Integrated approach to Skadar Lake ecosystem chemical risk assessment

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Abstract. Effects-based monitoring relying on bioassay testing can provide an insight of risks for the environment and human health associated with exposure to complex mixtures of different low-level pollutants and their possible synergistic effects. In this research alongside chemical analysis of pollutants in water, sediment and biota samples from Skadar Lake, a battery of *in vitro* bioassay tests will be used to provide more comprehensive risk assessment of certain pollutants to the environment and human health. Additionally, the food chain will be also included as an important exposure pathway by which contaminants in the sediment could reach humans.

1 Problem definition, background, research methodology and our progress

Skadar Lake, the largest lake on the Balkan Peninsula is a significant fresh water reserve and a home to diverse flora and fauna species. It has been declared a National Park on the Montenegrin side, and as a "Managed Natural Reserve" on the Albanian part of the lake. In 1995, the lake is added to the World's List of Wetlands of International Importance by the Ramsar Convention [1].

Constant monitoring of Skadar Lake`s environmental status is of the highest importance for its protection having in mind that the lake is extremely vulnerable ecosystem affected by numerous sources of anthropogenic pressures [2]. Chemical water and sediment quality of Skadar Lake is currently assessed by target analysis of concentrations of individual chemicals. The chemical status assessment is based on compliance with Environmental Quality Standards (EQSs) for priority substances as defined in Water Framework Directive (WFD). The monitoring of target chemical compounds does not give a comprehensive overview about the effects of chemicals in the lake ecosystem, because of existence of unknown chemicals, transformation products and synergistic effect chemical compounds can exhibit [3].

The first step in this research will be screening and identification of hotspots for pollution from priority substances in the Skadar Lake. Alongside chemical analysis of priority substances in water, sediment and biota samples, a battery of in vitro bioassay tests will be used to provide more comprehensive risk assessment of certain pollutants to the Skadar Lake ecosystem. With a bottom-up approach, we will assess potential genotoxicity of sediment samples, as sediment serve as a sink for many emerging pollutants which will then guide us to further chemical analysis to identify possible contaminates responsible for this activity, as well as the routes of exposure. Determination of levels of contaminants in fish is a rich source of information for applied environmental science [4]. Measurements of contaminant levels in fish will be used as a complementary tool to assess risks from potential contaminated sediments on the environment and people's health taking into consideration bioavailability of the pollutants.

Chemical and bioassay analysis will be carried out in the laboratories of the Center for Ecotoxicological Research. Our initial genotoxicity screening will employ the SOS Chromotest kit, developed by Environmental Bio-Detection Products Inc., Canada. This bioassay test is renowned for its wide-ranging sensitivity to a variety of toxic substances, including heavy metals, organic and inorganic pollutants and antibiotics. The assay is based on the ability of a toxicant to inhibit the de novo synthesis of an inducible enzyme (β-galactosidase) in a highly permeable mutant of *E. coli* and yields easily observable results through a colour change after a short incubation period. After a two-hour incubation period, the genotoxic materials interact with the DNA of *E. Coli* and induce de novo synthesis of b-galactosidase.

In the final stage of this genotoxicity test, the amount of enzyme produced as a result of the induction of the SOS system, is measured by adding chromogen. The red chromogen clearly gives a visible dark red color, most suitable for visual qualitative assessment of genotoxicity or for quantitative reading of the results on a photometer [5]. In this research the quantitative approach will be chosen calculating the sediment genotoxicity potential (SGP). The sediment samples with SGP value below 2 will be considered as non-genotoxic, the ones with SGP between 2 and 2,5, as potentially genotoxic, and the ones with SGP above 2,5 as genotoxic. The samples with SGP above 2 will be candidates for further research with extensive chemical analysis in order to determine the pollutants, which acting synergistically, cause the genotoxic effect.

2 Future works and Conclusions

The selection of the sampling locations for the screening analysis will be primarily based on the national water quality monitoring program. Furthermore, guided with the results of sediment genotoxicity tests, additional locations will be chosen to identify potential sources of contamination, pathways, and receptors that may be impacted. After collecting all the relevant data about Skadar Lake, tributaries, potential sources of pollution etc., a conseptual site model for the location will be done. It will provide a clear visual overview of the Lake's key features and potential environmental hazards. Sampling campaigns will be carried out between October and June, the period with the lowest discharge rate for Skadar Lake tributaries as recommended in the Guidance on Surface Water Chemical Monitoring under The Water Framework Directive [6]. A long list of the WFD priority substances (polycyclic aromatic hydrocarbons, different classes of pesticides such as organochlorine, organophosphorous, triazine, quinolone, polychlorinated biphenyls, polybrominated diphenyl eters, bis-(2-ethylhexyl) phthalate, oktyl and nonyl phenols, pentachlorophenol), will be analysed in all samples of water, sediment and biota collected for Skadar Lake. A list of selected phthalates and heavy metals will also be included in the scope as an important parameter for assessment of ecosystem contamination. For the first time in Skadar Lake water and sediment samples, the analysis of the short chain chlorinated paraffins (C10-C13 chloroalkanes) will be conducted.

To gain a comprehensive understanding of the potential risks associated with these complex chemicals, it is important for methods to effectively evaluate any cumulative effects on the organisms involved. One possible way to understand better the potential risks associated with complex samples is by using bioassays. These tests can effectively assess total bioactivity for a specific pathway or mode of action and can account for the challenges of evaluating cumulative effects on organisms. By reducing complex samples to a few activated biological pathways, bioassays will simplify our assessment process.

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