Problems of providing Russian Arctic population with high quality drinking water

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Abstract. Regulation of drinking water quality remains the most important area of protecting health and improving quality of life of Russian Federation population, including that living in Russian Arctic. Problems of providing Russian Arctic zone population with drinking water are discussed. We studied laboratory test findings of drinking water supplied by centralized systems in Russian Arctic populated areas and data on population provision with high quality drinking water in 2007-2018. In 2018 provision of Russian Arctic territory population with centralized water supply amounted to 95.4% and almost 100% for urban residents. However, a number of residential communities, especially in Sakha Republic (Yakutia) do not have centralized water supply sources. 89.3% of Russian arctic population was provided with drinking water complying with safety requirements (in Russian Federation it was 91.35%). Satisfactory situation with drinking water is due to the cities and urban-type communities where majority of Russian Arctic population live. The worst situation is reported on Arctic territories of Sakha Republic (Yakutia) and Nenets Autonomous District. Regional programs adopted in all Russian Arctic entities for increasing drinking water quality are aimed at improving the situation related to provision of population with high-quality drinking water.

1. Introduction

Water is crucial for sustaining life, and satisfactory (adequate, safe and available) water supply should be provided for everybody [1]. Currently over 2 billion people do not have permanent access to pure drinking water, 844 million people have to spend at least half an hour a day to get water, or do not have access to it [2].

UN considers availability of water resources for everybody and its rational use to be one of the objectives in the field of sustainable development, according to which overall and equal access to safe and affordable drinking water should be provided to global population by 2030 [3]. Assessment of achievement of this aim is carried out according to percent of population using water supply service organized in compliance with safety requirements.

Russia is taking an active part in development and improvement of global indicator monitoring system for achieving sustainable development aims. Many activities on monitoring sustainable development objectives are being carried out at the national level as well.

Quality improvement of drinking water supplied to Russian Federation population in the framework of “Pure water” Federal project of “Ecology” national project for 2018-2024 (hereinafter the Federal project) is supposed to be realized through upgrading water supply and water treatment systems, using advanced domestic technologies. By 2024 it can result in the growth of population percent provided with qualitative drinking water from centralized water supply systems up to 90.8%, and up to 99% among urban population.
1.1. Purpose of the study
The purpose of the study was to analyze drinking water quality from centralized water supply systems in Russian Arctic, results of fulfilling “Pure water” federal project of the “Ecology” national project in 2019, and to suggest measures to improve provision of Russian Arctic population with high quality drinking water.

2. Materials and methods
We studied laboratory test findings of drinking water supplied by centralized systems in Russian Arctic populated areas and data on population provision with high quality drinking water in 2007-2018.

3. Results
Provision of population in Russian Arctic with centralized drinking water supply in 2018 amounted to 95.4% from the total resident population; provision of urban population was approaching to 100% (99.2% from the total number of urban population). In the urban Vorkuta district (Komi Republic), centralized drinking water supply is provided for the entire population, but in the Arctic territories of Sakha Republic (Yakutia) only for 40.7% of population (Figure 1).

Figure 1. Percentage of Russian Arctic population, including urban population, provided with centralized drinking water supply in 2018

Proper organization of centralized water supply on Russian Arctic territory, taking into account huge sparsely populated areas of Chukotka and Nenets Autonomous Districts and Sakha Republic (Yakutia), is a complex technical and technological task, especially in permafrost conditions [5].

Centralized drinking water supply in Russian Arctic is currently carried out from 349 sources, including 164 underground and 184 surface ones. Rivers: Anadyr, Dudinka, Northern Dvina, Yenisey, Kola,
Indigirka, Ob, Taz, Usa, and lakes: Glubokoe, Dikson, Imandra, Umba, Utinoe, Khainozero, and others are used as water sources. However, there is no centralized water supply in Anabarskii, Verkhoyanskii, Zhiganskii, Momskii, Olenekskii, Srednekolymskii and Eveno-Bytantaiiskii municipalities of Sakha Republic (Yakutia).

High pollution level of water supply sources is one of the factors affecting drinking water quality. In 2018 42.9% of surface and 16.4% of underground sources of centralized drinking water supply on Russian Arctic territory, and 32.73% and 14.23% in Russian Federation, respectively, did not meet sanitary standards and rules [6].

Iron, manganese, sulphates, nickel, ammonia, nitrates are found to be the major chemical pollutants of water sources (their concentrations exceed health standards) in Russian Arctic. Even if there is no technogenic pollution of underground sources, unfavorable chemical-hygienic parameters of their water cause negative effect on population health [7].

In spite of the fact that percentage of drinking water samples having unsatisfactory sanitary-chemical characteristics in Russian arctic had a steady decreasing trend throughout 12 years, in 2018 it exceeded the Russia-average indicator 1.7 times and amounted to 21.5%. Over 40.0% of drinking water samples in settlements of Chukotka Autonomous District, Sakha Republic (Yakutia) and Republic of Karelia did not meet hygienic standards by sanitary-chemical indicators (Figure 2).

![Figure 2. Percentage of drinking water samples which did not meet hygienic standards by sanitary-chemical characteristics in 2018](image-url)

In 2018, drinking water quality did not comply with hygienic standards by the following indicators [8]:

- aluminium – Arctic areas of Arkhangelsk region, Murmansk region,
- iron – Murmansk region, Nenets, Yamal-Nenets, Chukotka Autonomous Districts, Arctic areas of Arkhangelsk region, Komi Republic, Republic of Karelia, Krasnoyarsk Territory,
- silicon – Yamal-Nenets Autonomous District,
• manganese – Nenets Autonomous District, Yamal-Nenets Autonomous District, Arctic areas of Arkhangelsk region, Krasnoyarsk Territory,
• nickel – Murmansk region, Arctic areas of Arkhangelsk region,
• nitrates – Murmansk region,
• strontium – Arctic areas of Arkhangelsk region,
• formaldehyde – Arctic areas of Arkhangelsk region,
• chloroform – Murmansk region, Arctic areas of Arkhangelsk region,
• zinc – Arctic areas of Arkhangelsk region.

Percentage of drinking water samples from centralized domestic water supply systems in Russian Arctic, which are unsatisfactory by microbiological indicators, shows a steady downward trend during 12 years. In 2018, it was 1.9%, which is 1.5 times lower than the average national indicator. In Arctic areas of Sakha Republic (Yakutia) 14.6% and in Karelia 16.6% of samples did not comply with hygienic standards with respect to microbiological indicators. Exceeding of hygienic standards with regard to coliform organism, thermostolerant bacterium and coliphage concentrations was reported.

According to drinking water quality classification of 2008 [9, 10], in 2018 89.3% of Russian Arctic and 91.35% of Russia population were provided with drinking water complying with safety requirements. The most unfavorable situation was seen in Arctic areas of Republic of Karelia and Nenets Autonomous District (Figure 3).

Figure 3. Percentage of Russian Arctic population provided with adequate quality drinking water

The analysis showed that cities and urban-type communities where majority of Russian Arctic population lives accounted for the favorable situation concerning drinking water: in 2018 percentage of urban population amounted to 88.8% of total resident population, in fact almost all urban residents being provided with centralized water supply (99.2%). Percentage of provision of urban residents with drinking water of adequate quality was the following: Novodvinsk – 79.7%, Arkhangelsk – 88.7%, Severodvinsk – 99.5% (Arkhangelsk region), Noyabr’sk – 94.6 % (Yamal-Nenets Autonomous District), Vorkuta – 99.4
% (Komi Republic). Drinking water in the town of Labytnangi (Yamal-Nenets Autonomous District) was assessed as poor-quality water. In other towns, all population was supplied with proper quality water.

4. Discussion
In accordance with Federal project passport, by 2024 [4] all population of Murmansk region and Chukotka Autonomous District should be provided with high-quality drinking water from centralized water supply systems (Table 1). Achievement of planned indicators of population provision with high-quality water is supposed to be realized by upgrading water supply systems using advanced technologies and by increasing of monitoring system efficiency of drinking water quality. According to the results of 2019 planned values of population provision with high-quality drinking water were exceeded in the areas of Nenets, Chukotka and Yamal-Nenets Autonomous Districts, and those in Murmansk region were almost achieved. Determination of quality of drinking water from centralized water supply systems and percentage of population supplied with high-quality drinking water is carried out by the Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing (Rospotrebnadzor) in accordance with the new water quality classification developed in 2019 using analysis findings of water samples taken in the framework of control-supervision measures and social-hygienic monitoring [11].

Table 1. Percent of Russian Arctic entity population provided with high-quality drinking water from centralized water supply systems (Federal project indicators)

| Entity of Russian Federation | Basic value (31.12.2017) | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|-----------------------------|--------------------------|------|------|------|------|------|------|------|
| Arkhangelsk region          | 72,0                     | 72,0 | 72,0 | 72,4 | 73,2 | 75,0 | 77,7 | 82,9 |
| Krasnoyarsk Territory       | 88,5                     | 88,5 | 88,5 | 88,6 | 89   | 89,7 | 90,8 | 92,9 |
| Murmansk region             | 99,7                     | 99,7 | 99,7 | 99,8 | 99,9 | 100,0| 100,0| 100,0|
| Nenets Autonomous District  | 51,4                     | 51,4 | 51,4 | 52,5 | 55   | 60,3 | 68,4 | 83,8 |
| Republic of Karelia         | 75,0                     | 75,0 | 75,0 | 75,3 | 76,1 | 77,7 | 80,2 | 84,8 |
| Komi Republic               | 91,8                     | 91,8 | 91,8 | 91,9 | 92,1 | 92,6 | 93,4 | 94,9 |
| Sakha Republic (Yakutia)    | 59,8                     | 59,8 | 59,8 | 60,3 | 61,6 | 64,2 | 68,2 | 75,8 |
| Chukotka Autonomous District| 74,6                     | 74,6 | 74,6 | 75,5 | 77,8 | 82,5 | 89,6 | 100,0|
| Yamal-Nenets Autonomous District | 87,0             | 87,0 | 87,0 | 87,1 | 87,3 | 87,7 | 88,4 | 89,7 |

In 2018, quality of drinking water from centralized domestic water supply systems was monitored in 342 points of Russian Arctic regions (Table 2). However, percentage of drinking water samples which are not in compliance with hygienic standards by sanitary-chemical indicators still exceeds Russia-average indicators in Chukotka Autonomous District, Arctic areas of Sakha Republic (Yakutia) and Republic of Karelia, by microbiological indicators in Arctic areas of Sakha Republic (Yakutia) and Republic of Karelia. Absence of exceeding in a number of residential communities can be caused by adequate quality water as well as by a short list of examined chemicals [12].

Table 2. Number of monitoring points and indicators monitored in drinking water of centralized domestic and drinking water supply systems on Russian Arctic territory in 2018

| Russian Federation entity          | Number of monitoring points | Number of indicators |
|-----------------------------------|-----------------------------|----------------------|
|                                   |                             | sanitary-chemical    |
| Arkhangelsk region                | 18                          | 22                   |
|                                   |                             | microbiological       |
|                                   |                             | 4                    |
Russian Federation entity | Number of monitoring points | Number of indicators |
|---------------------------|-----------------------------|----------------------|
|                           | sanitary-chemical | microbiological       |
| Krasnoyarsk Territory      | 18                          | 31                   | 6                     |
| Murmansk region            | 154                         | 16                   | 5                     |
| Nenets Autonomous District | 11                          | 8                    | 2                     |
| Republic of Karelia        | 6                           | 9                    | 2                     |
| Komi Republic              | 7                           | 7                    | 3                     |
| Sakha Republic (Yakutia)   | 2                           | 8                    | -                     |
| Chukotka Autonomous District | 81                         | 17                   | 8                     |
| Yamal-Nenets Autonomous District | 45                     | 7                    | 6                     |

A regular monitoring using social-hygienic monitoring data, production control, as well as revising the system of monitoring points and a list of indicators, which do not allow the objective assessment of the situation, is required for objective hygienic assessment of water quality and safety.

5. Conclusions
In 2018 provision of Russian Arctic territory population with centralized water supply amounted to 95.4% and almost 100% for urban residents. However, a number of residential communities, especially in Sakha Republic (Yakutia) do not have centralized water supply sources.

Percentage of unsatisfactory drinking water samples from centralized domestic water supply systems in Russian Arctic is higher than that for Russian Federation, but is lower as regards microbiological indicators. According to drinking water quality classification of 2008, 89.3% of Russian arctic population was provided with drinking water complying with safety requirements (in Russian Federation it was 91.35%). Satisfactory situation with drinking water is due to the cities and urban-type communities where majority of Russian Arctic population live. The worst situation is reported on Arctic territories of Sakha Republic (Yakutia) and Nenets Autonomous District.

Regional programs adopted in all Russian Arctic entities for increasing drinking water quality are aimed at improving the situation related to provision of population with high-quality drinking water.

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