic matter, trace metals, and organic contaminants.

Results: Among the investigated metals, Cd, Cu, Hg, Pb, and Zn were of the greatest concern since their concentrations frequently exceeded sediment quality guidelines for the Lowest Effect Level (LEL, [3]) both in 1999 and 2008/09 (in 7-100% of total number of samples, [4, 5]). For organic contaminants, PCBs and PAHs concentrations were also frequently above the LEL level (up to 50%, [5, 6]). Sporadically, concentrations of both types of contaminants also exceeded the Severe Effect Level (SEL). River-wide mass balance estimates for the selected priority contaminants in the surficial sediments indicated little or no changes in chemical mass over the investigated time interval. Furthermore, Getis-Ord geospatial analysis indicated no major shifts in the location of areas demonstrating high or low contaminant concentrations, however, a more refined picture of contaminated and clean zones was obtained [5].

Discussion: Due to its location (Canada and U.S. border), and its importance (part of the St. Lawrence Seaway), the Detroit River receives well-deserved attention from monitoring and research institutions. This river has been recognized as being contaminated with priority pollutants since the late 80's, with the understanding of the contaminated sediments crucial role, as a major cause of environmental problems. Moreover, substantial effort has been put into sediment remediation actions during the past 20 years [7]. A more detailed look into this system dynamic shows that anthropogenic source proximity has a stronger impact on the contaminant distribution pattern than geochemical sorting processes [8]. Despite these observations, the recent study shows no real change in sediment contamination. This highlights, from the local perspective, that the river status seems to be either acceptable, despite major concerns about fish and wildlife populations, or negligible due to more important concerns, i.e. maintaining production and shipping services.

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