

ORIGINAL RESEARCH ARTICLE

Socio-environmental problems of the development of water management in Dagestan

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ABSTRACT

The article shows the most significant problems of functioning and development of the water economy of the Republic of Dagestan—the southernmost region of Russia. The results of a comprehensive analysis of the state of the waters of the Caspian Sea, the main pollutants of which are coastal cities and other settlements with their wastewater and other waste from human activities, are presented. Ecological problems of Dagestan rivers and reservoirs are considered. The necessity of restoring the natural state of the Terek River Delta, in particular the ecological rehabilitation of its estuarine streams and lakes, is emphasized. Special attention is paid to the task of stopping the uncontrolled economic development of reservoirs of mountain hydroelectric power plants—the main drinking water resources for the cities of Dagestan. The medical and hygienic condition of water supply sources is discussed with an emphasis on the serious problem of contamination of groundwater used for drinking purposes. The issues of water supply and sanitation (non-centralized, centralized, departmental and communal) are considered in detail. It is indicated that urban and district centralized water supply systems do not comply with sanitary and hygienic standards, and there is an extreme shortage of sewage treatment plants in almost all cities of the Republic. The progress of the implementation of a number of federal programs to improve the water supply systems of the population of the Republic is described.

Keywords: Dagestan; Caspian Sea; Water Supply; Sanitation; Sanitary Hygiene of Water Use

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1. Introduction

The global crisis due to lack of fresh water is becoming more and more evident. The reasons for this are the rapid growth of water use, climate warming and severe pollution of life-giving moisture in all the spaces most developed by man. Therefore, the key tasks of conservation and ecology of water resources of the Russian Federation are currently being actively discussed at the level of the government of the country. By 2024, it is planned to create a unified water register of water sources, which is part of the program “Geology: The revival of a legend”. The budget for the implementation of this program provides for 31.6 billion rubles, including more than 10 billion rubles for 2022^[1]. The program will allow not only to protect sources more effectively, but also to plan water use in the regions. We must not forget that today in some regions of the country, this problem is extremely acute: If in Russia as a whole more than 90% of the population is provided with water from centralized sources, then in Kalmykia (the region north of Dagestan)—only 7% of its inhabitants^[2].

Dagestan is sufficiently provided with natural waters, both surface and underground^[3]. Nevertheless, many water management problems of the Republic are very serious. It is necessary to start solving them immediately, combining the efforts of the authorities and the scientific

community^[4].

“Everything that is characteristic of Russia is reflected in Dagestan, as in a drop of water”, President Vladimir Putin said, talking about the current socio-political situation in Dagestan^[5]. In this sense, not only social processes, but also the main problems of water use on a national scale can find their model reflection in the relatively small geographical space of Dagestan. Thus, comprehensive studies of the processes of water use in this region can serve to understand ways to solve the most important problems of water use and sanitation for Russia as a whole. The purpose of the article is to describe those processes of water use and sanitation that are able to reflect the main features of the spatial and functional structure of the water management system of the Republic of Dagestan. This work can also be considered as the final stage of scientific research to substantiate the content of the hydrographic and water management blocks of the Atlas of Cultural and Natural Heritage of Dagestan, work on which was started in 2020^[6,7].

1.1 Geographical characteristics of the region

Dagestan is located at the junction of Europe and Asia and is the southernmost region of the Russian Federation. The Republic mainly occupies the northeastern area of the Caucasus and is located in the southwest of the Caspian lowland within 41°11' and 44°59' north latitude, 45°07' and 48°35' east longitude. The area of Dagestan is 50.3 thousand km² (of which 8.9% are forests, 4.4% are reservoirs and watercourses, 67.4% are agricultural lands, and 19.3% are other lands)^[8].

The length of the territory of the Republic of Dagestan in a straight line is 420 km from north to south and 216 km from west to east. The highest point—Bazarduzu (4,466 m)—is located in the extreme south of the Republic and represents one of the peaks of the Main Caucasian Ridge. The lowest place (−28 m) is located on the coast of the Caspian Sea, which Dagestan is washed from the east. The coastline of the sea stretches for about 600 km from the mouth of the Kuma River in the north to one of the channels of the Samur River in the south. The Republic of Dagestan borders with five states: Kazakhstan, Turkmenistan and Iran on the Caspian

Sea; by land—in the west with Georgia for 150 km, in the southeast with Azerbaijan—315 km. Within the Russian Federation, is adjacent to Kalmykia in the north for 110 km (along the Kuma riverbed), in the northwest with the Stavropol Territory—186 km and in the west with the Chechen Republic—420 km^[9].

The population of the region according to the Federal State Statistics Service for the Republic of Dagestan (Dagestanstat) as of 1 January 2023 amounted to 3.2 million. The rural population prevails over the urban population: 1.7 against 1.5 million people. There are 10 cities, 18 urban-type settlements and 41 rural municipal districts and about 1,600 rural settlements in the Republic. One of the municipal districts (high mountain Tsuntinskiy district) includes an independent site with the central settlement of Bezhta. The largest municipal districts by area are Nogaiskiy (8,871 km²) and Kizlyarskiy (3,047 km²), the smallest areas are Akhvakhskiy (291 km²) and Novolakskiy (218 km²) districts.

According to its economic profile, Dagestan belongs to the agrarian-industrial regions. Agriculture occupies a special place in the economy of the Republic, the leading branches of which are animal husbandry, fruit and vegetable growing and viticulture. The industry is relatively poorly developed and is mainly represented by enterprises of the energy and fuel industries, mechanical engineering, chemical, food and local industries. Most of the objects of industry and agro-industrial complex of the Republic are characterized by a low level of implementation of environmental protection technologies^[10,11].

1.2 Morphology and physiology of water management

Dagestan's water management system has its own “morphology” and “physiology”. The elements of morphology include a hydrographic network that includes both natural and artificial reservoirs, as well as coastal waters of the Caspian Sea and eternal snow on the peaks of the Caucasus mountains. The main morphological objects of water management are presented on the following map (**Figure 1**).



Figure 1. Natural zones, watercourses and reservoirs of Dagestan.

Source: Author.

It should be noted that the map shown in **Figure 1** reflects the spatial structure of water use in the Medical and Hygienic Atlas of Dagestan, which was created with the participation of the author of the article 20 years ago^[12]. In the process of devel-

oping the above-mentioned new Atlas of Dagestan's Cultural and Natural Heritage, a series of general socio-economic and environmental maps was prepared^[13]. This series includes a map of the main socio-ecological objects of the Republic (**Figure 2**).

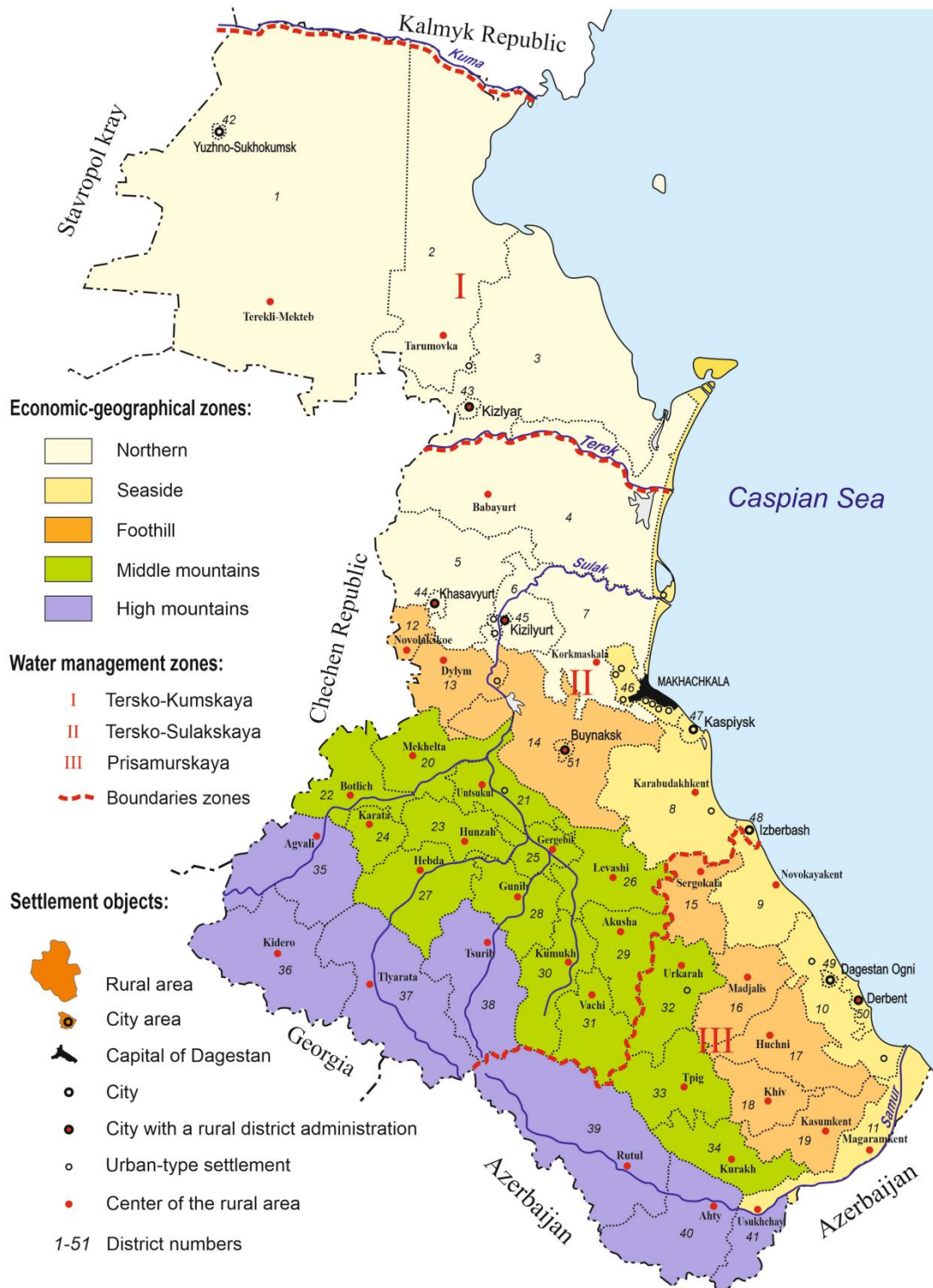


Figure 2. Map of the main socio-ecological objects of the Republic of Dagestan.

Source: Author.

The settlement objects marked on the second map are listed in sequence from north to south. They are grouped by the main economic-geographical zones of Dagestan, and their quantitative data are presented in **Table 1**.

The information systematized by geographical zones about the main objects of settlement of Dagestan is intended to facilitate the perception of the subsequent text of this article, which focuses on the territorial differentiation of objects and problems of water management in the region.

Table 1. The number of permanent population by municipal districts and urban districts of the Republic of Dagestan as of 1 January 2023 (in thousands)

Municipal areas			
<i>I. Northern zone:</i>		27. Shamil'skiy district	30.9
1. Nogaiskiy district	17.9	28. Gunib'skiy district	30.3
2. Tarumov'skiy district	35.6	29. Akushin'skiy district	54.3
3. Kizlyar'skiy district	78.8	30. Lak'skiy district	12.1
4. Babayurtov'skiy district	53.7	31. Kulin'skiy district	10.5
5. Khasavyurtov'skiy district	174.1	32. Dakhadaev'skiy district	36.3
6. Kizilyurtov'skiy district	76.0	33. Agul'skiy district	10.4
7. Kumtorkalin'skiy district	29.2	34. Kurakh'skiy district	14.9
<i>II. Seaside zone:</i>		<i>V. High mountain zone:</i>	
8. Karabudakhkent'skiy district	102.0	35. Tsumadin'skiy district	27.2
9. Kayakent'skiy district	59.5	36. Tsuntin'skiy district	21.2
10. Derbent'skiy district	100.4	37. Tlyaratin'skiy district	23.9
11. Magaramkent'skiy district	55.7	38. Charodin'skiy district	14.2
<i>III. Foothill zone:</i>		39. Rutul'skiy district	20.4
12. Novolak'skiy district	33.8	40. Akhtyn'skiy district	31.8
13. Kazbekov'skiy district	51.1	41. Dokuzparin'skiy district	15.2
14. Buynak'skiy district	85.3	Urban districts	
15. Sergokalinsk'skiy district	26.6	<i>I. Northern zone:</i>	
16. Tabasaransk'skiy district	52.4	42. Yuzhno-Sukhokumsk city	10.6
17. Kaitag'skiy district	33.4	43. Kizlyar city	53.0
18. Khiv'skiy district	20.7	44. Khasavyurt city	157.5
19. Suleiman-Stal'skiy district	57.4	45. Kizilyurt city	50.0
<i>IV. Middle mountain zone:</i>		<i>II. Seaside zone:</i>	
20. Gumbetov'skiy district	21.4	46. Makhachkala city	759.5
21. Untsukul'skiy district	31.8	47. Izberbash city	57.4
22. Botlikh'skiy district	60.9	48. Kaspiysk city	125.7
23. Khunzakh'skiy district	31.3	49. Dagestan Lights city	31.9
24. Akhvakh'skiy district	24.8	50. Derbent city	126.1
25. Gergebil'skiy district	20.2	<i>III. Foothill zone:</i>	
26. Levashin'skiy district	81.5	51. Buynaksk city	69.0
		Total (Republic of Dagestan)	3,209.8

Source: Dagestanstat data.

2. The Caspian Sea as the main body of water in Dagestan

Dagestan is a seaside region, the length of its coastline is about 600 km. Taking into account the fact that the Republic is the southernmost subject of the Russian Federation, its resort prospects are tempting. It has a fairly comfortable climate and a large number of sandy beaches on the shores of the Caspian Sea^[14,15]. However, from the sewer pipes of large settlements, as well as with the flow of Da-

gestan rivers, a huge amount of pollutants and garbage gets into this sea. The unfavorable situation in this regard is characteristic primarily for rivers with unregulated channels, since garbage, especially plastic, in this case does not linger in artificial reservoirs and is completely thrown into the sea^[3,16].

Currently, bathing on most urban beaches of the Republic is officially prohibited due to the fact that the norms of maximum permissible concentrations of harmful pollutants during the bathing season within the city beaches are exceeded by tens and sometimes hundreds of times^[17]. The epicenter

of the spread of intestinal and other health-threatening diseases is an underwater collector located on the northern outskirts of the Makhachkala suburban beach, which has long been broken by waves from the so-called Main pumping station near the village of Turali. Similar discharges of household and fecal waters into the sea take place off the coast of Kaspiysk, Izberbash and Derbent^[18,19].

2.1 The level of pollution of seawater

The above problems are a natural consequence of the ongoing large-scale pollution of the Caspian Sea. During the period when the last scheme for the ecological development of the sea coast of the capital of Dagestan and its satellite city of Kaspiysk was being developed (1980s), these two cities dumped 350 thousand m³ per day of sewage into the sea. Of these, 200 thousand m³ (70–75 million m³ per year) are untreated wastewater, and the remaining 150 thousand cubic meters are water that has passed treatment facilities. Now it will not be a mistake to double these volumes, since only over the past three decades the population of the Makhachkala-Caspiysk agglomeration has more than doubled and exceeded 1 million inhabitants^[20].

The quality of seawater is deteriorating mainly due to an increase in the volume of runoff in settlements, an insufficient degree of their refreshment at existing sewage treatment plants, the leaching of pesticides and agrochemicals from irrigated lands by collector-drainage waters. More than 60% of the studied seawater samples do not meet hygienic standards for sanitary and chemical indicators and up to 50%—for sanitary and bacteriological^[21].

It is important to note that the centralized sewerage networks of Makhachkala should serve not only the city itself, but also numerous recreation centers concentrated on the Caspian coast north and south of the Dagestan capital. The northern section stretches from Makhachkala oil harbor to the mouth of the Krivaya Balka River, the southern section stretches from Kaspiysk to the northern border of Izberbash. The expediency of the shared participation of all these health resorts in financing the construction of common water management systems for them is obvious. Of course, all of the above also applies to Derbent and its environs^[22].

2.2 Sewerage centralization projects on the built-up seashore

It is planned to build four district centralized treatment facilities in the coastal strip of the Dagestan capital. Currently, only one of them (System No. 1) is functioning, which provides treatment for about a quarter of all wastewater per year in the Makhachkala-Caspiysk agglomeration. The remaining domestic wastewater is discharged into the sea without reaching the treatment facilities. The main area of such discharge is the above-mentioned water area of the capital of the Republic.

In 1989, a detailed plan was developed for the second stage of construction and reconstruction of the entire sewer network of the capital agglomeration of Dagestan. The project started on the eve of perestroika and ended with the construction of a sewer collector with a length of 9.7 km (65.5% of the design length). At the same time, the work was financed by 5 billion rubles, and the volume of unfinished construction amounted to 4.6 billion rubles. Analysis of the condition of the collector, created underground 5 years ago, showed extremely poor quality of construction with blatant violations of the norms of concrete laying works. The Ministry of Construction of the Russian Federation, for unknown reasons, did not ensure the investment of works planned for 2016 to continue the construction of a sewer tunnel to treatment facilities with a total funding of 2 billion rubles^[23]. In the prices of that time, the cost of the entire volume of work-in-progress was estimated at 100 billion rubles. If we take into account the real growth of the agglomeration itself, then the cost of completing the construction of the entire urban drainage system should be at least 0.5 trillion rubles. Currently, government circles are talking only about the minimum threshold for such financing in the specified amount of 100 billion rubles^[24].

Reconstruction and construction of new sewage treatment plants in Derbent are being carried out more actively. It remains to be hoped that the water management transformations that will take place in this southernmost city of Russia will spur work in this direction in other coastal cities of Dagestan.

2.3 Economic futility of the port of Makhachkala

The well-being of sea cities usually largely depends on the nature of the development of port complexes in them. Port cities live by the sea, tourism, fishing, longboats, liners, ferries, yachts, boats, parking lots, piers, berths, etc. It's natural. But this does not apply to the port of Makhachkala—a completely empty, dead place. Here, as in most Russian port cities, no one rents a parking lot, yachts do not stand on the roadstead, music does not play on cruise liners, passengers are not loaded onto pleasure boats and the morning catch is not unloaded. There is nothing here but military, customs and maritime police^[23].

Of course, sooner or later, progressive changes will occur in the coastal infrastructure not only of Makhachkala, but also of all other cities of Dagestan. But apparently, this will not happen soon: since 2020, both Republican ports—Makhachkala and Caspian—have been equipped as bases for the deployment of ships of the Caspian Flotilla of the Russian Navy, which were previously stationed in the Astrakhan port complex.

3. Ecology of water bodies as a reflection of state policy

In this context, the actions of the country's parliament are of great concern, which potentially carry huge risks to the environment. Recently, the deputies of the State Duma of the Russian Federation adopted a law allowing the privatization of land plots in the zones of protection of water sources and their subsequent development^[25]. With this decision, the state removes restrictions on the sale of land in the so-called second belt of sanitary protection zones for rivers, lakes, canals and reservoirs serving as sources of drinking water^[26].

Unfortunately, modern practice is an ongoing process of abuse of elementary water protection standards, environmental and economic interests of ordinary citizens. After all, natural water in every sense is life itself. It seems that we are now going through the most difficult and terrible historical stage of development in terms of consequences for the ecology of the country.

3.1 Lakes in the Terek River Delta

In 1996, the monograph *Water Resources of Dagestan* was published^[3]. The authors of this book were the leading hydrologists and hydrographers not only of the Republic, but also scientists of the Lomonosov Moscow State University. An important place in this scientific monograph was occupied by the issues of substantiation of the program of protection and ecological rehabilitation of the Terek delta, as well as the northern and southern groups of estuarine reservoirs of this river. The developers of the program proposed to strengthen the ramparts on the southern shore of the Terek as much as possible, protecting the South Agrakhan Lake from flood sediments of the Terek, giving freedom to the river itself in the zone of the Nizhnetersk fishing reservoirs and the North Agrakhan lagoon. It was proposed to direct the Terek with the help of point dredging along the selected trajectory. At the same time, the main task was to return the lower reaches of the largest river in southern Russia to its natural delta^[27]. Now the lower reaches of the Terek are a huge aqueduct—an earthen trench stretching for a long distance as a result of the centuries-old history of the collapse of this river. Therefore, we consider the project of ecological rehabilitation of the Nizhneterskaya zone to be an extremely urgent task^[28].

3.2 Mountain reservoirs

In recent years, garbage has become a byword, which is brought into the reservoirs of mountain hydroelectric power plants by rivers flowing into them. This garbage is first collected at unauthorized landfills near settlements in the mountains, and after heavy rains, a significant part of it falls into the reservoir lines. There are many car washes in the mountains of Dagestan, where chemicals dangerous to health are used. Wastewater from these transport infrastructure facilities is discharged into rivers without treatment, after which all this chemistry enters reservoirs. No one is following this; there is no monitoring of the water condition in such reservoirs^[29].

A particular problem is the uncontrolled development and recreational use of the water area of the Miatli reservoir, which is actually a reservoir of drinking water for a third of the population of the Republic, including residents of Makhachkala and

Kaspiysk. It is necessary to restore the strict ban on the economic use of such reservoirs, legalized in Soviet times. The construction of residential buildings here is permissible only at a considerable distance from the shore. Engineering systems of water treatment and sewerage in such houses should be subject to the strictest control. However, nothing is currently being done in this regard. There is a massive unauthorized seizure of territories and the construction of zones of strict sanitary protection of reservoirs.

3.3 Makhachkala lakes

To the north and south of the capital of Dagestan, there are several freshwater lakes with unique ornithological, ecological and recreational significance—Osadchee, Vuzovskoye, Griazevoe, Ak-Gel, Uytashskoye, Turalinskije, etc. The main ones among them are Lake Ak-Gel, located within the capital of Dagestan. This is a fairly deep freshwater body of lagoon origin, with an area of more than 1 km². Surrounded by numerous residential and industrial buildings, the lake is experiencing a strong anthropogenic impact. Nearby, there are industrial enterprises and a transport complex, from which toxic effluents are often discharged into this reservoir. Fish have not been caught in the lake for a long time, it is ignored by a migratory bird, not to mention its nesting here^[30]. Recently, a pipe with water from the October Revolution Canal was stretched for the ecological rehabilitation of the lake. However, this should not be the end of the matter. Measures are needed to eliminate all sources of polluting effluents in Ak-Gel, fish farming and strict protection from poaching by the newly-appeared “owners” of this lake. A special issue is the development of children’s yachting and other types of water recreation that do not harm the lake ecosystem. It is also important to stop the illegal seizure of lake lands included in the zone of strict sanitary protection. And the whole list of such questions will not fit into one scientific article.

4. The state of the water infrastructure of the region

About half of the population of the Republic consumes water that does not meet the norm for organoleptic indicators (turbidity, color, smell, and

taste). About a third of Dagestan residents use bacterially contaminated water for household needs. Currently, more than 50% of water samples confirm a real epidemic danger, since the level of their contamination is ten times higher than the permissible level. Thus, in general, the medical and ecological situation with the use of water from lakes, reservoirs, river network and underground sources of the Republic is very alarming^[24].

The assessment of the state of water management facilities in the region is carried out taking into account specific sanitary and hygienic standards of water supply and sanitation, as well as the existing experience of systematization of elements of water infrastructure. Such infrastructure assumes the presence of sanitary protection zones, cleaning and disinfecting devices, as well as the provision of residential premises with water supply, sewerage and heating systems.

Taking into account the studies carried out in different years, it is possible to state a very serious contamination of underground water, which is drunk by residents of Babayurtovskiy and Kizlyarskiy districts. A particularly unfavorable situation in this regard has developed with the use of groundwater for household needs by the population of the northernmost city of the Republic of Yuzhno-Sukhokumsk.

On the territory of Dagestan, water is widely used for drinking, in which the content of fluoride significantly exceeds the maximum permissible norms. The indicator of epidemiological danger of territories in relation to the use of drinking water in Makhachkala and its suburbs, as well as in Kayakentskiy, Sergokalinskiy, Levashinskiy and Derbentskiy districts of the Republic is very high. The average long-term indicator of microbial contamination of water in the pipeline network (the percentage of non-compliance of samples with the norm) is excessively high in the Novolakskiy, Levashinskiy and Akhtinskiy districts of the Republic of Dagestan.

4.1 Decentralized water supply

Such water supply is based on the use of mainly underground water sources by the population. Water intake is carried out using individual or publicly available devices and structures. At the

same time, widely branched pipeline networks, as a rule, are not used. This type of water supply is typical for the population living in rural areas.

According to the results of studies conducted by the Center for Sanitary and Epidemiological Surveillance in the Republic of Dagestan (now State consumer supervision for the Republic of Dagestan), the highest level of chemical pollution is inherent in decentralized sources of Levashinskiy, Kayakentskiy and Derbentskiy districts, as well as the cities of Yuzhno-Sukhokumsk and Derbent. Microbial pollution is typical for sources of decentralized water supply in the foothills of Novolakiy, Kazbekovskiye and Buynakskiye districts, as well as the mountainous Levashinskiy and Akushinskiy districts of the Republic of Dagestan. At the same time, it should be noted that such water in many regions of the republic has not yet been studied according to the specified criteria of medical and environmental safety^[24].

4.2 Centralized water supply

Unlike decentralized, centralized water supply to the population is a complex infrastructure complex, including not only pipeline lines, but also water intake, pressure and distribution stations. The main elements of such a complex are the highways through which water is supplied to consumers, as well as numerous structures that ensure the stable operation of drainage and purification systems. Centralized water supply can be either gravity or pressure. The first method is determined by its natural movement when the source is above the object of consumption. The operation of pressure systems involves the installation of additional equipment, including pumping stations and water towers.

The study of water samples from sources (underground and surface) of centralized water supply is carried out quite strictly and on an ongoing basis according to chemical and microbial indicators. At the same time, the specific weight of such sources is determined for the territories of the Republic according to the criterion of compliance and non-compliance with the current sanitary and epidemiological standards^[31]. The largest percentage of samples confirming the inconsistency of the analyzed water with the normatively clean state is observed in Tarumovskiye, Buynakskiye, Tsumadinskiye,

Lakskiye and Kulinskiye districts, as well as in the cities of Kaspiysk and Izberbash.

Underground sources of centralized water supply that have not met sanitary and hygienic standards for many years have been registered in the foothills of Kazbekovskiye, Sergokalinskiye, Dadadayevskiye and Khivskiye districts; the mountains of Khunzakhskiye, Gergebilskiye, Gunibskiye, Tsuntinskiye, Rutulskiye, Akhtynskiye and Dokuzparinskiye districts; the cities of Kaspiysk, Izberbash and Dagestan Fires^[24,32].

4.3 Departmental water supply

Departmental water intakes and water pipelines are mainly on the balance sheet of industrial enterprises and are serviced by the latter. Unfortunately, not all departmental water intakes, such as artesian wells, meet modern requirements for the level of their pollution. The situation is bad with the creation of disinfection and purification facilities for such sources, the organization of sanitary protection zones around them.

There is a large proportion of departmental water pipes that do not meet sanitary standards due to the lack of disinfection devices in Babayurtovskiye, Kayakentskiye, Buynakskiye, Levashinskiye, Botlikhskiye, Tsumadinskiye and Rutulskiye districts. Departmental tap water from surface sources of Buynakskiye and Levashinskiye districts of the foothill zone, Botlikhskiye, Khunzakhskiye and Shamilskiye districts does not meet sanitary standards. Departmental water pipelines in the cities of Makhachkala, Buinaksk, Khasavyurt and Derbent are experiencing an acute shortage of treatment facilities. In rural areas, the situation in this regard is particularly unfavorable in Khasavyurtovskiye, Kayakentskiye, Buynakskiye, Botlikhskiye, Shamilskiye and Rutulskiye districts^[12,32].

A large number of non-standard water samples according to sanitary indicators in departmental water pipes is due to the increased content of trace elements harmful to the human body. It is obvious that water extracted from exploratory and production wells drilled 50 or more years ago should be subjected to a thorough and widespread medical and hygienic analysis.

4.4 Municipal water supply

The key object of responsibility in municipal water supply systems is the municipal territory with people living on it. The power of utility systems is usually brought to a level that provides the total water demand of consumers. Such systems consist of complexes of organizations, processes, activities, tools and resources that are necessary for the extraction, purification, distribution of drinking water, and sanitation. The traditional source for public water supply networks is fresh groundwater.

The territories of Northern and Central Dagestan (Nogaiskiy district and the city of Yuzhno-Sukhokumsk, Tarumovskiy district and Kizlyar, Kizilyurtovskiy district and Kizilyurt, Khasavyurt, Buinaksk and Makhachkala, Kayakentskiy districts and the city of Izberbash) have relatively good indicators for the provision of residential premises with equipped water supply. In Southern Dagestan, it is more or less safe in the Magaramkentskiy district, as well as in the cities of Derbent and Dagestan Ogni. Good provision of residential premises with Sewer networks is well provided for the cities of the Republic and, first of all, Khasavyurt and Buinaksk. However, in most mountainous settlements of Dagestan, dwellings are deprived of equipped sewage systems. In recent years, the flow of tourists to the mountainous regions of Dagestan has sharply increased. Accordingly, guest houses for visitors began to be created in the villages. This process was a good incentive to activate the process of arrangement of sewage drainage in the private sector of Dagestan mountain village.

When assessing the state of municipal systems, the criterion of non-compliance of water with sanitary standards is given great importance due to the absence of sanitary protection zones, disinfection devices and treatment facilities. Municipal water pipelines from underground sources that do not meet medical and hygienic requirements due to the lack of sanitary protection zones are found in all economic and geographical zones of Dagestan. Nogaiskiy district and the city of Yuzhno-Sukhokumsk, Novolakskiy and Kazbekovskiy, Gergebilskiy and Akhvakhskiy, Sergokalinskiy, Levashinskiy and Kulinskiy, Suleiman-Stalskiy,

Kurakhskiy, Akhtynskiy and Dokuzparinskiy districts are especially unfavorable in this regard. The same negative situation is typical for those territories where groundwater and surface water sources for engineering networks do not have disinfection devices: Babayurtovskiy, Novolakskiy, Kazbekovskiy, Levashinskiy, Tsumadinskiy, Charodinskiy, Dahadayevskiy, Khivskiy, Akhtynskiy, Dokuzparinskiy and Rutulskiy districts^[12,32].

5. Water supply projects for the population of the region

The ongoing projects to provide the population of Dagestan with clean water inspire optimism. Thus, according to the Ministry of Construction of Dagestan, the federal project “Clean Water” has been successfully implemented in the Republic since 2019 as part of the national project “Housing and Urban Environment”. The main goal of this project is to improve the quality of drinking water through the construction and modernization of water supply systems throughout the country. The total amount of funds provided for 2019–2024 is about 4.5 billion rubles. By the end of the project period, it is planned to build 28 drinking water supply facilities in 13 municipalities in Dagestan. These are Derbent, Izberbash, Kizilyurt, Kizlyar, Makhachkala, Khasavyurt, as well as seven municipal districts: Akushinskiy, Buinakskiy, Gunibskiy, Tabasaranskiy, Khasavyurtovskiy, Khunzakhskiy and Charodinskiy^[24].

In some regions of the Republic, the process of updating water supply systems takes place through participation in other programs. For example, in the Suleiman-Stalskiy district, a project included in the federal state program “Integrated Development of Rural Areas” is laying water pipes with a total length of 71 km.

It is also important to note that by 2025, one of the oldest cities in Russia, Derbent, will receive more than 180 billion rubles for its comprehensive development. Currently, this is one of the largest urban development programs in the south of the country. An important place in this program is occupied by measures for the reconstruction and construction of water utilities—water pipelines, sewage treatment plants and sewerage. The financing

of the program is distributed as follows: 46.7 billion rubles will be allocated from the federal budget, 7.6 billion rubles will be invested in the implementation of the plan by the region itself, and the remaining 129 billion rubles will be received from private investors. The main engine of this program is the Russian senator, a native of Derbent, billionaire Suleiman Kerimov^[22].

6. Conclusion

The Makhachkala agglomeration, which is now home to more than 1 million people, is characterized by chronic underfunding of the construction of the urban drainage system. The public raises the question of the need for progressive changes in the work of the port economy of the capital of Dagestan and other coastal cities of the Republic, since without this it is impossible to fully develop tourism and resorts.

The ecological state of Dagestan reservoirs and streams reflects the huge scale of violations of existing water protection standards. It is necessary to return the Terek River to its natural delta with the restoration of its estuarine reservoirs. It is required to implement comprehensive programs for the hydroecological rehabilitation of Lake Ak-Gel in Makhachkala.

A separate issue is the hygiene of reservoirs of mountain hydroelectric power plants. One of the important tasks is to stop the uncontrolled development and recreational use of the waters of the Mitli and other mountain reservoirs—the main sources of drinking water for the urban population of Dagestan.

In the Republic, there is a low content of fluoride in the main sources of water supply, which leads to a high incidence of caries among the population. More than 400 thousand residents of the northern region of the Republic (Nogaitskiy, Tarumovskiy, Kizlyarskiy and Babayurtovskiy districts) use water with a high content of toxic arsenic. For a number of districts of Southern Dagestan, the illegally preserved tunnels of the Kizil-Dere deposit, polluting the Akhtychai and Samur rivers with heavy metals, are dangerous.

Sanitary hygiene in the use of water supply networks in the Republic is poorly observed. The

water in the decentralized water supply network in many cities and practically all rural areas of Dagestan is heavily polluted. Urban and district centralized water supply systems also do not comply with sanitary and hygienic standards. All cities of Dagestan are experiencing an extreme shortage of sewage treatment plants. A more thorough and mass medical and hygienic analysis of the water of production wells drilled 50 or more years ago is needed. Most of the municipal water pipes of the Republic also do not meet the medical and hygienic requirements.

At the same time, a number of federal programs are being implemented to improve the water supply systems of the population of the Republic. The most significant of them are the federal project “Clean Water”, as well as other hydroecological programs for certain territories of Dagestan.

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Conflict of interest

The author declares no conflict of interest.

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