ECOLOGYCAL CONDITION OF THE RIVER ARGUN DURING THE YEARS 2000-2010

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Abstract: The article considers perennial changes in the concentrations of principle ions, oxygen regime and salinity of the Argun River water for 2000-2010. Since 2000, because of atmospheric precipitation decrease, there is a tendency of salinity reduction which is accompanied by a multidirectional inter-annual variability. The chemical water composition is related to hydro-carbonate class. The deficiency of dissolved oxygen in the period of winter freeze-up is connected with organic, phenols and oil products pollution.

Keywords: hydrochemistry, low of water phasewater salinity, pollutants, trans-border River.

Introduction:

The River Argun is related to the Upper Amur Basin, being a right part of the river Amur. The Amur basin is a single geographical and ecological system of cross-border object, covering the territory of Russia and China. The headwater of the River Argun is located on the western slope of the ridge Bolshoy Khingan and within PRC, the river is known as Hailar. The total length of the Argun-Hailar is 1683 km, of which 951 km, within Zabaikalsky Krai (Transbaikal Territory), is a natural border between Russia and China. The total catchment area is of 164 thousand km^2, in the Trans-Baikal region it is 49.1 thousand km^2. The seasonal and annual irregularity of the runoff is marked. The average annual water consumption is 336 m^3/sec: within Russia – 139.4 m^3/sec; on China territory – 196.6 m^3/sec (Chechel 2010). The changes in the hydrological regime of the river under the climate influence (Obyazov 2007) and anthropogenic factors (Simonov and Egidarev 2012) are marked. All of these changes are reflected in the hydro-chemical state of surface waters.

The aim of the present work is to describe the nature of the long-time average annual changes in concentrations of principle ions, oxygen, and oxidizability and some pollutants in the River Argun's water.

Materials and methods:

In this paper, the state of the River Argun in 2000-2010 is analyzed on the basis of hydro-chemical data SI "Chita CHME-R". Estimation on the pollutants was made in relation to the maximum concentrations' limit of the substances in the water content of the fishery water body – MCL (AUSS 27065-86).

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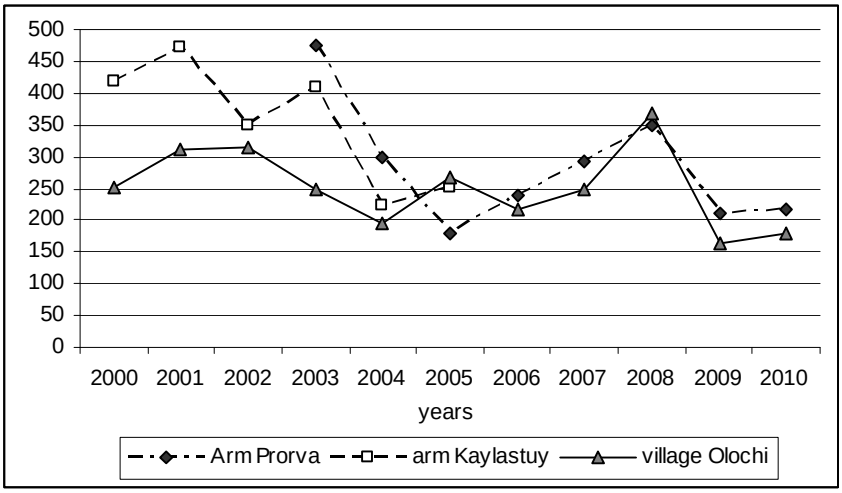
Results and discussion:

The annual amounts of precipitation are marked with the 15th 20-year cycle of high-water and dry years change. The low-water period began in 2000. The total water salinity, given in Image 1, shows that during 2000-2010 mainly river waters of medium (200 – 474 mg/l) salinity were formed. In 2000-2003 the average concentration of ions amounts indicate a predominance of underground rivers supply over the atmospheric power. In this regard, in dry years, ice salinity increases in some cases up to 623 mg/l (February 2008 at village Olochi) and 803 mg/l (February 2001 at arm Kaylastuy). In general, the intra-annual distribution of ion concentration for the years 2000 – 2010 is marked by the decrease in the average value of salinity of the River Argun water, which is associated with a decrease in the transfer of substances from the catchment area by reduced precipitation. The tendency of salinity reduction in 2000 is accompanied by a multidirectional inter-annual variability (Fig. 1).

Figure no. 1 Water Salinity ($\sum_{и}$, mg/l), the River Argun.



Over 2000-2010, pH values vary from slightly acidic (6.2) to mildly alkaline (8.5). In their ionic composition, the river Argun's waters are related to hydro-carbonate class, the calcium group (Tab. 1).

Predominance of hydrogen calcium in the chemical composition of the water is observed during the whole research period. Maximum concentrations of principal ions in the water are mainly confined to the winter runoff low (Fig. 2).

Thus, in the anion composition of water: sodium ions vary from 51.9 to 188.0 mg/l, chloride ions from 2.8 to 12.1 mg/l, sulfate ions from 12.9 to 33.7 mg/l.

The content of the dissolved oxygen in water is essential for the assessment of environmental and health status of water bodies and watercourses. The oxygen must be contained in water in sufficient quantities providing the conditions for aquatic breathing, for self-cleaning of waters, as it is involved in the oxidation of organic or other impurities, decomposition of dead organisms. The reduction of oxygen concentration indicates the change in the biological processes in the reservoir, including the reservoir's contamination with various rapidly oxidizing substances.

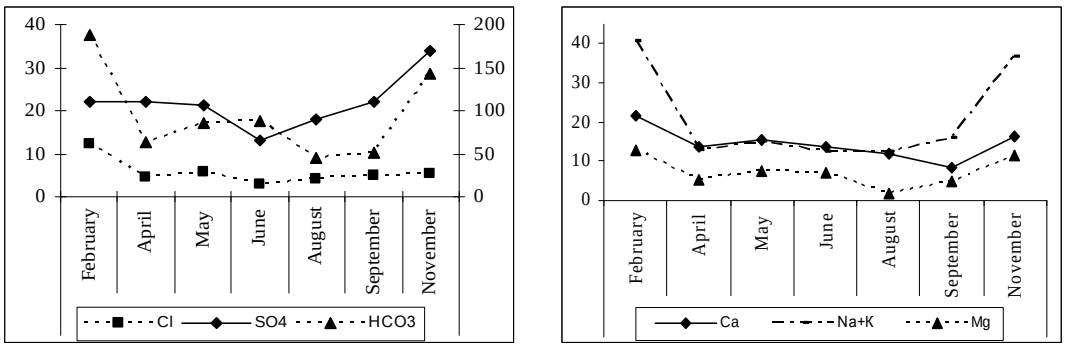
According to the results presented on Figure 3, we can see that in the water of the

river Argun, the oxygen concentration widely varies from 1.63 to 14.2 mg O/l. MCL of dissolved oxygen for fishery water bodies is accordingly set: 6 mg/l – for valuable fish species, 4 mg/l – for other species (AUSS 27065-86).

Table no. 1 Concentration of principal ions in the River Argun's water (mg/l).

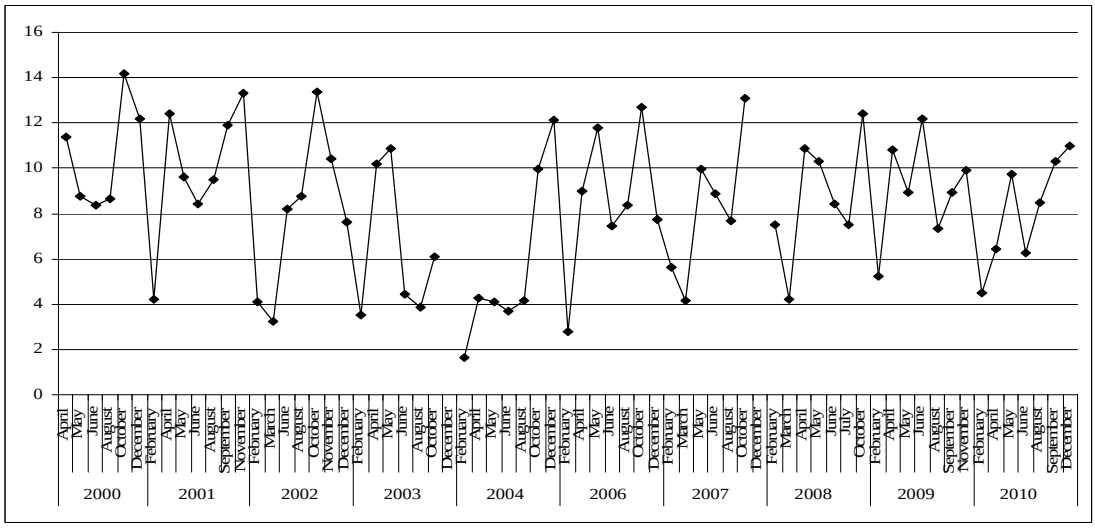
Years	Ca^{2+}	$Na^{+} + K^{+}$	Mg^{2+}	Cl^{-}	SO_4^{2-}	HCO_3^{-}
The Argun (arm Prorva)						
2003	29.6	78.0	20.1	40.4	21.0	284.9
2004	22.0	52.3	8.3	18.1	27.6	170.0
2005	20.9	20.0	6.5	6.7	19.5	76.6
2006	21.4	29.6	10.7	10.6	26.5	57.4
2007	28.0	39.0	11.3	14.6	20.3	182.7
2008	26.1	35.8	15.0	20.1	26.5	196.1
2009	17.0	27.9	10.1	10.4	25.1	121.4
2010	19.1	27.9	9.4	10.1	21.2	127.1
The Argun (village Olochi)						
2000	24.2	30.4	11.0	12.6	28.4	145.4
2001	27.0	43.5	12.8	22.7	34.6	169.7
2002	31.3	37.7	13.7	20.1	38.7	171.6
2003	23.9	27.2	12.0	11.7	16.0	159.2
2004	21.7	22.2	6.8	6.4	23.2	113.7
2006	22.0	20.6	11.3	7.5	26.3	127.5
2007	27.9	23.7	11.0	10.1	24.4	150.3
2008	35.1	42.3	17.1	17.9	36.1	219.5
2009	14.6	20.8	7.2	5.6	21.7	95.0
2010	18.5	17.9	8.7	6.2	23.4	174.5

Figure no. 2 Inter-annual change of principal ions concentration (mg/l) (the Argun, village Olochi).



The sharp oxygen starvation occurs mainly in winter low runoff. The frequency of such events is observed in the lower course of the river Argun within Zabaikalsky Krai. It is the most populated and developed territory. In the middle course of the river Argun (village Olochi) the winter reduction of dissolved oxygen was observed during the years 2002-2006. Such low concentrations of oxygen led to the contamination of the watercourse due to very low oxidizability of various organic substances.

Figure no. 3 The content of dissolved oxygen in the water of the river Argun (village Olochi, mg O/l).



BOD_5 (Biochemical Oxygen Demand within 5 days) indicators vary over a wide range from 1.15 to 9.54 mg/l (according to the degree of contamination from moderately clean to dirty state) in-between 2000-2010. In one case (March 2004) it was noted the high water pollution with easily oxidized organic substances according to BOD_5 (23.4 mg/l) in the arm Prorva near the village Molokanka (River output from China territory). In the winter time following the decline in water temperature, the indicators of biochemical oxygen demanded increase. Thus, BOD_5 concentrations higher than 5 mg/l are marked from December to February 2004-2006, 2008, 2009. The poor water quality in the ice-covered period is explained with poor oxygen regime and high water pollution together with extremely low water levels of the river.

Typical pollutants in the river Argun's water are resistant to oxidation organic substances (in bichromate oxidizability), phenols and oil products. Contaminants in the water of the river Argun, presented in Table 2, are characterized by: arm Prorva – a front part of the river from CPR territory and above village Olochi – is a sector of the middle course of the river Argun, its water collection featuring a highly intense economic development.

Table no. 2 The content of organic substances, phenols and oil products in the water of the river Argun (mg/l).

Years	COD	Phenols	Oil products
The Argun – Arm Prorva			
2003	34.4	0.002	0.232
2004	42.9	0.002	0.095
2005	31.0	0.002	0.159
2006	25.2	0.002	0.073
2007	28.4	0.001	0.033
2008	27.7	0.001	0.238
2009	29.8	0	0.200
2010	27.1	0.001	0.214
The Argun – village Olochi			
2000	27.1	0	0.515
2001	31.3	0.002	0.143
2002	40.2	0.001	0.117
2003	31.2	0.001	0.291
2004	27.6	0.001	0.125
2005	34.4	0.002	0.163
2006	29.9	0.001	0.324
2007	26.9	0.001	0.069
2008	26.9	0.001	0.081
2009	24.6	0.001	0.163
2010	22.2	0.002	0.294

The given data show that in all these years the aquatic ecosystem of the River Argun experienced pollution according to COD (MCL from 1.5 to 2.9), phenol (MCL from 1 to 2) and petroleum products (MCL from 1.4 to 10.3). The greatest contamination was observed in summer time (August-September). The highest concentration of hydrocarbons, corresponding to 1.48 mg/l was stated in September 2008 in the water of arm Prorva. Consequently, during the months with the highest rainfall, typical for Zabaikalsky Krai (August-September), oil products, phenols and organic substances have been washed from the catchment area.

The anthropogenous transformation of ecosystems, under the influence of chemical pollution, is redoubled with the remoteness of self-purification natural factors (the partial aridization of the basin, the decrease of flow and biological diversity etc.). The flow regime of the rivers in southeastern Zabaikalye is subject to cyclical changes according to fluctuations in air temperature and atmospheric precipitation. The period from 2000 to 2010 is marked as shallow. The reduction of the areas' moisture, noted in recent years, is connected with the dry phase in inter-secular cycle (Obyazov 2007; Simonov and Egidarev 2012). Modular runoff coefficient of the river Argun, during high water and low water years within Zabaikalsky Krai, are, respectively, 2.29 (46.7 km^3 per year) and 0.36 (7.7 km^3 per year) (Chechel 2010).

Since 2000 up to 2002 the temperature was the highest during the period of 1980-2010, that reduced the water flow and increased the concentration of pollutants. And at the same time, the mountainous nature of the relief causes high hydrodynamic energy of water flows when pollutants are distributed over large distances. In the Argun River basin, the mining industry based on the field of non-ferrous, rare and precious metals has developed, the main negative effects of the mining production are dust air and soil pollution with toxic components, as a result of their wind transport from dumps and the input of contaminant into surface and ground water (Zamana 2011). Another feature of the river Argun basin is its trans-boundary nature, which determined that most of it be located on the territory of China (the river Hailar), and only the left bank of the lower reaches is within Russia, being 30 % of the total catchment area, i.e. the main flow of the river Argun is formed on the territory of China. The river basin is presented with an extensive agricultural and mining region. It has been noticed that the emergency discharge of the sewage into the river basin is made by the Russian and the Chinese sides, usually 2-3 times a year (Simonov and Egidarev 2012).

According to the Department of Water Resources in Zabaikalsky Krai of Amur Basin Water Directorate in 2010 as a result of a joint Russian-Chinese monitoring of the river Argun state, extremely high water pollution with mercury compounds and manganese was noted. On the stretch of the River Argun (village Molokanka) the manganese concentration reached from 863 to 1263 mcg/dm^3 that is 86-126 of MCL, on the arm Prorva – 71-163 of MCL, the River Argun (village Olochi) - 43 of MCL. The mercury concentration in the river water near the village Molokanka exceeded MCL 4-6 times (0.00004 - 0.00006 mg/dm^3) (Report on the Environmental Situation 2011).

Due to the climatic changes that strengthened the folding natural management in the upper basin of the Amut River we can observe the transformation of natural systems. The limiting factor of natural management in the basin is the water resources (water scarcity and its quality).

Conclusions:

Taking into account the trans-border character of the Argun River, its ecological, social and economic importance, it is necessary to take measures for the conservation of the river's eco-system and its basin. This problem can be solved only by joint efforts of Russia and China, with regard

to the nature unity and the impossibility of its division between artificially made frontiers. The water problem of XXI century leads it to the globalization of its solving. To achieve the result it is necessary:

- to transit to the sustainable natural management, flexible flow regulation and control of transboundary transport of pollutants, the special status should be given to the Amur River basin. (e.g. Lake Baikal) in the light of interstate agreementt;
- to make complex investigations on the problems of the environment condition and economical development of trans-border territories and trans-border basins;
- to include the topics of complex investigations, practical recommendations to the National Programs and Action Plans for the ecological enhancement and the conservation of bio-diversity in the Argun River basin.

Rezumat:

CONDIȚIILE ECOLOGICE
ALE RÂULUI ARGUN
ÎNTRE ANII 2000-2010

Articolul are în vedere schimbările survenite în concentraţiile principalilor ioni, regimul oxigenului şi salinitatea apei râului Argun în perioada 2000-2010. Începând din anul 2000, din cauza regimului scăzut de precipitaţii atmosferice, a existat o tendință de reducere a salinității, însoţită de variabilitatea multidirecţională inter-anuală. Compoziţia chimică a apei este în legătură directă cu grupa hidro-carbonaților. Deficitul de oxigen dizolvat pe timpul iernilor geroase este în strânsă corelație cu poluarea prin produşi organici, fenoli şi produse petroliere.

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