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Water quality at the catchment scale: modelling of copper content in the Belaya River based on the ECOMAG-HM model

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The aim of research is modelling studies on the identification of natural and anthropogenic sources of copper and identify the spatiotemporal regularities of metal content in the streams of the Belaya River basin (area 142 000 km2). The Belaya River is situated in the South Ural region of Russia and it is one of the biggest tributary of the Volga River. More than sixty years the diverse economic activities are carried out in the Belaya River basin. The leading industries in the region are metallurgy, oil production, petroleum processing, chemistry and petro chemistry, power industry.

To simulate hydrochemical processes in the catchment, a distributed ECOMAG-HM model was involved. The model consist of two main submodels. The hydrological submodel describes the main processes of hydrological cycle of land: infiltration, evapotranspiration, thermal and water regime of soil, snow cover formation and snowmelting, forming of surface, subsurface, groundwater and river runoff. The geochemical submodel of ECOMAG-HM describes the processes of accumulation of pollutants on the surface, dissolution of pollutants, penetration of soluble pollutants into soil, interaction with soil solution and soil matrix, biochemical degradation of pollutants, their transport by surface, subsurface, groundwater and river waters.

Tests of the ECOMAG-HM model for the calculation of hydrochemical characteristics in the Belaya river basin showed the model describes satisfactorily the regularities of heavy metals migration in the components of river basin geosystem: on the surface, in soils, groundwater and river waters. The simulated results are compared with data from hydrological and hydrochemical observations. In most cases, the magnitude of the discrepancy between the calculated and observed values of copper concentrations is comparable with the magnitude of the error in their measurement. In particular, the model reproduces satisfactorily the average annual and spatial differences in the copper content at the 32 monitoring sites on the river. The maps of the mean annual surface and soil-ground runoff of copper in the basin were constructed. It was established that the share of soil-ground transport of copper prevails in most of the catchment area, especially in its eastern, and only in the west the surface component of the copper runoff may exceed it.

Quantitative assessments of the contribution of various sources to the pollution of river waters by copper at the outlet site of watershed are studied. Approximately 80% of the river flow of copper is formed due to washing out of soil-ground layers, almost 20% - due to surface washing. The anthropogenic component does not exceed 1% of the total runoff of copper from the catchment area. About 45% of the total amount of copper coming from the catchment area to the rivers accumulates in the river bed because of subsidence with sediments.

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