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Impact Monitoring of Mining Enterprises of Kursk Magnetic Anomaly on Hydro Ecological River Situation of the Belgorod Region.

Andrey G Kornilov*, Sergey N Kolmykov, Mariya A Petina, and Mariya G Lebedeva.

Belgorod State University, 85, Pobedy Str., Belgorod, 308015, Russia.

ABSTRACT

The results of contrastive analysis of hydrochemical state of surface water bodies exposed to the impact of mining enterprises, by way of example of small rivers of the Belgorod region, according to the results of exploration carried out in the years 2009-2014. Direct action of Lebedinsky and Stoylensky Mining and Processing Plants at open development is evident within 15 km, and resident-industrial wastewaters of infrastructure exert greater impact on hydroecological situation of the river Oskol. On the whole, hydrochemical situation of the rivers exposed to the impact of mineral resource industry in the Belgorod region's territory for the last years remains stable.

Keywords: mineral resource industry, surface water, pollution of water bodies, hydro-ecological characteristics.

Corresponding author

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INTRODUCTION

The key economy of the Belgorod region is mining development that is based on iron-ore deposit of Kursk magnetic anomaly (KMA).the most large-scale mining enterprises are PC "Lebedinsky MPP" (LMPP, Lebedinsky Mining and Processing Plant), PC "Stoylensky MPP" (SMPP, Stoylensky Mining and Processing Plant), Yakovlevsky mine. Development of iron-ore deposit with the complex of drainage works at opencast mines and organization of considerable by volume service water bodies connected with mineral processing (tail dump, slurry tank), led to serious changes in natural water balance of the territories of the area greater than 450 km^2, mixing waters of different water-bearing formations prevailing in this territory, quality change of surface waters [1-3] at the expense of discharge of drainage and waste waters. The rivers that are exposed to the impact of these enterprises are the Vorskla, the Oskolets, the Chufichka, the Oskol. Location of LMPP and AMPP and schematic representation of impact of plants and accompanying infrastructural objects on hydro-ecological situation (discharge of drain waters, public sectors of accompanying residential areas) are illustrated in figure 1 [4].

THE MAIN BODY

In the Belgorod region's territory it is applied two methods of iron ore mining: deep-mined output and strip mining. In the earlier published materials [4-6] it has been shown that the method of mining, applied in the Yakovlevsky mine, exerts considerable influence on the Vorskla river for chloride, sodium, bromine, boron, sulphate, fluorine content. Negative effect is observed by the complex of components (excepting nitrates) for 68 km after waste waters discharge. This effect is evident from fluorine [5], sulphate, chloride up to border line of Kozinka (102 km after discharge).

LMPP extracts iron ore by strip mining. The enterprise dumps sewage and some of drainage water directly into the Oskolets river. Input of drainage waters of LMPP to the supply rate of the Oskolets (annual rate 1,26 m^3/sec) is about 0,44 m^3/sec or 35 %, that has positive effect on magnitude of the river flow. We estimate that since 2007 the content of all pollutants (excepting solid residual and sulphates) has decreased after LMPP's discharged water being dumped into the Oskolets [5].

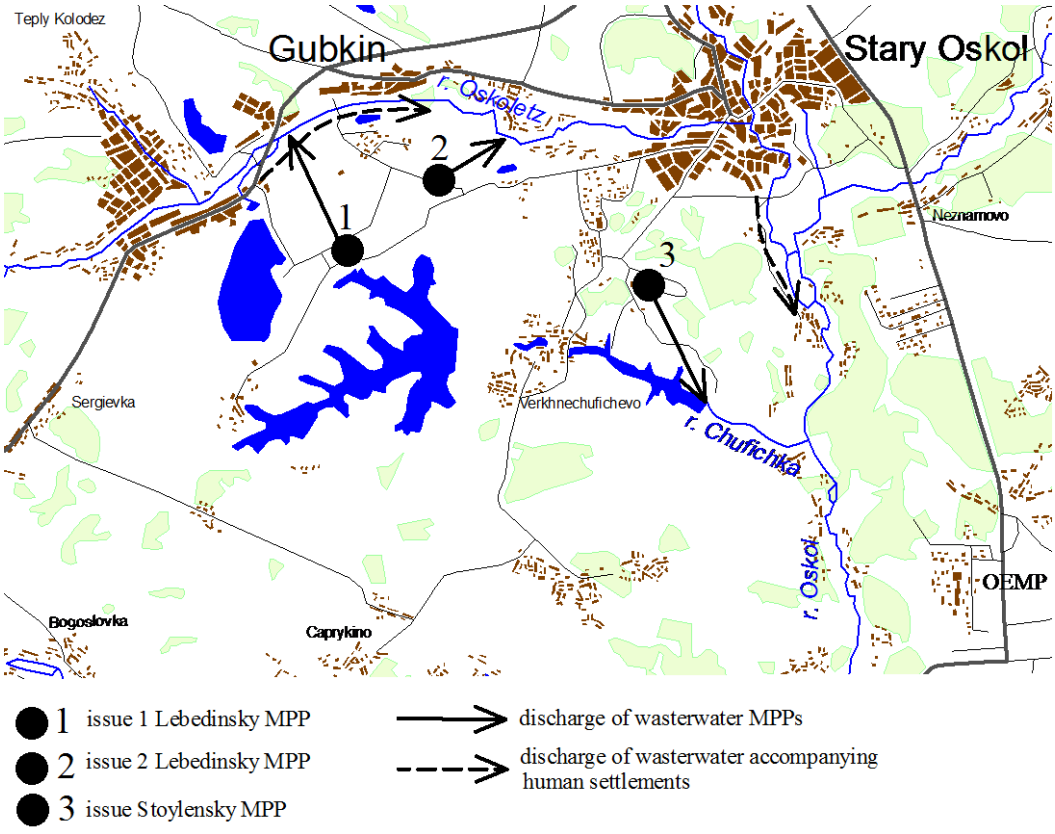

Figure 1: Location of Lebedinsky and Stoylensky MPPs in the Oskol river basin

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Surveys of LMPP impact on the Oskolets river carried out in terms of the State task of the Department of Education and Science of RF to be undertaken by Belgorod State National Research University as of the year 2015 (Project code: 185), show that initially the level of surface flow is arisen from high urbanized resident-industrial territory the town of Gubkin . Thus, background content indices of pollutants in the Oskolets river according to data observations of environmental service on a series of ingredients are high enough: sulphates (1,12 MPC, maximum permissible concentration), ammonium ion (1,08 MPC), nitrites (10,06 MPC), iron general (3,16 MPC), phosphates (4,09 MPC), BOD_5 (biochemical oxygen demand) (1,74 MPC).

In the first discharge of the waste waters by LMPP there it is observed the exceeding of the acting fishery MPC on sulphates, nitrites, iron, BOD_5 in the drainage waters. Relatively high content of nitrites, iron, BOD_5 depends on substantial background content of these ingredients in the Oskolets river, the waters of which are partially discharged into the drainage quarry waters and then put into drainage water discharge. In the second issue of the drainage waters the analogous situation is observed: similar to prior instance, the second issue insignificantly degrades the indicators of hydrochemical condition of the river Oskolets only on sulphates, and the content of remaining ingredients in comparison with the background ones partially improve. Overall impact of mining industry on hydroecological situation of the river Oskolets is characterized by the following processes:

- The content of nitrites in the river Oskolets decreases three times and BOD_5 – 15%, that leads to insignificant improvement of hydroecological situation according to components data;
- Insignificant increase in sulphates content is observed.

The Oskol river is largely exposed to the impact of mining enterprises of Stary Oskol and Gubkin industrial region, as, ultimately, all water flows fall into it. The total river length is 472 km, 220 km of which account for the region of Belgorod, average annual water discharge in the town of Stary Oskol with 95 % supply accounts for 3,52 m^3/s. LMPP exerts an influence by means of dumping sewage into the river Oskolets, that is right branch of the river Oskol. SMPP exerts influence on the river Chufichka, that is also the right branch of the river Oskol. The Oskol Elektrometallurgical Plant dumps sewage straight into the river Oskol in the district of the country Golofeyevka. The water from tailing dumps of LMPP and SMPP is filtered into underground water-bearing horizon with its subsequent discharge into the river Oskol – it is so called disorganized stray issue into the river Oskol.

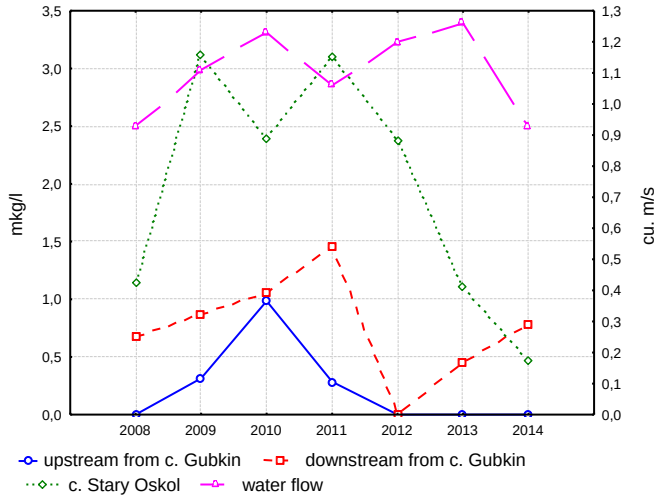

Figure 2: Copper content in the river of Oskolets

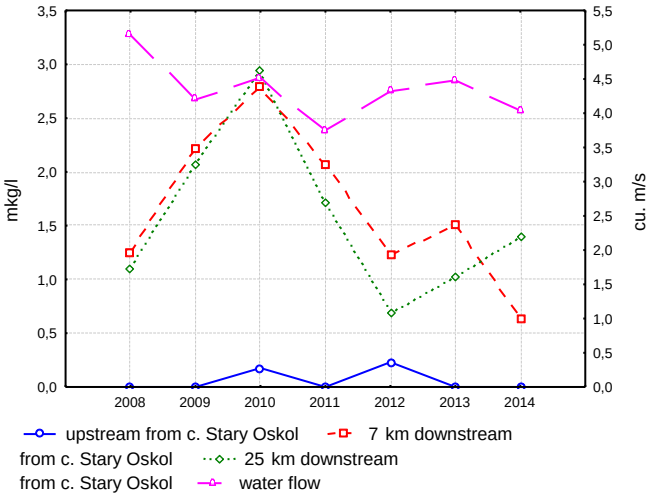

Figure 3: Copper content in the river Oskol

The preceding indices have shown that the content of petrochemicals, manganese, strontium, sulphates, fluorides, zinc, as compared to their quantity to the zone to be influenced on by the mining enterprises (further north than the town of Stary Oskol) increases, and of some substances (suspended matters, mineralization, solid residual, COD (chemical oxygen demand), iron, magnesium, chlorides) – decreases (14,8 km after the last dumping) [7]. Background studies, carried out in the years 2011-2012, have shown, that the quality of water in the river Oskol after inflow of the river Chufichka (partly – of waste waters

of Stoylensky MPP) does not considerably change. Below, figures 2-3 represent updated information according to pollution indices of the explored rivers on data of Russian hydrometeorology for the years 2008-2014. In analyzing the data of Russian hydrometeorology it is evident the impact of the town of Gubkin on the increased nitrate content in the Oskolets river that may be caused by the discharge of waste waters of housing and communal services. Moderate impact of the town of Gubkin and LMPP on the content of iron is observed in certain years. LMPP and Gubkin exert a moderate impact on the increased content of sulphate.

The rate of content changes of nonferrous and heavy metals, zink, nickel and, for example, copper (figure 2), on hydrochemical posts of the river Oskolets points to considerable influence not only of the mining industry but the zone of residential industry in Stary Oskol, as well. Hereby, the metal content increases on the average 2,7 times. On the whole, the influence of the Stary Oskol resident-industrial zone on hydrochemical situation of the river Oskolets is much evident than the influence of LMPP that defines the increase of sulphates content.

The content of nitrates, iron and sulphates increases by degrees downstream of the Oskol. Hereby, the most appreciable influence of resident-industrial zone of the town of Stary Oskol and disorganized agricultural waste waters develops in the increased content of nitrates. A moderate influence of the above-mentioned waste waters on the content of iron and sulphates is observed. The content of zink, lead and, for example, copper, (figure 3) appreciably increases on the post 7 km down of Stary Oskol (approximately 8 times), and then downstream the process of self-purification occurs and the content of the mentioned metals decreases approximately 5-15 %.

Thus, the influence, exerted by the complex of mining and metallurgical enterprises of the industrial region of Stary Oskol and Gubkin on the river Oskol and its inflows, is multidirectional. The influence of Lebedinsky MPP (strip mining) on bordering small rivers (the Oskolets) has dual character: on the one hand – the content of the major part of the observed pollutants after their discharge decreases, on the other hand– at the expense of decrease of water content of the river by 46 % (from 2,32 m^3/s in the period of undisturbed flow in the years 1933–1974 to 1,26 m^3/s in the period of disturbed flow at the present time), self-purifying ability of the Oskolets considerably reduces in relation to diffusive residential and agricultural polluting runoff [8]. For the period of natural runoff at average annual amount of precipitations of 511 mm average annual run-off was equal to 2,32 m^3/s, and in the period of disturbed runoff at amount of precipitations of 613 mm/year water flow did not practically change. If there were not anthropogenic disturbance of flow at precipitation of 613 mm, the average annual flow would be equal to 2,78 m^3/s. Coefficient of mean annual flow decreasing for the period of anthropogenic impact equals 0,85.

CONCLUSION

As in the previously conducted researches [9; 10] mixed character of the impact of mining plants of the Belgorod region on hydroecological state of water resources has been confirmed. The area of active influence of LMPP and SMPP on the river Oskol is surveyed at a distance of 15 km. But much important factors of influence on the river are not MPPs in themselves, and accompanying resident-industrial waste waters. In particular, the assessment of influence of SMPP on the river Oskol by means of discharge of sewage into the river Chufichka indicates that it does not exert appreciable influence on the hydrochemical water composition of the river Oskol.

SUMMARY

The analysis of the results of hydrochemical observations shows that , in the whole, the hydrochemical situation of the rivers exposed to influence of mining industry has been remaining stable during last eight years. On intensity of influence on the surface waters the underground winning of iron ore exerts more appreciable influence than opencast mining.

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