

Conference Paper

Problems of Drinking and Domestic Water Supply in Mountainous Areas of the Chechen Republic

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Abstract

The article presents the results of assessment works on drinking groundwater of alluvial sediments of the river valleys, perspective for water supply of mountainous regional centers of the Chechen Republic (Itum-Kale, Khimoi, Shatoi and Vedeno villages). The problem of providing quality water to more than 65,000 people living in four regions of the Chechen Republic mountainous areas is becoming more and more critical every year. According to the technical (geological) task, water demand for drinking and domestic water supply of the population is 4.0 thousand m³/day. The assessment of groundwater reserves for domestic and drinking purposes directly in the areas of the above-mentioned settlements was not made earlier, except for Itum-Kalinskoye, where in 2012--2013 HIDEK CJSC performed prospecting and assessment of the underground water reserves in the area of the projected riverbed water intake for the needs of the "All-season ski resort Veduchi". Based on the results of these works, the Khacharoiakhk field of fresh groundwater was explored in the alluvial deposits of the Khacharoiakhk River valley, which belong to the upper quaternary and modern quaternary system.

Keywords: Groundwater, surface water, alluvial sediments, recessed valleys, prospecting and assessment works, waterproofing.

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1. Introduction

Currently, almost half of the world countries are experiencing a shortage of fresh water. This problem is becoming more acute every day. It is known that about 75 % of the world fresh water reserves are located in icebergs and glaciers, the rest of the fresh water is underground. Even 1% of the underground fresh water is enough to supply mankind.

Russia is not on the list of countries suffering from lack of fresh water. Despite this, looking ahead, scientists in Russia are studying the possibility of preventing negative phenomena related to the problem of fresh water shortage.

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2. Problem Statement

The Chechen Republic, like other North Caucasian regions, is already facing a lack of drinking water that is protected from external influences. The problem of providing quality water to more than 65,000 people living in four regions of the mountainous area of the Chechen Republic is becoming more acute every year. Historically, water supply in mountainous areas was based on the use of spring water and partially river water. At present, the population growth has led to the enlargement of settlements, which makes it necessary to organize centralized water supply. The use of surface water for drinking purposes, which is subject to possible pollution by sewage and other domestic and industrial effluents, is dangerous for public health. In recent years, there have been about 10 outbreaks of acute infectious diseases related to water, including in the cities of Shali and Argun, -- the settlement Itum-Kale, which use water from the river, settlements in Vedenskiy, Shatoyskiy, Kurchaloyevskiy, Sharoyskiy, Itum-Kalinskiy and Nozhay-Yurtovskiy regions of the republic. At the same time, over the past four years, due to dry summers and low snowfall winters in the foothills of the Republic, in the regions such as Nozhay-Yurtovskiy, Kurchaloyevskiy, Vedenskiy, Sharoyskiy, Shatoyskiy and Itum-Kalinskiy, many centuries-old springs have dried up, and the consumption of the largest spring in the Chechen Republic, Benoy-Yasi, has decreased by more than 2 times, from 700 to 200 l/s.

3. Research Questions

Today, the deficit in drinking water for mountainous areas is more than 30 thousand m³/day [2, 3, 6, 7]. Covering the existing deficit is possible by finding sources of groundwater supply, as the latter have a number of undeniable environmental and economic advantages over surface water.

4. Purpose of the Study

Within the framework of solving the problem of providing the population of the mountainous area of the Chechen Republic with quality drinking water we have carried out assessment works on drinking groundwater of alluvial sediments of overdeepened valleys, studied the factors determining the regularities of formation of drinking water reserves, allocated areas, perspective for localization of deposits (sites) for water supply of regional centers and nearby settlements of Vedenskiy (Vedeno), Sharoyskiy (Khimoi),

Shatoyskiy (Shatoi) and Itum-Kalinskiy (Itum-Kale) regions located in mountainous and high-mountainous areas of the republic and experiencing acute shortage of drinking water [1, 4, 5, 8]. The implemented works will allow to sufficiently address the issue of water supply to the population in the regional centers, which are the least provided with quality drinking water, in the poorly studied mountainous part of the country, to improve sanitary and hygienic living conditions of the population.

5. Research Methods

Ground waters of alluvial sediments are confined to gravel and boulder-shingle deposits of Lower Pleistocene age, which compose floodplains of river valleys and represent hyporheic and hydrodynamic flow, the feeding area of which are river basins and their tributaries. They belong to the category of insufficiently protected due to the absence of a reliable blocking water reservoir, close hydraulic connection with surface waters and supply of horizons within the boundaries of their distribution.

The water in Khimoysky region is characterized by the results of sampling of a drilled prospecting and ratable well with a depth of 30 m (Figure 1) and its quality monitoring.

The well uncovered hydro-carbonate calcium waters, fresh with a mineralization value of 0.3 g/dm³. In the course of regime observations the chemical composition in it changed to sulfate-hydrocarbonate magnesium-calcium, mineralization reached 0.2--0.5 g/dm³. The fluctuations are related to the seasons of the year; the increase in mineralization is timed to coincide with the inter-annual (March) period; the decrease is timed to June (flood period). In terms of the total hardness of water of medium softness with the value from 3.1 to 5.5 mg-equiv/dm³, neutral or slightly alkaline reaction (pH 6.9--7.5). There are no nitrites and ammonium in the water, and the concentration of nitrates does not exceed the maximum allowable values (1.2--23.9 mg/dm³); normalizable micro-components are contained in the allowable limits. The concentration of oil products (total less than 0.005 mg/dm³ at the rate of 0.1 mg/dm³), phenolic index (<0.001mg/dm³) and anionic surfactant (<0.025 mg/dm³), as well as radioactive elements (alpha- and beta-radioactivity -- 0.044 and less than 0.1 Bq/dm³, respectively) in water is in concentrations, times lower than the maximum allowable standards. In terms of organoleptic indicators, water also complies with hygienic standards: smell and taste are absent, chromaticity is less than 5 degrees, turbidity is less than 0.58--0.69 FTU (at norm of 1.5 FTU).

Water quality in the Shatoysky area is based on the results of testing a 30 m deep exploration and evaluation well (Figure 2) and quality monitoring of the well.

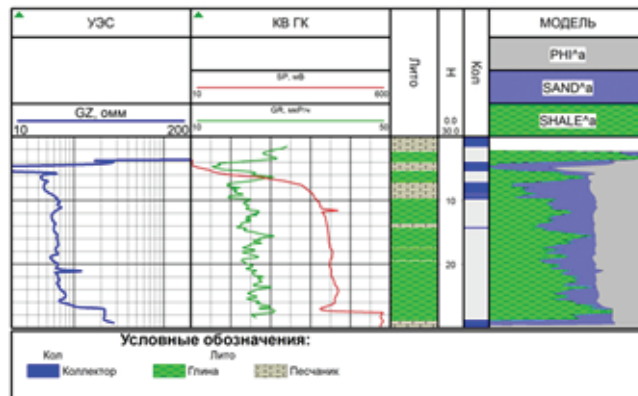


Figure 1: Interpretation tablet for GIS data of Khimoi village.

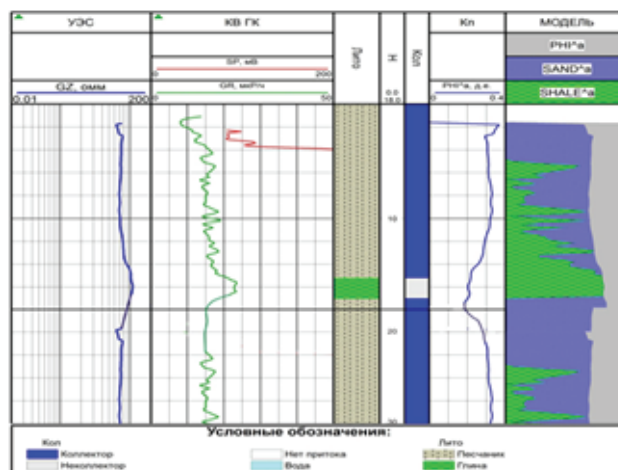


Figure 2: Interpretation tablet for GIS data of Shatoi village.

The well discovered sulfate-hydrocarbonate magnesium-calcium waters, fresh with a mineralization value of 0.6 g/dm³. In the course of regime observations, the chemical composition of the water changed to hydrocarbonate with the same cationic composition. Mineralization decreased to 0.5 g/dm³ during the flood period.

Total water hardness varies from 6.2 to 7.35 mg-eqv/dm³, pH value is 7.0--7.4.

Nitrites and ammonium are absent in water, only in a single case the concentration of ammonium in the amount of 0.2 mg/dm³, which does not exceed the norm, was registered. The concentration of nitrates changed from 7.8 to 30.6 mg/dm³ during the period of regime observations, however, not exceeding the maximum allowable value. The iron concentration in the norm is less than 0.1 to 0.2 mg/dm³.

The regulated micro-components in the groundwater of the Shatoi area are within acceptable limits.

It should be noted that the fluorine content is very low: less than 0.2 mg/dm³.

The content of oil products (total 0.023 mg/dm^3 at the rate of 0.1 mg/dm^3), phenolic index ($<0.001 \text{ mg/dm}^3$) and anionic surfactant (0.34 mg/dm^3), as well as radioactive elements (alpha- and beta-radioactivity -- 0.02 and less than 0.1 Bq/dm^3 , respectively) in water are in concentrations that are significantly lower than the maximum allowable standards. According to organoleptic indices of water also correspond to hygienic norms: smell -- 1 point, taste is absent, chromaticity is less than 5 degrees, turbidity is less than 0.58 FTU (at norm 1.5 FTU).

The water in the Itum-Kalinsky area are characterized by results of sampling of the drilled prospecting and evaluation well with depth of 30 m (Figure 3) and its quality monitoring.

The well discovered sodium-magnesium-calcium sulphate-hydrocarbonate waters, fresh water with a mineralization value of 0.7 g/dm^3 . In the course of regime observations, their chemical composition did not change, and during the flood period there was a decrease in the content of sodium from 68.3 to 26.4 mg/dm^3 and chlorine from 69.5 to 19.5 mg/dm^3 . Salinity varies from 0.5 to 0.7 g/dm^3 . The fluctuations are related to the seasons of the year; the increase in mineralization is timed to coincide with the inter-annual (March) period; the decrease -- to June (flood period). In terms of total hardness of water of medium softness with value from 4.4 to 5.8 mg-eqv/dm^3 , neutral to slightly alkaline reaction (pH 6.6 -- 7.5).

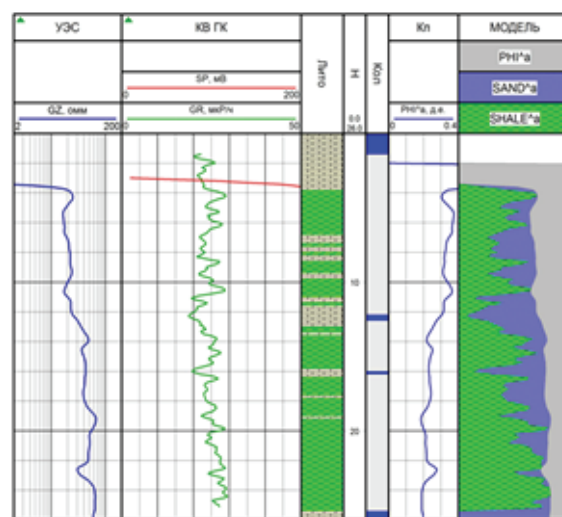


Figure 3: Interpretation tablet for GIS data of Itum-Kale village.

There are no nitrites and ammonium in the water, and the concentration of nitrates does not exceed the maximum allowable values (0.6 -- 1.0 mg/dm^3).

The regulated microcomponents in the water of the Itum-Kalinskiy area are within the allowable limits. The exception is manganese, which is 7.8 MAC. It is impossible

to judge unequivocally on the basis of a single sample about the increased content of manganese on the site. Additional study of water quality is required.

The content of oil products (total 0.008 mg/dm³ at the rate of 0.1 mg/dm³), phenolic index (<0.001 mg/dm³) and anionic surfactant (<0.025 mg/dm³), as well as radioactive elements (alpha and beta-radioactivity -- 0.06 and 0.1 Bq/dm³, respectively) in water are in concentrations that are significantly lower than the maximum allowable standards. In terms of organoleptic parameters, water also complies with hygienic standards: odor, flavor and color are absent, turbidity is less than 0.58 FTU at the rate of 1.5 FTU.

The water in the Vedensky area is characterized by the results of testing a 30 m deep exploration and appraisal well. (Figure 4).

The well discovered sulfate-hydrocarbonate magnesium-sodium-calcium waters, fresh with a mineralization value of 0.5 g/dm³. In terms of the total hardness of water of medium softness with the value from 4.0 to 4.2 mg-eqv/ dm³, slightly alkaline reaction (pH 7.6--7.7).

All components of the nitrogen group (nitrates, nitrites and ammonium) are present in water, but their concentration does not exceed the maximum permissible values: nitrates -- 2.7--3.1 mg/dm³, nitrites -- 0.5 mg/dm³, ammonium -- 1.2 mg/dm³.

In water there is an increased iron content (up to 2.5 mg/dm³ at the rate of 0.3 mg/dm³. i.e. 8.3 MAC).

The regulated microcomponents in the water of the Vedeno area are within the allowable limits. It is necessary to note a very low content of fluorine (0.3 mg/dm³), which is typical, however, for the whole territory described in this paper.

The content of oil products (total 0.023 mg/dm³ at the rate of 0.1 mg/dm³), radioactive elements (alpha- and beta-radioactivity -- 0.06 and 0.1 Bq/dm³, respectively) in water is in concentrations, several times lower than the maximum allowable standards. According to organoleptic parameters of water also correspond to hygienic norms: smell and taste are absent, chromaticity is less than 5 degrees, turbidity is less than 0,58 FTU (at norm 1,5 FTU).

According to the microbiological indicators of water of Khimoysky, Itum-Kalinsky areas (according to the results of prospecting and evaluation works the excess of MPC for manganese was obtained, which requires additional research for the final solution of the issue) and Shatoysky area according to the conclusion of the branch of the FBHI "Hygienic and Epidemiological Center" in the Chechen Republic in the Shatoysky area (№ 01/795-02 of 01.06.2015) meet the requirements of the current Sanitary and Epidemiological Norms [8]. The Vedensky water area according to the conclusion of the

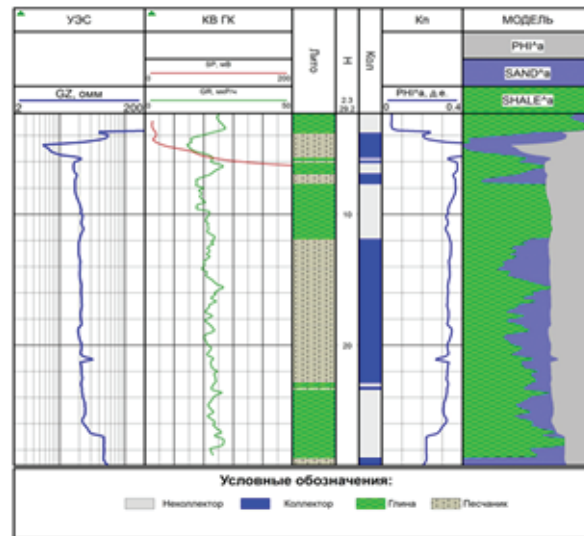


Figure 4: Interpretation tablet for GIS data of Vedeno village.

branch of the FBHI "Hygienic and Epidemiological Center" in the Chechen Republic in the Shatoysky area (N^o 01/795-02 of 01.06.2015) do not meet the requirements of the current Sanitary and Epidemiological Norms, the number of colonies in 1 sm³ is equal to 1, the presence of thermotolerant coliform bacteria (TCB) is 0.3 and total coliform bacteria (TCB) is 0.3, which in accordance with the requirements of the current Sanitary and Epidemiological Norms must be absent. In order to use them for drinking purposes, it is necessary to take a set of measures to improve the sanitary condition of the area and to disinfect water before it is delivered to the consumer (Sanitary and Epidemiological Norms 2.1.4.1074-01, 2001).

6. Conclusion

The above-mentioned characteristic shows that the quality of alluvial aquifer groundwaters at the three assessed areas meets the requirements for drinking groundwater for all indicators. At the Itum-Kalinskiy area, based on the results of prospecting and evaluation works, the manganese MAC was exceeded, which requires additional research to finally resolve the issue. The water in the Vedensky area does not meet modern requirements for microbiological indicators, as evidenced by the conclusion of the Federal Supervision Agency for Customer Protection and Human Welfare. To use them for drinking purposes it is necessary to take a set of measures to improve the sanitary condition of the area and to disinfect water before it is delivered to the consumer.

Groundwater pollution on the assessed areas under the existing sanitary and environmental conditions within the limits of the proposed water intakes, geological land

allotments and sanitary protection zones (zones of limitation) is not expected, as on their territory there are no (or almost no) anthropogenic objects [9, 10]. However, when preparing the areas for development, it is necessary to constantly monitor the maintenance of proper sanitary and environmental conditions in the adjacent areas. This well-being should be primarily the responsibility of subsoil users, supervising and controlling services at all levels.

Hydrochemical and sanitary-microbiological examination of groundwater and surface waters of river valleys on the basis of sanitary-chemical and microbiological indicators has shown that groundwater quality of most springs and water intakes meet the requirements of regulatory documents. The only exception is the underground waters of the Vedensky site, which cannot be used for drinking purposes without preliminary treatment prior to their delivery to the consumer, according to the Federal Supervision Agency for Customer Protection and Human Welfare.

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