

Researches on Risk Assessment and Management of Hazardous Water Pollutants:

Case Studies in Tianjin, China

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Abstract

In this dissertation, researches extend to risk assessment and water quality management of water pollutants. They mainly include: human health risk assessment of heavy metals resulting from wastewater irrigation and sewage sludge land application, examination of the adequacy of two existing national environmental quality standards, comparison study of environmental policies in cost efficiency and pollutant removal effectiveness, the development of a new type of discharge permit transaction scheme which can overcome the “hot spots” problem.

The main contributions of this study are as follows:

In Chapter 2, a dynamic model based on material flow and material balance of heavy metals is built to calculate heavy metal concentrations in farmland soil. The uptake rates of heavy metals by wheat and rice in Tianjin, China are estimated by means of regression analysis. Then, the exposure to heavy metals from dietary consumption of agriculture products grown in sludge-applied soil is estimated. By comparing average daily doses (ADDs) of heavy metals to the related risk reference doses (RfDs) provided by the USEPA, we know that in Tianjin, for rural sludge-applying individual, their average daily doses of Cd, Hg, As, Zn are larger than reference doses, especially for Cd and Hg, whereas for both exposure groups of urban individual and rural sludge non-applying individual, the hazards are not considered to pose a great threat to public health. This case study shows the necessity of reexamining the two national standards for soil and agricultural use sludge in the context of risk assessment.

In Chapter 3, based on risk management principle of risk-benefit analysis, the existing environmental management policies of direct regulation and pollution levying system, as well as tradable permit are assessed mainly in cost efficient, environmental effectiveness and administrative practicability. Furthermore, the possibility of applying tradable permit in China and the responsibilities of Environmental Protection Bureau in managing and directing discharge permit transaction are discussed in detail. A case study of chromium reduction in Tianjin is conducted. The conclusion suggests that the discharge permit transaction should be used for pollution reduction in China more widely. The environmental policies in China should be a policy mix of direct regulation, pollution levying system and discharge permit transaction.

In Chapter 4, an inter-zone discharge permit transaction scheme is developed to overcome the “hot spots” problem of non-uniformly dispersed pollutants. The inter-zone discharge permit transaction scheme is introduced to a BOD/COD reduction pilot program of 20 firms on three independent sewage networks in Tianjin. Results indicate that this discharge permit transaction scheme can offer a tradeoff among cost efficiency, environmental effectiveness and administrative practicability. Sensitivity analysis shows the soundness of these conclusions even when total COD reduction increases, or initial permit allocation changes, or COD reduction technologies improve.

The final chapter (Chapter 5) summarizes the main conclusions of this study and some directions for the future research.