EGU21-12864
https://doi.org/10.5194/egusphere-egu21-12864
EGU General Assembly 2021

Anthropogenic impact on behavior of nutrients and potentially toxic elements in the Moskva River water

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The Moskva River catchment is a complex system consisting of a network of rivers affected by a wide variety of land- and water-use factors that create unique spatial and temporal patterns of their water quality. Major sources of anthropogenic impact on the Moskva River and its tributaries include multiple flow regulation structures on streams, direct pollution from municipal sewage and industrial wastewaters of Moscow megacity and smaller towns, runoff generated in agricultural areas and within multiple landfills located on the watershed, and many more. Only a short upstream section of the Moskva River remains relatively unchanged in terms of water runoff and geochemistry.

In 2019, we began a pioneering study focusing on collecting detailed field data on geochemistry of water, suspended matter and bottom sediments of the Moskva River and its major tributaries, including concentrations of nutrients, potentially toxic elements (PTEs), polyaromatic hydrocarbons and total petroleum hydrocarbons (TPH). The main purpose of this project is to obtain a holistic picture of material fluxes within the river system combined with an inventory of natural and anthropogenic factors controlling them.

Our results indicate gradual increase of total dissolved solids, and content of nutrients and some PTEs (i.e., Cu) in water along the course of Moskva River. It can be linked to non-point pollution, as well as drastic changes occurring downstream Moscow and other urban areas caused by direct pollution. Massive increase of chloride, sulfate, sodium, mineral phosphorus, nitrogen, Mo and Sr concentrations in water is observed downstream outlets of Moscow wastewater treatment plants, which is characteristic of insufficiently treated urban sewage. Concentrations of nutrients and PTEs only slightly decrease downstream the city, remaining at levels often exceeding environmental guidelines up to the river's mouth, whereas increased concentrations of other pollutants, such as TPH, are more closely limited to urban areas and fade more quickly with distance from the source.

Nutrient pollution of the Moskva River, as well as concentrations of some PTEs (i.e., Sb, Pb), steadily increased during summer low-flow period, when low dilution capacity limits biochemical self-purification. On the other hand, Mn, Co and Zn reached maximum concentrations during the spring flood due to their accumulation in city road dust and subsequent concentrated inflow with snowmelt runoff.

The Moskva River tributaries that flow within close proximity to the metropolitan area were

revealed to have significantly higher pollution levels than the Moskva River itself, indicating stronger anthropogenic stress.

Balance calculations performed on our database showed that during the flood the Mozhaysk Reservoir – the single large reservoir on the Moskva River – retains huge volumes of major elements and PTE, at times even greater than their subsequent input from urban areas downstream from the dam. It proves crucial role of the reservoir's retention capacity in the Moskva River's geochemical balance formation.

Authors acknowledge Russian Geographical Society (project 28/2019-I), Russian Science Foundation (project 19-77-30004) and Russian Foundation for Basic Research (project 19-05-50109) for financial support.