HYDROCHEMICAL SITUATION OF THE VORSKLA RIVER IN THE VICINITY OF THE MINE YAKOVLEVSKY

KOLMYKOV S.N., KORNILOV I.A., KORNILOV A.G.
Belgorod State National Research University, Russia

Abstract
The study presents the results of hydrochemical state of the Vorskla River in the zone of influence of the mining company for the last 5 years. It is shown that the discharge of shaft water Yakovlevsky mine causes additional excessive contamination in the river Vorskla for chloride, fluoride, boron, bromine. Contamination on these ingredients exceeds the background for the Vorskla river over 20 km (fluoride, bromide) to 74 km (chlorides, boron). In contrast, with regard to nitrogen compounds diluted mine water naturally high content of nitrates in the Vorskla river caused by agricultural run-off and is "improve" the quality of water is observed for more than 10-15 km. Analysis of the studies in 2007 and 2012 shows that the hydrochemical situation in the Vorskla river during the study period remains unchanged.

Keywords
hydrochemical situation, polluting ingredients, miming complex.

The studies were performed in the framework of the state task Ministry of Education and Science of the Russian Federation by the Belgorod State National Research University (Project Code: 185).

The Vorskla River originates at v. Rozhdestvenka in the southeastern part of the district Ivnyansky. The river flows from the north- east to south-west on Ivnyansky, Yakovlevsky , Borisovsky , Grayvoronsky areas and at a distance of 10 km south-west of the Graivoron city goes to Ukraine and then flows into the river Dnepr. The total length of the river is 464 km, within the region – 114 km. The catchment area of the Vorskla river is 14,700 km^2, of which within the area – 2650 km^2.

A basin of the Vorskla river located in the western part of the region and is bordered to the north and west of the pool of the Psyol river, in the east – Seversky Donets River , in the south – the Uda river. Treated basin occupies the southern slopes of the Central Russian Upland and in general is a gently undulating plain dissected by gullies and ravines and has a typical forest-steppe zone natural conditions in respect of the relief, soil type, vegetation and climate. The area adjacent to the river valley, lowland plains, wavy, and occupied by farmland and partly occupied by forest. Right slope of the valley is steep, left one is flat, folded loam and has cretaceous deposits. Floodplain is left bank, 700-800 m wide, has swampy places. Meandering river is channel, sandy, has muddy places , width at low water is 15-20 m, 0.8-1.5 m depth of the river [1].

The Vorskla River by his regime refers to a type of lowland rivers. The main feature of this regime of rivers is relatively high spring tide, mostly snow-fed. In the water regime of the rivers are clearly distinguished two maim phases – spring tide and low water, interrupted summer rain floods and floods during winter thaws.

The Vorskla River basin is home to about 46000 people and 55000 urban rural populations. The largest settlements are Stroitel, Borisovka, Tomarovka, Graivoron and Yakovlevo. One of the largest enterprises that directly affect the ecological condition of the Vorskla River is

Yakovlevsky mine. This mining complex is based on the rich iron ore deposits of the Yakovlevo, one of the largest iron ore deposits in the basin of the Kursk Magnetic Anomaly.

The current issue of sewage industrial site Yakovlevsky mine is carried out in a retention pond and then out of it through the overflow into the beam Terny, characterized by low consumption of natural runoff, filtered through water and riparian vegetation (cattails, reeds, etc.) for 3 km. Subsequently, the water enters the pond Ryazanovsky, which refers to the second category fishery reservoir, from which over 1300 meters Krapivninskoe enters the reservoir created by the Vorskla river (Fig. 1). The Vorskla River is fishery ponds of the highest category. Ryazanovsky pond also relates to the flshery pond, but the second category. Respectively, when compared to the concentrations of pollutants from sanitary norms used fishery regulations (MPC).

Pumped mine water chloride sodium composition with salinity 3,3-3,9 g/l, with a weakly alkaline medium, high rigidity (8,0-9,3 mg-Eq/l) is discharged through a retention pond in the district of the Vorskla river at about 4 million m^3 per year (0,13 m^3/s) [2].

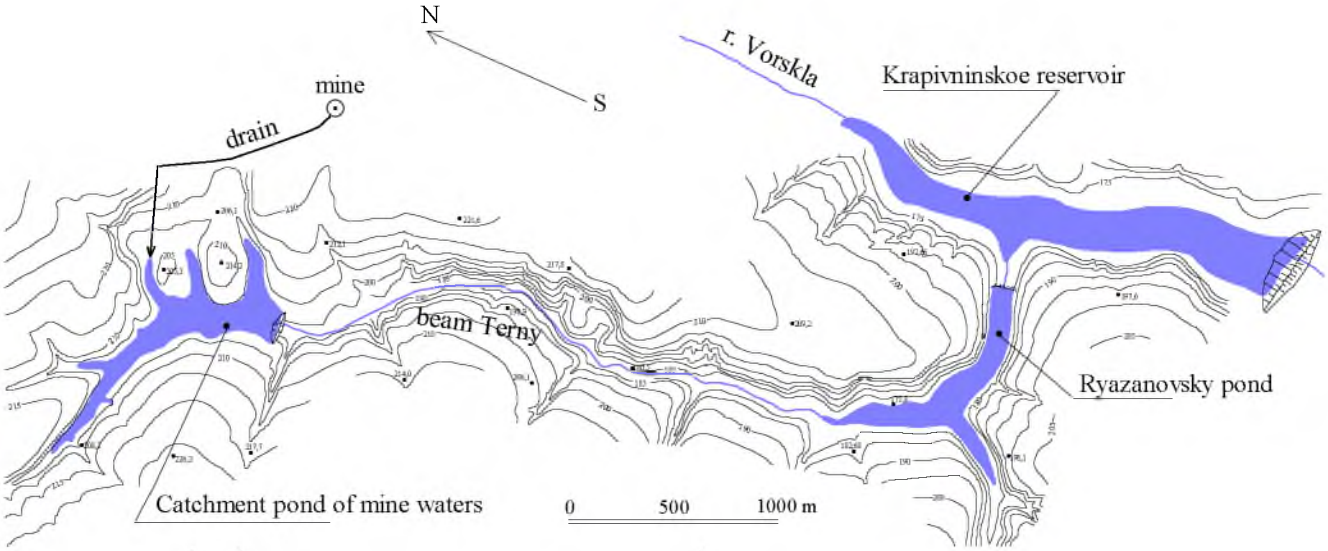

Fig. 1: Reset circuit of shaft waters of Yakovlevsky mine

Our research in 2007 [3] (Fig. 2, Table 1) shows that the greatest impact of the waste waters Yakovlevsky mine have on the content of chlorides, sodium, bromine, boron, fluorine in the Vorskla river.

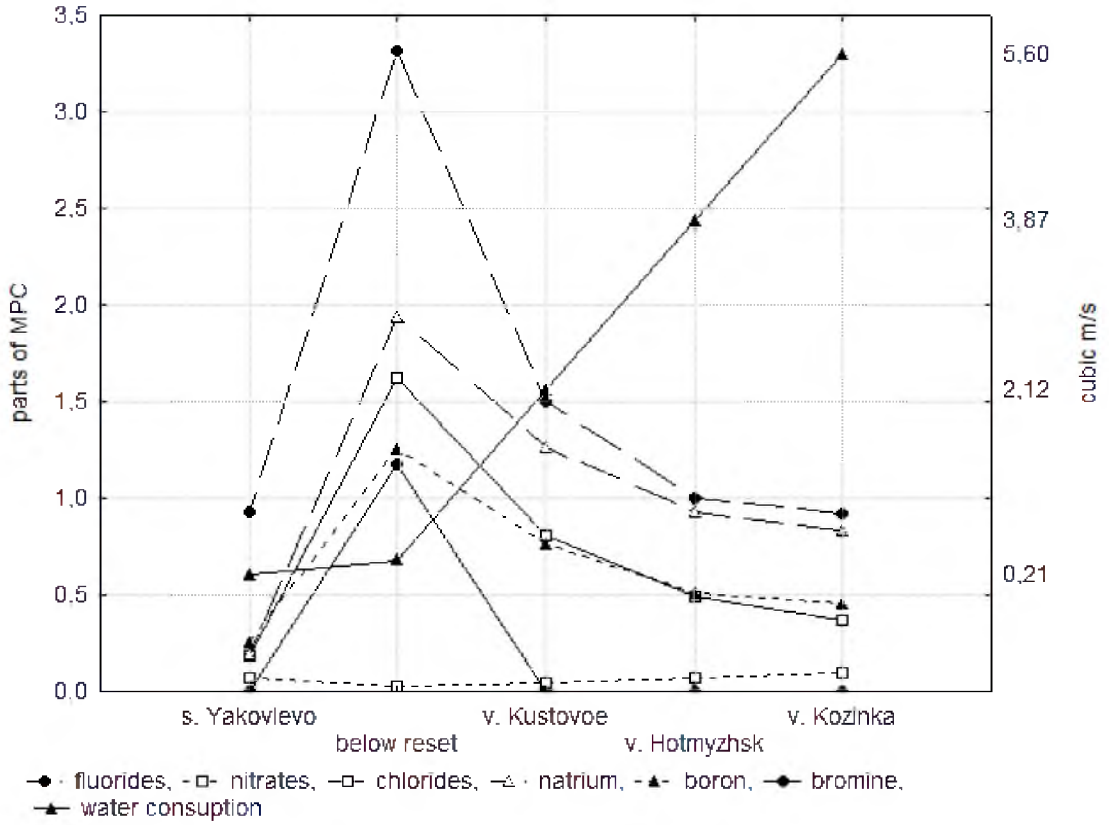

Fig. 2: Dynamics of pollutants in the Vorskla river (2007)

Chloride content after discharge increased by 8,9 times compared to the value it had before the reset at 1,6 MPC. Content of sodium ions after wastewater discharge increased 9,89 times and is 1,9 MPC. Bromine (1,18 MPC) is observed just below the discharge of waste water discharge above it is missing. Boron concentration after wastewater discharges increased by 4,9 times and the MPC is 1,25. Fluorine concentration after discharge increased by 3,6 times and 3,32 of the MPC.

In general, the Vorskla river cope with the load, which has Yakovlevsky mine: the concentration of pollutants does not exceed the MPC or have to v. Kustovoe (33 km after reset for bromine, chloride, boron), or to Hotmyzhsk (68 km after reset for fluoride, sodium ions).

Table 1: Chemical analysis of water in the presence of the Vorskla River discharge of mine water from the settling pond Yakovlevsky mine (mg/dm^3)

№ п/п	Ingredients	MPC	2007		2012	
			s. Yakov-levo (above reset)	Below Krapiv-ninskoe recervoir	s. Yakov-levo (above reset)	Below Krapiv-ninskoe recervoir
1	Mineralization	-	483,35	1317,95	673,245	1079,625
2	Natrium	120,0	23,35	**232,9**	-	-
3	Chlorides	300,0	55,04	**487,63**	13,7	**449,2**
4	Sulphates	100,0	19,32	20,12	30,12	27,99
5	Phosphates	0,2	**1,135**	**0,806**	**0,63**	**0,90**
6	Ammonium	0,5	0,336	0,372	0,29	**0,52**
7	Nitrites	0,08	0,0514	0,023	<0,02	0,028
8	Nitrates	40,0	2,85	1,10	0,49	<0,10

9	BOD-5	2,0	**2,72**	**2,6**	**3,60**	**3,31**
10	Total ferrum	0,1	**0,356**	**0,427**	**0,329**	**0,336**
11	Copper	0,001	**0,028**	**0,031**	**0,0117**	0,0001
12	Zimk	0,01	0,004	0,008	**0,027**	**0,029**
13	Nickel	0,01	**0,014**	**0,0235**	0,0032	0,0048
14	Cadmium	0,005	0,0	0,0	0,00158	0,00002
15	Manganese	0,01	0,0	**0,06**	**0,055**	**0,173**
16	Plumbum	0,006	0,0025	0,00525	0,0002	0,0012
17	Oil-products	0,05	0,025	0,029	**0,06**	**0,13**
18	Fluorides	0,05 in addition	**0,679**	**2,418**	**0,72**	**2,74**
19	Boron	0,5	0,128	**0,6255**	0,12	**0,76**
20	Bromine	1,35	0,0	**1,59**	<1,0	**1,44**

Bold concentrations exceeding MPC

Our research in 2012 [4] (Fig. 3, Table. 1) shows that the area of the Vorskla River from the village Yakovlevo to Krapivninsky reservoir, after being hit by sewage in the Vorskla river in the presence of mine water discharge, increased chloride concentration with 0,05 to 1,5 MPC, phosphate 3,15 to 4,5 MPC, ammonium from 0,58 to 1,04 MPC, iron from 3,29 to 3,36 MPC, zinc from 2,7 to 2,9 MPC, manganese from 5,5 to 17,3 MPC, molybdenum from 1,5 to 2,1 MAC, oil from 1,2 to 2,6 MPC, fluorides from 0,94 to 3,56 MPC, boron from 0,24 to 1,52 MPC, bromine his absence to 1,07 MPC. Decreased concentration of BOD-5 from 1,8 to 1,66 MPC, copper from 11,7 to 0,1 MPC. Stroke -specific concentrations in the presence of the Yakovlevsky mine discharge of shaft water from the settling pond is shown in Fig.3. The content of other ingredients (sulfates, nitrites, nitrates, chromium, nickel, cadmium, arsenic, lead, vanadium) does not exceed the MPC.

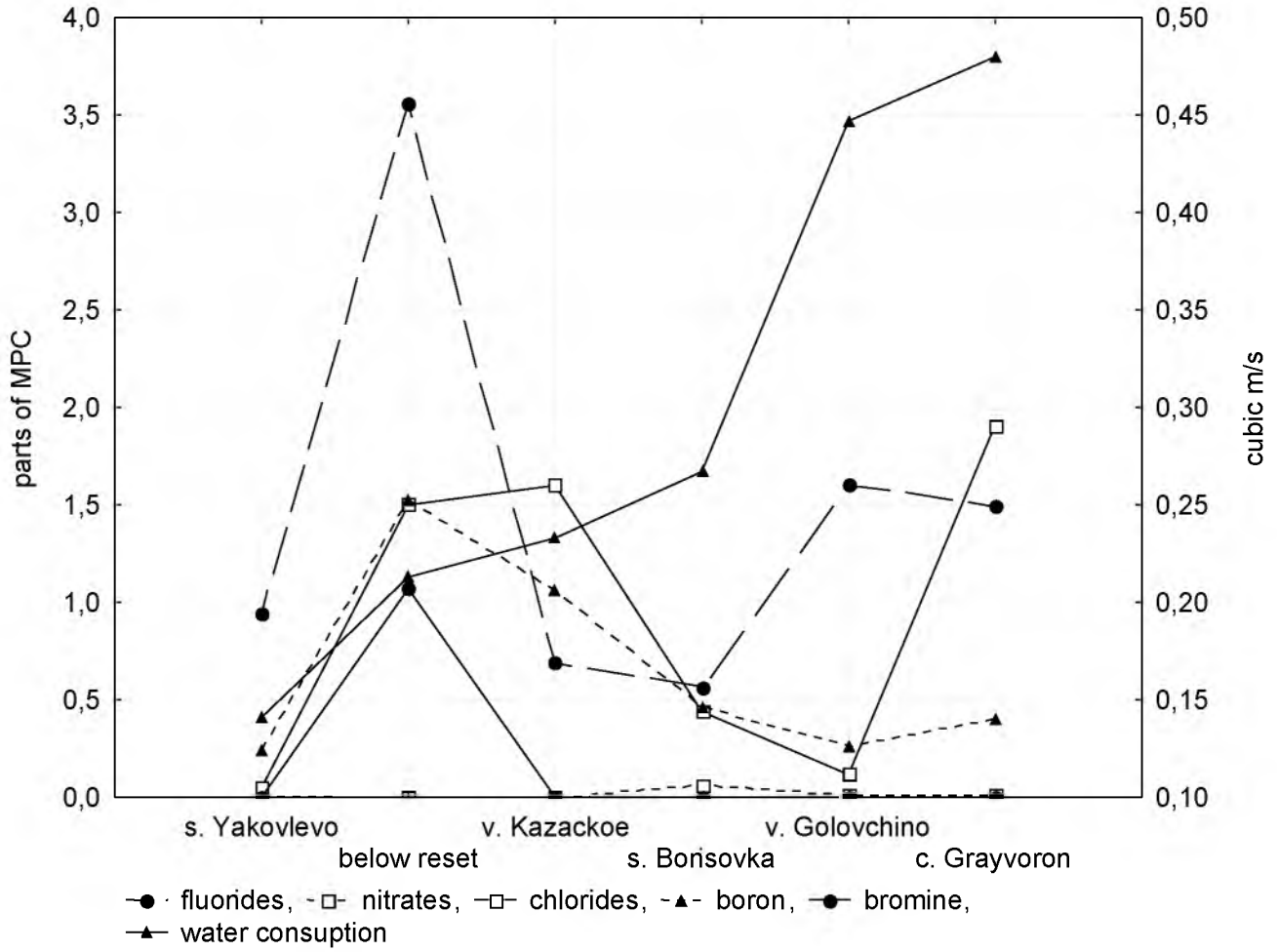

Fig. 3: Dynamics of pollutants in the Vorskla river (2012)

Thus, it is seen that when hit shaft water of the Yakovlevsky mine into the river increases the concentration of 11 substances. It is worth noting that the concentration of 7 of them (phosphates, iron, zinc, manganese, molybdenum, oil, fluoride) already exceeded the MPC in the background alignment of the Vorskla river. Reset shaft waters of Yakovlevsky mine causes additional excessive contamination in mine water discharge (Krapivninskoe reservoir) The following ingredients: chlorides 1,5 MPC, fluorides 3,56 MPC, boron 1,52 MPC, bromine 1,07 MPC. Contamination on these ingredients exceeds the background for the Vorskla river over 20 km (fluoride, bromide) to 74 km (chlorides, boron).

It should be noted that with regard to nitrogen compounds diluted mine water naturally high content of nitrates in the Vorskla river caused by agricultural run-off and is "improve" the quality of water is observed for more than 10-15 km.

The content of elements such as iron, copper, zinc, lead in the Vorskla river water, and the drain water is of complex origin. This high natural content of copper, zinc and iron in soils of the Belgorod region, and a large number of sources of anthropogenic lead, copper, zinc, iron, in addition to mining activities, and the complex processes of transport of iron and other elements in the marsh, and further regulated parts of the creek until reset values of the Vorskla river the dynamic processes of deposition and the secondary selection in the aqueous medium, including, depending on the hydrological situation [5].

Analysis of the studies in 2007 and 2012 shows that the hydrochemical situation in the river Vorskla during the study period remained generally are unchanged. To confirm or refute these results is necessary to conduct regular monitoring studies for the qualitative composition of surface waters above the wastewater discharge (s. Yakovlevo) in reset (reset shaft water retention pond, creek in the gully Terny and Ryazanovsky pond) and below the reset (the Vorskla river is below Krapivninskoe reservoir) wastewater Yakovlevskogo mine.

References

[1] Petin A.N., Serdyukova N.S., Shevchenko V.N. Small water bodies and their ecological condition: stud. method. aid. – Belgorod Univercity, 2005. – 240 p.

[2] Comparative characteristics of the impact of mining KMA on the ecological situation of rivers Belgorod Region / Kornilov A.G., Kolmykov S.N., Kichigin E.V., Gordeev L.Y. // Mountain information-analytical bulletin (scientific and technical journal). – № 6, 2010. – p. 134-139.

[3] Kolmykov S.N., Kornilov A.G., Kichigin E.V. Impact on development Yakovlevsky deposits on the ecological status of the Vorskla River // Questions drainage mining geology and subsoil protection, geomechanics, industrial hydraulic engineering, geoimformatics, ecology: Proceedings of the Ninth International Symposium. - Belgorod, May 21-25, 2007. – Belgorod: Federal State Unitary Enterprise "VIOGEM", 2007. – p. 371-375.

[4] Kornilov I.A., Kolmykov S.N., Petin A.N. Measuring the impact of mining on the KMA hydroecological situation Belgorod region // Mining Journal. – № 9. – 2012. – p. 29-32.

[5] Water pollution Belgorod region under the heatwave in 2010 / Kornilov A.G., Petin A.N., Lebedeva M.G., Kolmykov S.N., Petina M.A. // Problems of regional ecology. – 2012. – № 2. – p. 58-62.