Geophysical Research Abstracts
Vol. 19, EGU2017-9477, 2017
EGU General Assembly 2017

Long-term trends of metal content and water quality in the Belaya River Basin

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The aim of this research is to identify the spatiotemporal regularities of iron, copper and zinc contents in the streams of the Belaya River basin. The Belaya River is situated in the South Ural region and it is one of the biggest tributary in the Volga River basin with catchment area of 142 000 km2. More than sixty years the diverse economic activities are carried out in the Belaya River basin, the intensity of this activity is characterized by high temporal variability. The leading industries in the region are metallurgy, oil production, petroleum processing, chemistry and petro chemistry, mechanical engineering, power industry. The dynamics of human activities in the catchment and intra and inter-annual changes in the water quality were analyzed for the period 1969-2007 years.
Inter-annual dynamics of the metal content in the river waters was identified on the basis of the long-term hydrological monitoring statistics at the 32 sites. It was found that the dynamics of intensity of economic activities in the Belaya River basin was the cause statistically significant changes in the metal content of the river network. Statistically homogeneous time intervals have been set for each monitoring site. Within these time intervals there were obtained averaged reliable quantitative estimations of water quality. Calculations showed that the content of iron, copper and zinc did not change during the analyzed period at the sites, located in the mountain and foothill parts of the basin. At other sites, located on the plains areas of the Belaya River Basin and in the areas of functioning of large industrial facilities, metal content varies. A period of increased concentrations of metals is since the second half of 1970 until the end of the 1990s. From the end of 1990 to 2007 the average metal content for a long-term period in the river waters is reduced in comparison with the previous period: iron - to 7.4 times, copper – to 6.7 times, zinc - to 15 times. As a result, by the end of the test period the average long-term metal content in the river waters is: iron 0.07-1.21 mg/l, copper 0.9-7.0 μg/l, zinc 2,0-12.5 μg/l.
Empirical probability distributions of iron, copper and zinc concentrations for various phases of the water regime in all investigated monitoring sites were approximated by Pearson type III curves and the average of the concentration values, the coefficient of variation and asymmetry, as well as the values of the concentrations of metal in the range of 1-95% of frequency were estimated.
It was found that by the end of the test period, the average long-term concentrations for iron and copper exceed MAC for fishery use, for zinc become smaller MAC in many streams of Belaya River basin. The probability of exceeding the iron and copper content of MAC level increases during floods, the zinc content of MAC level increases during the winter low.
Acknowledgements. The work was financially supported by the Russian Foundation for Basic Research (Grant 15-05-09022)