Monitoring of drinking water quality from the distribution network of the regional centralized water supply

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Abstract. The territory of the Irkutsk region belongs to one of the most endowed with fresh water. Along with this, monitoring studies to provide residents with quality drinking water from the distribution network of centralized water supply revealed an excess of hygienic standards. The discrepancy is due to the excess content in drinking water of iron, manganese, nitrates, magnesium, increased rigidity, the presence of common and thermotolerant coliform bacteria. The main causes of poor quality of drinking water are identified, the sources of systematic pollution of water bodies are called. It was recommended to conduct activities that bring the quality of drinking water into line with the requirements of current legislation.

The most important factor in people’s health is high-quality drinking water. Standardized indicators for different uses of water constitute the quality norm. In Russia, regulation of the drinking water quality is provided for by various regulatory acts. The Federal Law “On Water Supply and Water Disposal” N 416 of December 7, 2011 regulates the state policy in terms of water supply and water disposal. Its main areas are the protection and improvement of the health and quality of life of the population through the organization of uninterrupted and high-quality water supply and sanitation. The Federal Law “On the Sanitary-Epidemiological Well-Being of the Population” N 52 of March 30, 1999 provides qualitative characteristics of the water in terms of epidemiological and radiation safety, chemical content and possible organoleptic parameters. The health and safety rules and standards (SanPiN) 2.1.4.559-96 “Drinking Water” determines the suitability of drinking water. These laws provide regulations for the quality of drinking water in terms of chemical content, organoleptic characteristics, and epidemic parameters.

In many regions of Russia there is a problem of drinking water supply meeting regulatory requirements [1-3]. The Irkutsk region belongs to regions with a significant supply of water resources. Based on the materials of the regional report “On the State and Environmental Protection of the Irkutsk Region in 2017”, the total volume of water resources of surface water bodies is slightly less than 180 km³, the total amount of groundwater is estimated at 47,065 thousand m³. However, in many parts of the region there is a problem of providing quality drinking water. In connection with above-mentioned issues the chosen research topic is urgent. The objective of this study is to monitor the quality of drinking water from the distribution network of centralized water supply of the Irkutsk region. The tasks of the study are to analyse the parameters of drinking water samples from the distribution network of centralized water supply with non-compliance with hygienic standards, to identify the causes of poor quality of drinking water in the region and to recommend measures to bring the quality of drinking water
in accordance with the requirements of the legislative regulations. The research methodology is to conduct local operational observations of the quality of drinking water [4-5].

According to the regional report “On the state and protection of the environment of the Irkutsk region in 2017” of the Ministry of Natural Resources and Ecology of the Irkutsk region, 240 monitoring points operate in the region to check the quality and safety of drinking water continuously from centralized drinking water supply systems (hereinafter referred to the CDWSS). In the last study year, 2,197 drinking water samples were taken for analysis.

Monitoring the quality of drinking water in supplying residents from the distribution network of centralized water supply showed a discrepancy in sanitary and chemical characteristics and deterioration of microbiological parameters. However, the excess of parasitological standards was not found (table 1).

| Table 1. Indicators of drinking water samples from the distribution network of centralized water supply with exceeding hygienic standards. |
|-----------------------------------------------|
| Indicators                        | 2015 Overall, un. | Share, % | 2016 Overall, un. | Share, % | 2017 Overall, un. | Share, % | Growth rate by 2015 |
|-----------------------------------------------|
| Sanitary and chemical                     | 560               | 7.98     | 902               | 12.1     | 800               | 10.7     | 34.1                  |
| Microbiological                          | 251               | 2.61     | 364               | 3.6      | 367               | 3.7      | 41.8                  |
| Parasitological                          | 0                 | 0        | 0                 | 0        | 0                 | 0        |                      |

Studies have shown that in the administrative districts of the region, drinking water supplied centrally is unequal in quality.

The absence of excess in hygienic standards was revealed only in two territories - the cities of Usolye-Sibirskoye and Ust-Ilimsk. According to sanitary and chemical indicators in three regions, namely - Kuytunsky, Kazachinsko-Lensky and Mamsky-Chui districts; on microbiological it was found in the cities - Zima and Svirs, and in the districts - Balagansky, Nukutsky, Tulunsky, Chunsky, Nizhneilimsky and Bayandayevsky (table 2).

The unsatisfactory level of hygienic standards on sanitary-chemical and microbiological indicators in drinking water was found in 13 territories. At the same time, in the indicated territories, the share of samples with excess is a quarter or more, according to sanitary-chemical standards from 22.6% to 80%, and microbiological from 21.4% to 25%. The most critical situation is in the excess of hygienic standards for sanitary and chemical indicators in Bokhansky, the share of samples is 86%, Zhigalovsky - 80%, Ust-Udinsky - 69.2%, Alarsky - 61.8%, Bratsk - 49.5% districts.

In the survey, about 8% of the samples do not meet the regulations on the content of chemicals in parts of iron, nitrates, manganese and magnesium [6]. In most of the samples, hygiene standards in drinking water consumed were observed to be higher in iron content in 13 municipalities of the region, in manganese in 10, and in nitrates in 8.

The standard total hardness (> = 10 mg/eq/l) is exceeded in the test material in 13.9% of cases. The excess of the total hardness was found in ten districts of the region This standard is exceeded in Zalarinsky and Alarsky districts, respectively 2.6 and 2.5 times, Ekhirit-Bulagatsky in 2.2, Bokhansky in 1.7, Irkutsk, Nizhneilimsky, Ust-Udinsky in 1.6 and Usolsky in 1.3.

Exceeded levels of epidemic safety of CDWSS water systems were found in 4.2% of drinking water samples. The presence of common coliform bacteria was detected in 34 localities, thermotolerant coliform bacteria in 26 and a total microbial number of 7.

| Table 2. Ranking of Irkutsk region municipalities in terms of the drinking water status of the central storage facilities in the distribution network in 2017. |
|-----------------------------------------------|
| Municipalities                                      | The share of water samples with an excess of hygienic standards for | Rank | Share of water samples with excess of hygienic standards for | Rank | The proportion of water samples with excess hygienic standards for |
|-----------------------------------------------|

Monitoring the quality of drinking water while providing residents from the distribution network of centralized water supply of the studied region revealed an excess of hygienic standards for sanitary-chemical and microbiological indicators.

Drinking water that does not meet accepted requirements contributes to the development of various types of diseases of the population [6-8].

The discrepancy in terms of sanitary and chemical indicators is associated with a high content of iron, manganese, magnesium and nitrates, as well as increased rigidity, which contributes to the development of diseases of the kidneys, cardiovascular system, urolithiasis. Increasing the content of nitrates leads to blood diseases: anemia, methemoglobinemia, causing hypoxia of organs and tissues. The inconsistency of microbiological indicators is associated with the presence of common (CCB) and thermodurable coliform bacteria (TCB) in drinking water, which can lead to the risk of infectious diseases in the population.
The conducted monitoring studies showed that the main reasons for the unsatisfactory quality of drinking water in the region are as follows:

- lack of sanitary protection zones and, as a result, pollution of surface and underground sources;
- inconsistency in the sources of water supply of standards for iron, manganese, total hardness due to the natural high content;
- carrying out water treatment of water from surface sources with outdated technologies;
- lack of the necessary integrated supply of water intake facilities;
- lack of disinfecting installations at water intake structures.

Systematic pollution of water bodies contributes to the deterioration of water quality, including the following factors:

- development of low-rise construction in the absence of a centralized sewerage system in cottage villages, cottage and horticultural non-profit partnerships;
- obsolescence and destruction of existing sewage treatment facilities, reducing the effectiveness of treatment;
- slow recovery and construction of new sewage treatment and water intake facilities in the region, sewerage engineering networks, water supply, heat supply;
- the emergence of spontaneous ship parking in the sanitary protection zones of drinking water intakes, unauthorized discharge of liquid household waste into water bodies.

In order to supply residents with high-quality drinking water, it is recommended to step up activities to approve projects of sanitary protection zones. Government and local authorities need to develop and approve target and investment programs for the development of municipal water supply and sanitation systems, plans of measures to bring the quality of drinking water in line with the requirements of the current legislative regulations.

References
[1] Tulakin A V, Sayfutdinov M M, Gorshkova E F and Rosolovskiy A P 2007 Regional problems of ensuring the hygienic reliability of drinking water use Hygiene and Sanitation 3 27-30
[2] Fedorovich N N, Fedorovich A N, Nagernyak M G and Sukhacheva A I 2013 Monitoring of drinking water quality Fundamental research 10(15) 3423-7
[3] Yegoricheva S D, Rodyukova O A and Avchinnikov A V 2015 Hygienic assessment of the state of drinking water supply of the population of the Smolensk region Public health and habitat 6(267) 16-9
[4] Porshakova A N 2014 Monitoring and Cadastre of Natural Resources: studies (Penza: Penza State University of architecture and construction) p196
[5] Vikin C C, Kharitonov A A, Ershova N B and Kolbneva E Yu 2015 Monitoring and Cadastre natural resources: studies (Voronezh: Voronezh State Agrarian University) p 238
[6] Konshina N G and Lezhnin V L 2014 Assessment of drinking water quality and public health risk Hygiene and Sanitation 93(3) 5-10
[7] Turbinsky V V and Maslyuk A I 2011 Public health risk of chemical composition of drinking water Hygiene and Sanitation 2 23-7
[8] Rosolovsky A P 2016 State of central water sources and impact quality of drinking water on the health of the population of the Novgorod region 2016 Public health and habitat 1(274) 8-10