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Simulation of river pollution by heavy metals under different scenarios of anthropogenic load on watershed and climate changes

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The distributed physically-based model ECOMAG-HM was applied to simulate cycling of water and heavy metals (HM) (copper, zinc, manganese) on the surface, in soil, groundwater and river water of the Nizhnekamskoe Reservoir (NKR) watershed under various scenarios of economic activity and climate changes*. The NKR watershed is located in the South Ural region of Russia and has an area of 186000 km2. This watershed is characterized by high background concentrations of HM due to wide occurrence of ore deposits and considerable concentration of ore-parent elements in rocks. The main purpose of the study was to quantify the contribution of point (wastewater) and diffuse sources to pollution of water bodies, which is necessary for planning measures to reduce HM pollution in the watershed. The first objective of the study was to assess the ECOMAG-HM model potential for large scale modelling water quality parameters at the different hydrological and hydrochemical monitoring stations by comparing simulated and observed the hydrological and hydrochemical regimes in the historical period on the main river and its tributaries. The local areas of the catchment were identified, which were not covered by hydrochemical observations, with significant levels of river water HM contamination. The maps of simulated spatial fields of genetic components of runoff and HM washoff to the river network were designed. The contribution of anthropogenic sources to the HM runoff formation was estimated and it has been established that with the current level of anthropogenic load, the contribution of wastewater point discharges does not exceed 4%. Scenarios and consequences of increasing the amount of HM discharged as part of wastewater are considered. The time scale of the catchment self-purification from HM was evaluated. The results showed that in the absence of external impacts on the catchment area, a decrease of HM content in river waters over a 400-year period will not be exceed 10%. Climate change impact assessment on water quantity and quality was simulated for future period on the level 2050 for copper. The results are (a) the average annual river flow will increase by 11%, (b) the average annual flow of copper - by 18%, (c) the increase in copper runoff was mainly due to an increase in river runoff, (d) the change in average annual concentrations of copper in river runoff is insignificant (+7%).
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*Motovilov, Yu.G., Fashchevskaya, T.B. Simulation of spatially-distributed copper pollution in a large river basin using the ECOMAG-HM model // Hydro. Sci. J., 2019, V. 64, Is. 6, pp. 739–756.