Use of on-line membrane separation techniques to assess the behavior of major and trace elements in Volga river watershed around Dubna city (Moscow region)

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This study is devoted to an ecological estimation of the Volga river's water quality in area of Dubna city, Moscow region. In this place, Volga is dammed and represents a lower pool of the Ivankovskoe reservoir, so the water quality depends of both anthropogenic situation in the Upper Volga basin and specific hydrological and hydrochemical regimes in the river. Besides, Volga is the main source of drinking water for Dubna city, but water supply point is situated just after the storage dam. The question remains, how the dam influences the water quality of Volga river. Therefore, a monitoring network for Volga was organized by Ecological-Analytical Center in "Dubna" University.

The monitoring is carried out in some individual and complex hydrochemical quality metrics (temperature, pH, dissolved oxygen, main ions, organic and biogenic substances etc.), which were selected in view of available long-term field data (since 1989). Different analytical equipment and techniques were used for both laboratory and field measurements. The ongoing observations of temporal dynamic of hydrochemical quality metrics (since 2004) demonstrate a dramatic change of element concentrations depending on season and discharge. The spatial dynamic of water chemistry helps to trace influence of the storage dam and municipal pollution.

Because the bulk chemical analysis of unfiltered or conventionally filtered ($<$ 0.22-0.45 μm) water samples does not provide any information of elements speciation and bioavailability, we invented a new method of on-line membrane separation. This technique allows investigating the distribution of trace metals and major elements among ionic, colloid and particulate forms. Our on-line multi-stage membrane system was already tested in other hydrological objects such as (Moscow river [1], Sister river [2]). Fractionation of a number of elements (Ca, Mg, Si, Mn, Zn, Sr, Ba, Pb, B, Al, Fe, Cu, Ni, Co, As, Se, Zr, Mo, W, Cd, Sn, Sb, Tl, U) was characterized in spring 2005 using ICP-AS and ICP-MS analysis. Our findings evidence that, in the Volga river natural rather than anthropogenic processes control the formation pattern of both organic matter and TE. Further insights on TE speciation were gained by combination of filtration, ultrafiltration and dialyses followed by ISP-MS analysis in order to assess the distribution of $\sim$ 40 major and TE (including toxic pollutants) and organic matter in both Volga river and adjustment aquatic systems (peat lands, groundwater's, small tributaries). Some mechanistic insights on water quality control by natural processes were gained by laboratory experiments were we performed multiple freezing-thawing of river and swamp water samples followed by membrane separation and TE analysis. Our preliminary results suggest that freezing cycles is a very common process in the temperate zone of the Volga river and its effect on metal and organic matter speciation and colloids distribution is strongly underestimated.

Reference

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