TIERED APPROACH FOR ENVIRONMENTAL RISK ASSESSMENT OF EMERGING POLLUTANTS IN AQUATIC SYSTEMS

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The increasing worldwide contamination of surface and ground-waters with a vast number of synthetic and natural organic compounds has been one of the key environmental problems recently. Some of these emerging compounds have been listed as priority hazardous pollutants in the field of water policy, but many of them are not listed in official registries, and legal regulation does not deal with them.

Although most of these chemicals are present at low concentrations, there has been emerging concern about many micropollutants because of their biological activities adversely impacting aquatic life and human health. Primary effects of these substances are well known, but their long-term effect to the ecosystem and their secondary effects evolving besides their primary (intentional) effect are largely unknown.

To solve the water quality problem caused by these hazardous micropollutants complex and efficient risk management system is necessary. First of all, tools to assess the long-term impact and risk of these pollutants on aquatic ecosystems and human health must be developed or refined and implemented. Secondly, effective water treatment technologies are necessary, because conventional waste water treatment techniques do not provide effective elimination of these organic contaminants.

Addressing these issues the Hungarian CDFILTER project aimed to develop new cyclodextrin-containing sorbents suitable for monitoring bioactive micropollutants and for removal these pollutants from drinking water and treated wastewater. The most important decision support tool of the CDFILTER research was the risk-based evaluation and management. As part of the risk management a tiered strategy for environmental risk characterization of micropollutants has been developed.

As the first tier, a qualitative risk assessment was applied. Potentially hazardous, risky micropollutants were selected for screening exercise taking into account their occurrence in surface and treated waste waters. This preliminary list is comprised of about 58 emerging contaminants including pharmaceuticals, industrial compounds, pesticides, nanomaterials, flame retardants and surfactants, personal care products, as well as caffeine and nicotine. Detailed substance data sheet were worked out for each chemicals including information about the volume of production, its use, the physical, chemical, biological properties of the substance, its fate in the environment and toxicity.

A comprehensive protocol was developed and set up to determine which substances must be included in the Priority List. Amount of production and consumption, physicochemical data, biodegradability as well as environmental and human health effects were taken into account aiming prioritization. In view of these results the most harmful compounds, which have critical risk in the environment have been chosen (Higher Priority Pollutants). Following this step the interaction between the selected chemicals and cyclodextrins was also considered in order to obtain efficient risk reduction. The prioritized chemicals were assessed in second tier by a generic quantitative risk assessment methodology. The last tier was the site specific risk assessment which gave a more detailed picture on the risk.

The application of the developed risk assessment methodology during the research resulted in more accurate risk characterisation of the selected micropollutants both in qualitative and quantitative terms.
On the basis of the comprehensive risk assessment results and the establishing experiment the technology for risk reduction using cyclodextrin sorbents was developed. In the case of higher priority pollutants such as bisphenol-A and β-estradiol outstanding risk reduction capability has been demonstrated by applying cyclodextrin filters.

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