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ESTIMATION OF WATER CONSUMPTION AND WATER DISPOSAL IN BASIN OF SVIYAGA RIVER

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Abstract

Consumer attitude to water resources within several decades, expressed in wide-scale water-supply activity for satisfaction of national economic and population needs, led to occurrence of adverse changes in water bodies' condition [1]. In this aspect water resources, particularly river waters of the Republic of Tatarstan, in which basins is concentrated a significant industrial and agricultural potential are, are not an exception too. On example of basin of Sviyaga river, author estimates amounts of water consumption and water discharge in water body in multi-year aspect. In process of research with application of comparative analysis and statistic methods was established that summary water consumption in river basin in period of years 2000-2015 was 68368.2 million m³.

At this a vast majority of water resources was used for industrial needs, 67,589.8 million m³ of water (95.6%), and the rest, 778.44 thousand m³ (1.1%), for satisfaction of agricultural branch needs. By river basin, the largest amount of fresh water use, approximately 49 694 million m³ in stated period belongs to share of Birlya river.

Amount of water discharge into the river basin for given period was 28510.09 million m³ of waste waters; at this the discharge into Sviyaga river directly was 712.08 million m³.

According to water pollution index (WPI), in stated period the Sviyaga river was related to "very polluted" river category. A significant pollution level of basin waters minimized the self-purifying ability of the river, and consequently, processes of transformation, sorption and other constituents of self-purification mechanism of Sviyaga river are expressed weakly. There were observed cases of massive fish mortality, accumulation of heavy metals in bottom sediments and ichthyofauna.

Key words: river basin, water consumption, water discharge, water pollution index, feeder.

Introduction: Conduction of water supply activity, often connected to exceeding amount of water resources outtake and worsening of their quality condition, is characteristic for major part of our country's water bodies [2]. But while

major provisions of water supply activity are developed to a sufficient degree on federal level, than, on the level of country's subjects, separate issues of water supply sphere are not highlighted enough. Particularly, issues of use of region's river flow resources for purposes of water consumption and water discharge require more detailed development. Also, due to variability of population and economic branches needs in water resources by virtue of diverse causes, the prolongation of existing researches on space-temporal laws of water use and also changes of water bodies themselves in contemporary social-economic conditions is required.

In this aspect is notable the region of the Republic of Tatarstan, where resources of river flow are formed by cost of local flow – 81.3 km³/year, among them a yearly flow of small rivers is 7 km³, cross-border flow – 230.8 km³/year and water outflow from republic's territory - 238.9 km³/year [3]. One of cross-border basins located on territory of two other country's subjects, beside the considered one, Chuvash Republic and Uliyanovsk region, is the Sviyaga river. Ecological burden of the basin is predetermined by its location in limits of eight municipal formations with high concentration of industrial enterprises and agricultural sphere that are using water resources of the basin and determining their quality. So, according to calculations based on statistic statements No. 2-ТП (water supply), the annual average amount of water consumption in period of years 2000-2015 was 5697.2 million m³, of which 5632.4 million m³ are used in industry and 64.8 thousand m³ – in agricultural branch. At this is established that the major part of water consumption in region is based on use of flow of the Sviyaga river itself and its feeder Birlya river, while the degree of use of water resources of Karla river and Arya river is insignificant.

Amount of water discharge into the river basin for considered period was 28510.09 million m³ of waste waters, at this the discharge into Sviyaga river directly was 712.08 million m³. The most polluted feeder of Sviyaga river is Birlya river. According to water pollution index (WPI), in stated period the Sviyaga river was related to "very polluted" river category. Consequently, the pollution level of basin waters minimized the self-purifying ability of the river, processes of transformation, sorption and other constituents of self-purification mechanism of Sviyaga river are expressed weakly.

Materials received on use of waters of Sviyaga river by diverse branches of national economic can be used for multi-years monitoring researches of basin waters condition, for highlighting of water supply thematics of region instate registers on condition of territory's water bodies. In perspective, issues of water discharge is rationally to be considered in connection with projects of maximum permissible discharges (MPD) regulations' development, what

are often left as closed agency information and do not find respective reflection in scientific analyzes and estimations applied to river basins.

Methods

Research of major aspects of researches problematics was conducted with used of statistic method for analysis of water resources use. Application of statistic methods of basic of data by form No. 2-ТП (water supply) allowed to detect the presence, quantity and quality of waters, their use for industrial, agricultural needs in order to control the quality of waters used. Objects of static observation by water resources of research territory were water consumers conducting withdrawal and discharge of water for economic needs.

Also, in the work was used a comparative method for analysis of data on water consumption and water discharge within multi-year period of observations.

Results

According to data of annual statement by form No. 2-ТП (water supply) for period of years 200-2015, water consumption in the river basin within border of the Republic of Tatarstan was conducted by 42 enterprises. Amount of total water consumption in river basin within period of years 2000-2015 was 68368.2 million m³.

On this basis, on the territory of a part of basin in borders of republic, a vast majority if water resources was used for industrial needs, 67,589.8 million m³ of water (95.6%), and the rest, 778.44 thousand m³ (1.1%), for satisfaction of agricultural branch needs. Of total amount of water consumption by river basin, the largest amount of fresh water use, approximately 49 694 million m³ in stated period belongs to share of Birlya river. By feeders of the river basin, the distribution of amounts of water withdrawn for diverse need within period of years 2000-2015 is the following: river Karla – 22.3 million m³, river Arya – 16.42 million m³, river Ulyema – 147.84 thousand m³, river Small Tsilna – 189.3 thousand m³ etc. Analysis of dynamics of water consumption in basin of Sviyaga river within period of years 2000-2015 shown a steady growth of this index in years 200-2008, also with some fluctuations, which is possibly stipulated by increase of amount of production manufactured at enterprises of industrial and agricultural specialization. Starting from 2011 and till 2015, the increase of water consumption was recorded again, although this growth had stick-slip nature. Economic use of river basin waters is accompanied by formation of waste water, overloaded by mass of foreign substances that are changing physical-chemical properties of water.

64 enterprises of industrial and agricultural complex, of communal-household sphere were conducting waste water discharge into the basin of Sviyaga river within the period of years 2000-2015. Substantial impact on qualitative

composition of river Sviyaga's water is made by its feeder, in which shore zone are functioning enterprises specialized as state above. Particularly, pollution of Sviyaga river is determined by presence of enterprises of feed, oil industry, residence-communal and agricultural economic on territory of municipal formations where it flows. This leads to intense pollution of the river by sulphates, nitrates and nitrite-ions, suspended substances.

Pollution of Ulyema river is caused by discharged waste waters of OJSC "Tetyushi-Vodokanal" and also in course of activity of multiple agricultural organizations.

28510.09 million m³ of waste water was discharged into the river basin within period of years 2000-2015, the discharge into Sviyaga river directly was 712.08 million m³.

By basin feeders the amount of waste water discharge in analyzed period was: by river Karla – 2447.82 million m³, river Birlya – 15354.05 million m³, river Ukyema – 2704.92 million m³, river Small Tsilna – 492.18 thousand m³.

Stated data are the evidence of the fact that most polluted are waters of Birlya and Sviyaga, less polluted is Small Tsilna river.

The major inflow of polluted water by river basin was observed from activity of enterprises OJSC "Kaybitskiy rybkhoz" (Birlya river), OJSC "Buinskiy shugan plant" (Sviyaga river), OJSC "Tetyushi-Vodokanal" (Ulyema river), where annual water discharge was 2700–2750 million m³.

Waster water inflow from small agro-companies using water resources of the basin of Sviyaga river was of lesser degree . In general, index of water discharge in period of years 2000-2009 was variable, for example, in 2003 the amount of discharge of waste water containing pollutants is higher by comparison to years 2000-2002, and since 2009 was recorded stable decrease of discharge into Svyaga river and its feeders.

Ingredient composition of polluting substances of river water of river basin of Sviyaga river was presented by nitrate and nitrite forms of nitrogen, sulphates, chlorides, solid residue, suspended substances, the source of which are waste waters of diverse industries, enterprises of agricultural and residential-communal economic.

Within analyzed period for river water of the basin is characteristic a small content of oil and oil products, no more than 0.011 tons. High-toxic metals – nickel, cadmium, cobalt and also polycyclic aromatic hydrocarbones are not found in water of the river. The presence of specific polluting substances, such as benzol, benzapyrene, toluol, stirol etc. in river water is also not detected.

Conclusions: The degree of basin's rivers pollution is diverse, but often is rather high. With all time period in water masses of the Sviyaga river was observe rather high content of suspended substances – up to 34.5 tons (2012),

sulphate-ions – up to 52640 tons (2009), solid residue – up to 859 tons (2012), nitrogen-comprising compounds.

Within considered period, the BOD complete index, as one of the most important indexes of water pollution by organic compounds level, is recorded on the level of 1029-4350 tons. In last years occurred the tendency of reduction of discharge mass of polluting substances with waste water, the degree of river's water pollution is in general maintained on the level of previous years. Quality class of water of the Svyaga river in considered period complied with "very polluted" category – 3 "b". In 2009, at hydro-post Sviyaga-Buinsk CDWPI was 3.71, which is a little higher of a similar index of the previous year, fixed at level of 3.46 [4]. In the following years the level of river pollution stayed at the level of previous years, for example, in 2011 CDWPI of Sviyaga river was 3.84, and water was also characterized like "very polluted". [5].

In 2011 in surface water of Sviyaga river BOD₅ and COD was 1.2 MPC. Within last years tendencies of water pollution level in Sviyaga river are maintained and water is estimated as "very polluted" [6]. Water mineralization in Sviyaga river varies in limits of 400-1100 mg/L. During most part of year the Sviyaga is related to rivers with increased mineralization, during spring flood the general content of ions drops to 150 – 200 mg/L.

Quality composition of Sviyaga river water was changing from hydrocarbonate-sulphate-calcium to sulphate-hydrocarbonate-sodium type to river's estuary. Waters were characterized as "soft" in spring season (1.-3.0 mg-eq/L) and moderately "lime" in low water season (3.0–6.0 mg-eq/l) with increased mineralization up to 700 mg/L within year [7].

Polluted feeders of Sviyaga river are Ulema and Birlya rivers, in which analysis of surface waters quality dynamics, conducted by materials of AHM by RT allowed to detect the following (see Table 1,2).

Within all analyzed period the priority polluting substances in river waters were suspended substances, sulphate and chloride-ions, solid residue, which content in waters varied in limits 7500–55900 tons (sulphates), 10.8– 18.3 tons (chlorides), by suspended substances – 0.021 ton (Ulema river) to 16.978 tons (Birlya river). Attention is drawn by principal difference of polluting substances composition in mentioned rivers' basins from ingredients of polluting substances that are present in other water passageways of the basin, So, in particular, in waters of Birlya river, within period of years 2009-2015 were not detected waste waters with nitrogene-comprising compounds and nitrite-ions. And in waters of Ulema river, differently from other basin's feeders, are detected forms of water-soluble forms of iron, which content is recorded on the level of 10 520 kg (2010) and 37.43 kg (2014).

Table 1:Concentration of major polluting substances in waters of Ulema river within period of years 2009-**2014 (according to data of AHEM by RT).**

Polluting substance	Concentration, kg (t)					
	2009	2010	2011	2012	2013	2014
Nitrogen ammonia	2020	1070	0.390	0.160	0.225	0.31
Iron (Fe ²⁺ , Fe ³⁺)	11270	10520	11720	14790	23050	37.43
Nitrate-anion (NO ³⁻)	3397100	3576660	2293110	2497660	3887440	2548
Nitrite-anion (NO ²⁻)	122360	217910	112150	43720	246530	394
Sulphate-anion (SO ₄ ²⁻)	10180	17210	15030	16760	14206	34.85
Chloride-anion (Cl ⁻)	17050	16730	10680	3980	5352	4.68
Suspended substances	4060	6370	4070	0.160	0.021	0.03
Solid residue	110290	102940	115000	76410	90493	47.21

Table 2. Concentration of major polluting substances in waters of Birlya river within period of years 2009-**2014 (according to data of AHEM by RT).**

Polluting substance	Concentration, t					
	2009	2010	2011	2012	2013	2014
Sulphate-anion (SO ₄ ²⁻)	6000	7500	8940	13159	55904	32.55
Chloride-anion (Cl ⁻)	12280	5600	10880	18317	14482	12.19
Suspended substances	4560	6000	6200	16978	10470	10.55
Solid residue	532000	491200	488900	544328	356480	492.93

Quality composition of Ulema river's waters was characterizes as hydrocarbonate-sulphate-calcium waters were distinguished by moderate limeness – 3.0–6.0 mg-eq/L in spring with increase to 6–9 mg-eq/L in low water season, increased mineralization up to 700 mg/L, medium turbidity of 2400 g/m³ [7]. Type of waters of Birlya water is hydrocarbonate-chloride-calcium, with low mineralization – 100–200 mg/L in high water period with increase up to 500–700 mg/L in low water period.

The chemical composition of Small Tsilna river's waters is impacted by waste waters of industrial and agricultural branch enterprises. Within considered period a composition of polluting substances, similar to other feeders of the

Sviyaga river, was detected in river's waters. It is represented by nitrate and nitrite compounds, sulphate and chloride ions, suspended substances. In river's waters nitrates are comprised in the largest amount, their content in waste waters in years 2009-2010 was 7500–87000 kg, reaching extremely value in 2012 – 1 618 800 kg.

Quality of waters of Karla river is impacted by cross-corder pollution and waste waters of enterprises of Buinskiy municipal district of the republic, where it flows. It was determined that within period of consideration the river's waters, similar to cases with other basin's feeders, had accumulated salts of nitrogen acid, sulphates and chlorides, to a lesser degree – phosphates and oil products, So, in 2001 into the river's water was discharged: nitrates – 452 000 kg, nitrites – 5200 kg, sulphates – 1970 t, chlorides –1370 t, while in 2015 indexes of pollution of the Karla river's waters by nitrates were maintained practically on the level of 2011, and content of remaining ingredients had substantially decreased. There were no significant changes in pollution of surface waters of Karla river's basin within all analyzed period. Waters quality of basin's river was in limits of class 3 and were estimated by complex water index as "very polluted". So, in years 2008–2009 the CDWPI of river was in limits of 3.50–3.72, in 2011 the water pollution index had decreased in class limits and was 3.00. In surface waters of Karla river in 2011 indexes BOD and COD were 0.9 MPC and 1.2 MPC respectively.

The above-mentioned material allows to speak about the fact that with quantitative and qualitative exhaustion of water resources are connected major ecological problems of the Sviyaga river. Pollution of the river by industrial, agricultural, communal-residential waste waters is promoting the eutrophication of the Sviyaga river waters, i.e, their enrichment by nutritional substances that lead to exceeding development of algae and destruction of water body's ecosystem. In result of systematic introduction of polluting substances from diverse sources into the river, it obtained a green color and swamp odor which is explained by presence of humic acids in Sviyaga river's waters. Problems is getting more acute due to the fact that waste waters of enterprises having outdated purification facilities, that respectively are unable to purify the water to the necessary degree, are discharged into Sviyaga river. Injection of non-purified waste waters lead to extreme pollution of river's waters by biogeneous elements. suspended substances. There also exists the problem of absence of storm drainage in inhabited communities, therefore the water from streets is flowing into the river without obstacles.

Summary:

In his research the author came to the conclusion that the basin of Sviyaga river is practically incapable of self-purification due to heavy load, process of sorption transformation is expressed weakly. Processes of transformation,

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sorption and other constituents of self-purification mechanism of the river with participation of biological layer are minimized [8].

Biological protection of water does not prevent the discharge of polluting substances and its impact is becoming toxic for water communities. There are observed cases of massive fish mortality, accumulation of heavy metals in bottom sediments and ichthyofauna [9]. Concentration of major polluting substances in waters of Sviyaga river increase the range of biochemical balance variation and more and more length of time is required for restoration of river's waters quality.

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