DYNAMICS OF THE LOWER AMUR WATER CHEMICAL COMPOSITION IN 2006

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Chemical composition of water in the Lower Amur is mostly formed due to mixing of the Middle Amur and the Ussuri waters. The Amgun, Tunguska and other Amur tributaries have less influence as their total drainage area makes only 12.1% of the Amur drainage area.

Studies undertaken by the Institute of Water and Ecology Problems, Far Eastern Branch of the Russian Academy of Sciences (IWEP FEB RAS) in 2000-2005 [1,3,4] showed significant changes of hydrological and hydrochemical regime of the Middle Amur water, caused by the construction of dams on the Amur tributaries Sungari, Zeya, Bureya and acceleration of economic activity in the Sungari basin. Such impact on the Amur hydrological regime also continued in 2006. In spring and the beginning of summer an active water resource accumulation in Zeya and Bureya water reservoirs caused low water level in the river in mid-June (Fig.1). Floods formed in the Sungary basin contributed to water level rise in July and August.

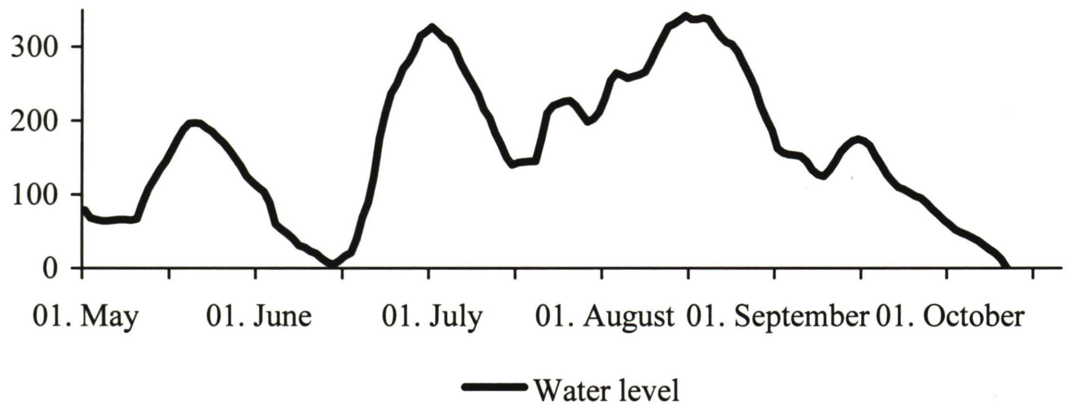

Fig. 1. Water level dynamics (cm) of the Amur near Khabarovsk in 2006

The Russian Hydrometeorological Agency (Roshydromet) conducted monthly monitoring of the Amur water chemical composition from March till October near Telegino village (3km up the City of Khabarovsk) and near Bogorodskoe at three stations equally spread across the river. The Interregional Center for Monitoring Hydroenergy Facilities (Accreditation certificate # ROCC RU 0001.515988) at IWEP FEB RAS carried out water sample analysis. Major ions (Na^+, K^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-) and nutrients (NO_3^-, NO_2^- and NH_4^+, HPO_4^{2-}, Fe, Si) in water were analyzed.

Major Ions. Maximum major ion contents in the Amur water upper Khabarovsk are registered at the very beginning of river freezing due to low water in the Zeya and Bureya in the pre-winter period. During the freezing period the share of these rivers in the Middle Amur run off gradually increases and thus, major ion contents gradually decrease by the end of March. Such specific features of winter hydrological regime coupled with snow melting water flow into water upper horizons under the river ice cover explain less high concentrations of major ions in the Amur water. That is why in March 2006 these concentrations were 1.3 times lower than in February. Near Bogorodskoe the situation is different. The distance between Khabarovsk and Bogorodskoe (740 km) and slow water current explain higher ion concentrations at Bogorodskoe in March (Fig. 2). Besides, economic activities in Khabarovsk, Amursk and Komsomolsk-on-Amur also contribute to ion concentration increase in the Amur water.

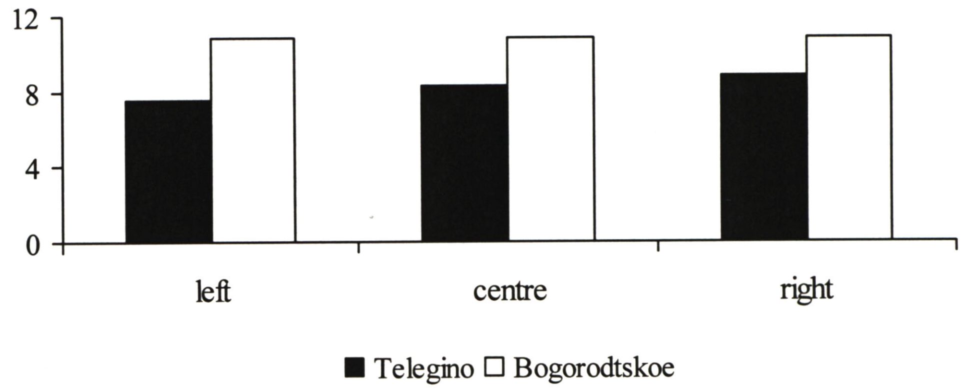

Fig 2. Distribution of calcium ion content (mg/l) across the Amur near Telegino and Bogorodskoe in March 2006.

Distribution of major ions across the river differs at the three stations. Near Bogorodskoe ion content is distributed between the stations more or less equally. Upper Khabarovsk the highest ion content is registered at the right bank of the river. Such difference is explained by the impact of Sungari water with higher ion concentrations compared to Amur water at their juncture [4]. At the beginning of March Na^+ and SO_4^{2-} contents in Sungari water near Tunjang city were 14.5 and 28.5 mg/l respectively and in Amur water near Amurzet village they were 2.1 and 2.9 mg/l respectively. In December 2005 after the accident at the chemical plant in Jilin SO_4^{2-} content in Amur water near Nizhneleninskoe village was much higher (up to 37.3 mg/l).

At the end of freezing period calcium ion prevailed in Amur water among cations (52.6% mg-equivalent) and hydrocarbon ion prevailed among anions 73.3% mg- equivalent). Similar water composition was registered near Bogorodskoe. Na^+, SO_4^{2-} and Cl^- content in water did not exceed 7.5 mg/l, whereas $K^+$and Mg^{2+} content did not exceed 3.0 mg/l.

Snow melting water inflow to the river net in springtime caused the change in major ion content. Decrease of Ca^{2+}, Na^+, SO_4^{2-} and Cl^- and increase of Mg^2 and K^+ were registered in Amur water upper Khabarovsk. Significant decrease of Ca^{2+}, Na^+, SO_4^{2-} and Cl^- (e.g. Na^+ 2.4 times) is also registered near Bogorodskoe. Behavior of sulfate ion was an exception as its concentration increased 1.3 times.

More significant changes in water chemical composition are registered during floods. Our studies showed that at this time major ion contents depend much on in which tributary basin the flood is formed [2]. Thus, during the flood in June (Fig.1), formed in the Upper Amur area, major ion contents in the water were the lowest in all the non-freezing period, but during the flood in July and August. Formed in the Sungari basin, it was the highest (Fig. 2). The difference in contents of Na^{+}, Ca^{2+}, SO_4^{2-} and Cl^{-} were the highest (1.5-2.0 times).

Near Bogorodskoe the difference in water chemical composition are less evident due to the impact of various river tributaries. Only SO_4^{2-} makes an exception. Its concentration in water in July was 1.65 time higher than in June.

In autumn the contents of Na^{+}, SO_4^{2-} and Cl^{-} in the Amur water upper Khabarovsk gradually decreased, while Ca^{2+} and Mg^{2} contents were not changed much. Near Bogorodskoe the situation is quite the opposite. Before freezing time major ion contents there reach the highest values, the only exception being Cl^{-}. These differences seem to be caused by the uneven distribution of chemical components throughout the water mass.

NUTRIENTS

Biogenic substance dynamics differs from the dynamics of major ions. Maximum contents of NH_4^{+} and NO_2^{-} and increased contents of NO_3^{-} and HPO_4^{2-} were registered in winter low water. Like in previous years [1-2] upper Khabarovsk the highest concentrations were registered at the right bank of the Amur. Near Bogorodskoe there is no much difference in water chemical composition across the river. Dissolved iron and silicon contents did not exceed 0.5 mg/l and 4.5 mg/l. Total nitrogen content at all the station across the river did not exceed 1.09 mg/l.

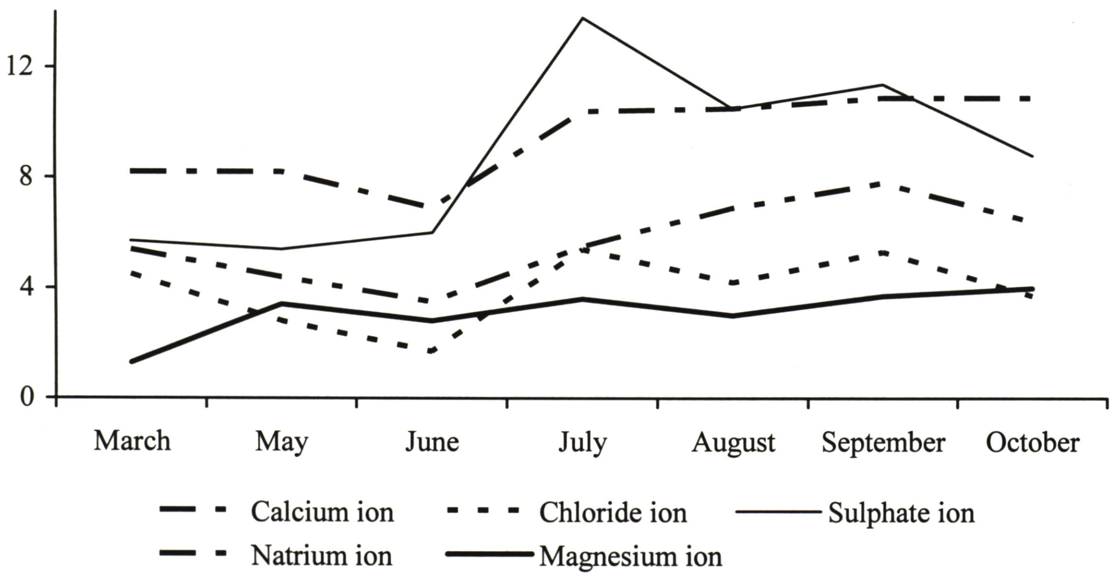

Fig. 3. Dynamics of major ion content (mg/l) in Amur water near Teltgino.

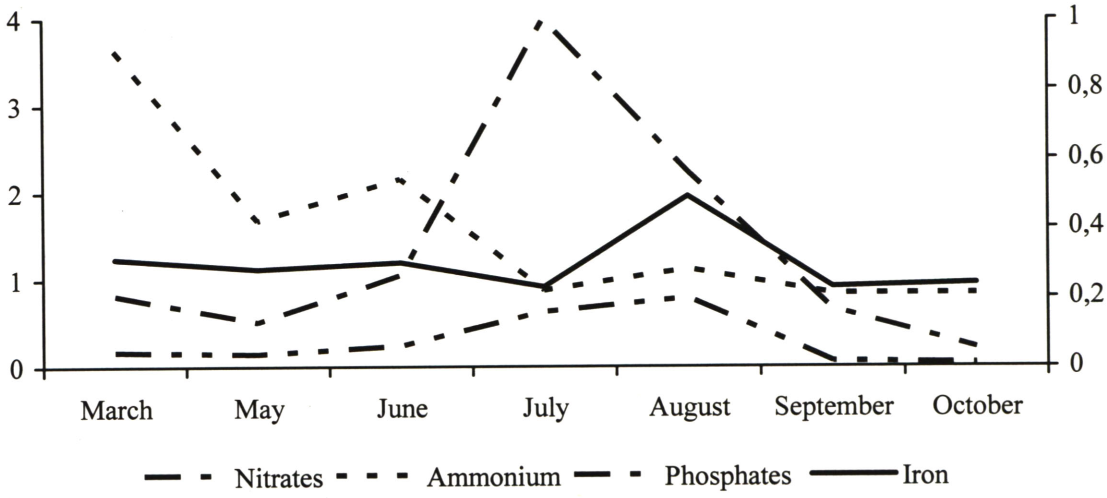

Fig. 4. Dynamics of Nutrients (mg/l) in Amur Water near Telegino.

In spring nitrogen compound contents in water and the difference in their concentrations across the river decreased due to the inflow of snow melting water into the river net. Iron and silicon compounds did not show much concentration changes.

Significant drop of water level in mid-June (up to 23 cm) did not cause much changes in the contents of phosphates and ammonia and nitric nitrogen in river water near Khabarovsk. Nitric nitrogen concentration was the lowest probably due to the growth of plankton. Similar situation was registered near Bogorodskoe, but at the end of June.

Significant changes of nutrient concentrations take place in flood time. The flood tide formed in the Upper Amur caused the increase of phosphates and nitric nitrogen concentrations with their maximums during July and August floods, formed in the Sungary basin. Similar concentrations of these substances were registered in the Amur water in August 1998 after the catastrophic Sungari floods. When the flood reached its peak near Khabarovsk the concentrations of phosphates, total nitrogen, iron and silicon compounds in water were the highest during the non-freezing time. Much difference in nutrient concentration distribution across the river was not observed.

Near Bogorodskoe in summer time NO_3^- and NH_4^+ contents were less compared to those ones near Khabarovsk, while HPO_4^{2-}, Fe and Si contents were of the same level.

In Autumn when flood subsided nutrient contents in water upper Khabarovsk gradually decreased, NO_3^- and HPO_4^{2-}showing a significant drop. Concentrations of these substances and also that of Si at that time were the lowest in the all period of observations. This fact indicates intensive processes in water, such as nitrification and photosynthetic phytoplankton activity.

At that time near Bogorodskoe only total nitrogen content showed significant changes, which can be explained as resulting from floods. That is why, total nitrogen content reached its maximum there by the end of September. Just before river freezing nitrogen compound concentrations significantly decreased. Nutrient concentrations across the Amur are distributed unevenly and their maximal levels are observed at the right bank of the river.

Thus, our studies showed that floods, formed within the Sungari basin had significant impact on dissolved substance content dynamics in the Amur water in 2006 and caused increased concentration levels of Fe and Si compounds, NO_3^- and HPO_4^{2-}.

REFERENCES

1. Shesterkin V.P., Shesterkina N.M. The Sungari Role in Formation of Middle Amur Water hydrochemical Composition in Winter Low Water Level // Biochemical and Hydrochemical Assessment of Terrestrial and Fresh Water Ecosystems. Vol.13. Vladivostok: Dalnauka, 2003.
2. Shesterkin V.P., Shesterkina N.M. Maximal Ion Consentrations in Middle Amur // Biochemical and Hydrochemical Studies of Terrestrial and Fresh Water Ecosystems. Vol. 12. Vladivostok: Dalnauka, 2002, p. 105-116.
3. Shesterkin V.P., Shesterkina N.M. The Impact of Zeya and Bureya Water Reservoirs on Middle Amur Hydrological Regime in Winter // Scientific Base for Ecological Monitoring of Water Reservoirs. Khabarovsk: IWEP FEB RAS, 2005, p. 63-65.
4. Shesterkin V.P., Shesterkina N.M., Forina Yu.A., Ri T.D. Sungari River Hydrochemistry and Amur Water Quality in 2005-2006 Winter Low Water Level // Modern Problems of Regional Development. Khabarovsk: IWEP FEB RAS, 2006, p. 159-162.