AMUR HYDROCHEMICAL REGIME IN WINTER

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In recent 50 years winter hydrochemical regime of Amur has undergone significant changes due to the construction of large water reservoirs on its tributaries, more intensive development of industry and agriculture in the Chinese part of the river basin, compared to its Russian part.

Prior the construction of the hydropower stations on the Amur tributaries Zeya and Bureya their share in winter Amur runoff was 18%. It was 4 times less than the Sungary runoff, where the Sunhuahu water reservoir was built after the war. After the Zeya water reservoir was put into operation Zeya and Bureya runoff share increased to 55%, as after the first stage of the Bureya water reservoir was completed it became 60%.

The northeastern provinces of China accelerated the growth of industry, building of new and modernization of old industrial facilities, whereas several large industrial complexes were closed in Russia. Hence chemical composition of the Amur water in recent years has been mostly formed in the middle part of the river basin, which hydrochemistry is less studied. There are still no hydrometeorological stations to monitor water quality in the border section lower the city of Blagoveschensk. There are no data on water chemical composition for the Chinese tributaries of the Amur (Sungari, Sunhe, etc.).

Such changes in the Amur basin in recent years together with the deterioration of the river water quality in winter low-water upper the city of Khabarovsk made hydrochemical research very urgent. Thus in 200-2002 they were initiated in the border section lower Blagoveschensk and undertaken at Khabarovsk from 1997 to 2005. Sampling was carried out at 3-5 sections equally distributed across the river (up to its fairway in the border section). Sampling was monthly except at Blagoveschensk. In 2000-2001 the work was supported by the Khabarovsk Krai Government and RF Fundamental Research grant (#01-05-96303).

Dissolved substance content in the Amur water at Blagoveschensk, including total iron was evenly spread from the Russian bank to the river middle (Fig. 1). High mineralization (170) and high content of dissolved oxygen (9.5 mg/l) were identified. Total iron concentration was less than 0.39 mg/l, and ammonia nitrogen - 0.13 mgN/l. Nitric nitrogen concentrations highly fluctuate from 0.15 to 0.38 mgN/l and ortho-phosphate ions content is very low.

From the Zeya and Amur junction downstream water chemical composition changes significantly due to the flow of colored (over 100^{o} Pt-Co scale) ultrafresh water from the Zeya river [1]. It has high contents of oxygen (over 10 mg/l), organic matter and total Fe (Fig. 1). Ammonia nitrogen content was relatively stable and varied in the observation years from 0.28 to 0.33 mgN/l. Nitric nitrogen revealed the different picture. Its concentrations both in the

Amur and Zeya waters change within a wide range 0.04-0.28 mgN/l. Such increase in nitric nitrogen content in water may be caused by the increase of forest fires [3].

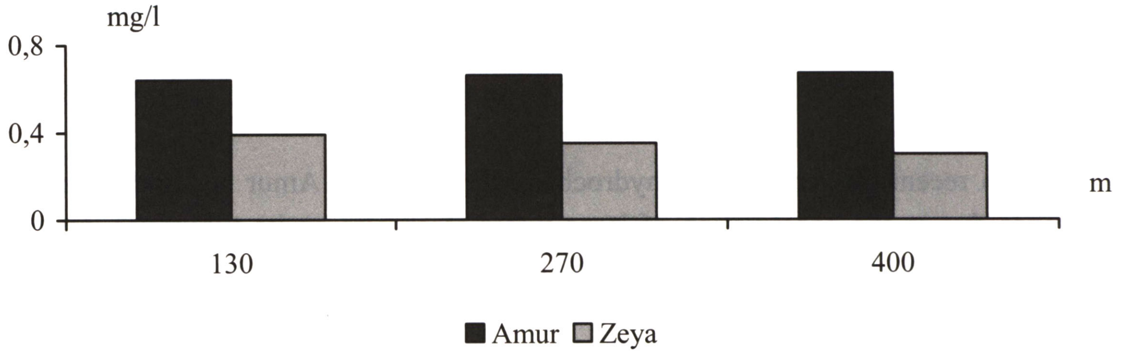

Fig. 1. Concentration of total Fe in water of the Zeya River (edgewise) and the Amur River (left bank-fairway), Blagoveschensk, March 2002

As Zeya runoff substantially dominates Amur runoff in the passage from Blagoveschensk to the Sungari junction, both rivers here do not differ much in their water chemical composition. Dissolved matter content is evenly distributed from the Russian bank to the river fairway in the Amur upper the Sungary. Compared to the Amur lower Blagoveschensk main ions content is 5 times less here and organic matter content is 2 time higher. In freezing time the water in this river section is characterized with a high content of dissolved oxygen (over 10 mg/l) and insignificant variation of concentrations of ammonia nitrogen, phosphates and total Fe (Fig. 2). Nitric nitrogen concentrations vary within a wide range from 0.03 to 0.42 mg/l.

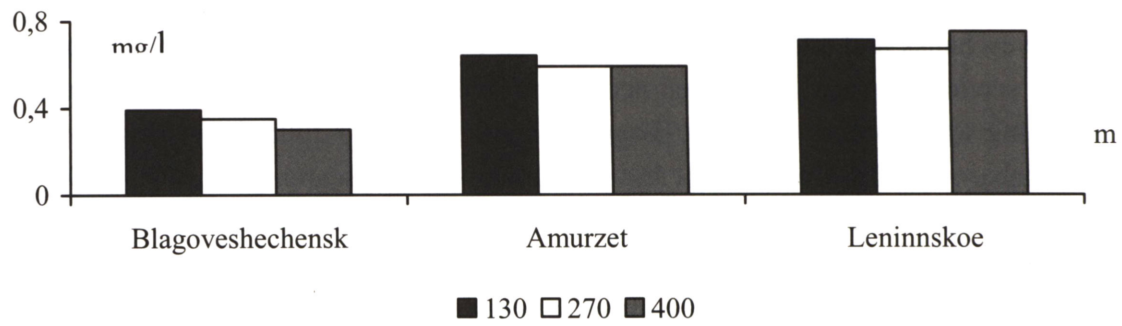

Fig. 2. Concentration of total Fe of the Amur River boundary stream part (edgewise from Russian bank to fairway), March 2002

Uneven distribution of dissolved substances throughout the river widths and significant decrease of water quality become evident low the Sungari junction. Dissolved matter content sharply increases at the river fairway compared to the Russian left-bank side. The highest increase (5-8 times) is registered for chloride, sulfate and phosphate ions and ammonia nitrogen (Fig. 3). Thus mineralization values are 3-4 times higher at the fairway than near the Russian bank. Dissolved oxygen content is also unevenly spread, being 2-3 times lower in the fairway than near the Russian bank. In March 2001 in the surface water horizons it was registered 4.5 mg/l and in February 2002 – 3.2 mg/l. Ammonia and nitric nitrogen concentrations at the surface also exceeded Russian permissible maximum concentrations. In March 2000-2002 in the surface water horizons they were 2.4 and 0.03 mgN/l respectively. In the Russian part of the river these concentrations were much lower. Our studies revealed the highest concentrations at the end of the freezing period, when lots of pollutants flow into the river from the drainage basin surface.

Fig. 3. NH_4^+-N of the Amur River boundary part (edgewise from Russian bank to fairway), March 2002

Nitric nitrogen, total Fe and phosphates concentrations were also higher in the fairway than in the Russian part of the river. The highest concentrations of nitric nitrogen (up to 0.194 mg/l) and phosphates (up to 0.89 mgN/l) were registered in 2001-2002 winter low water. Although the Sungari water colourity was low, Fe concentrations there were quite high. The main form of Fe migration in the Sungary water seemed to be suspended matter.

Uneven distribution of dissolved substances across the river observed at the Sungari junction remains near Khabarovsk. The highest concentrations are registered 150-200 meters from the right bank of the river (Fig. 4). Differences in the concentrations due to water mixing in such a long passage of 270 km are usually not significant [4-6]. The biggest difference was registered in 1998 after a catastrophic flood in the Sungari basin. In December 1998 mineralization in the central part of the river was twice higher than at the right bank. In January 1999 water mineralization exceeded 175 mg/l and was the highest, registered by the Russian Hydrometeorological Service since 1948. It was 1.4 times higher than in 1951-1978 and 2.3 times higher than in 1979-1988. In winter 1999 dissolved matter discharge was also unusual. In December 1951-1978 it fluctuated within 8407-21048 ton/day and in December 1999 it reached 38102 ton/day, i.e. increased 1.8-4.5 times [2]. Nitrogen and Fe discharge was also high, 267 and 204 ton/day respectively. Phosphates discharge was 22.3 ton/day.

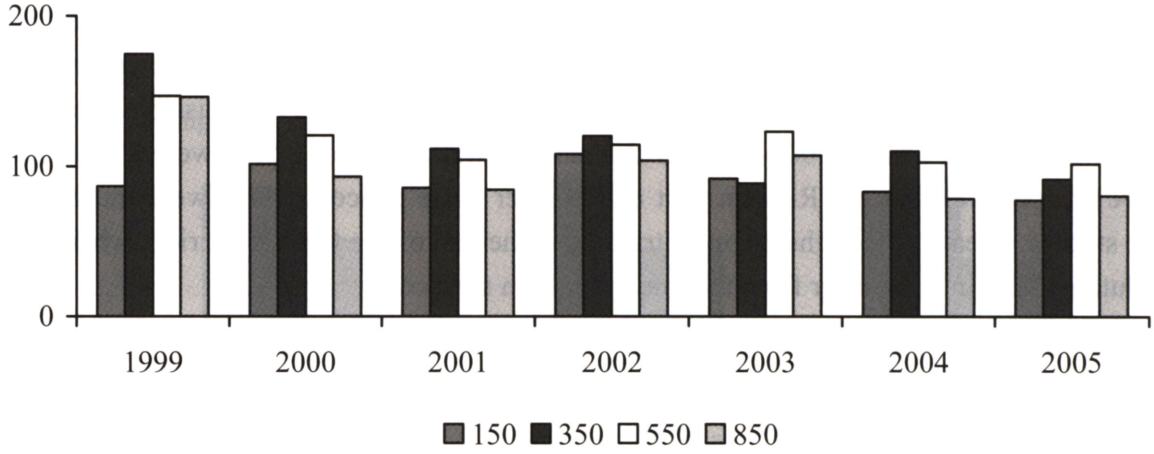

Fig. 4. Changes of Amur water mineralization (edgewise) at Khabarovsk In January 1999-2005.

In other years dissolved matter discharge was much lower: December 1999 – 20.78 thousand tons/day, 2000 – 19.44 thousand tons/day, 2002 – 12.12 thousand tons/day, 2003 – 23,27 thousand tons/day.

Several changes of the Amur hydrological regime are taking place in recent years due to the Bureya river industrial complex development. Hydrological studies in the first years of the Bureya water reservoir operation indicated low contents of dissolved substances. In 2003 annual average water mineralization was 25.2 mg/l and in 2004 – 29.6 mg/l. Total Fe and ammonia nitrogen contents were 0.30 mg/l and 0.59 mg/l respectively, much less than in the Zeya water reservoir. Organic matter content was also lower. In autumn 2003 average water colourity in the Bureya water reservoir was 65^0, and in winter 2004 – 58^0.

Dissolved matter content in the Amur water decreased due to the substantial inflow (200 m^3/sec) of ultrafresh Bureya waters, less coloured compared to Zeya waters. Compared to 2001-2002 and 2002-2003 winter low water periods in 2003-2004 winter low water time water mineralization decreased 1.15 times, Na and Ca ions concentrations decreased 1.4 and 1.13 times respectively, concentrations of ammonia nitrogen - 1.56 times and sulphate ions – 1.16 times. Colourity increase of 1.34 times indicates a significant increase of organic matter content in water [7].

Amur hydrological regime will be changing significantly in the future after the Bureya hydropower station is fully put into operation. Six times more water will pass through its 6 turbines compared to the present state of the station. Contaminated Sungari waters having low concentrations of dissolved oxygen in winter low water will be further diluted.

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