Search and study of treatment spring water: A case study of Jizzakh region in Uzbekistan

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Abstract Determining the amount of groundwater sources (springs) and analyzing their quality has always been an important issue, because the health of the population largely depends on the quality of the water. This article presents the analytical results of a study of 242 springs in the Jizzakh region for 2018-2020. During these years, 242 sources (springs) in Farish, Bakhmal, Zaamin and other districts located in the mountain side of the Jizzakh region and 164 (68%) of 242 in the Farish district, 33 (14%) in the Bakhmal district, 27 (11%) in the Zaamin district and 18 (7%) located in the Gallaorol. Analysis of chemical and physical properties (total mineralization of the sampled water, iron, silicon compounds, bromine, iodine, carbon dioxide content, organic matter, pH, hardness, etc.) showed that 107 out of 242 springs are natural sources for human health and diseases prevention. The largest number of these springs is 68 (64%) in Farish district, 29 (27%) in Bakhmal district, 9 (8%) in Zaamin district and 1 (1%) in Gallaaral, respectively. These results will play an important role to research with large-scale quantitative and qualitative on healing springs in the future.

1. Introduction
Population growth and urbanization are leading to a sharp rise in global demand for freshwater for drinking, sanitation, agriculture, energy production [1-7], industry, and environmental protection. But the sustainability of the freshwater supply is seriously threatened because of widespread depletion of groundwater, surface water pollution, and climate change impacts [8]. In recent years, climate change impacts such as changes in the reliability of stream flow, erratic monsoons, and flooding have been pronounced; these, coupled with other anthropogenic causes, have led to serious water shortages [9]. Drought and over pumping of groundwater to supply population growth and support irrigated agricultural production have been linked to reductions in spring flow [10, 11].

All life forms especially humans depend on their surrounding biophysical environment for their well-being and survival but due to overuse of these resources, environment has been degrading rapidly. Among these fundamental resources, water is one of the most important natural resource for humans, wildlife and the whole environment. Assessment of ambient water quality determines its use for humans and ecological purposes [12]. Water quality represents the purity of water and expresses the suitability of water for various uses like drinking, industrial water supply, and irrigation, propagation of aquatic organisms and generation of hydro power [13, 14, 15]. The water quality is assessed in order to determine its portability, safety of human contact and ecosystem health. Poor quality of water is due to high level of organic and inorganic substance that does not fit in the standard limits given by government.
quality indicated by various physical parameters such as pH, total solids, total dissolved solids, total suspended solids, alkalinity, free CO₂, dissolved oxygen, hardness, chlorine content, and sodium content. Nitrate contamination results from human and animal wastes, soil nitrogen content, plant debris, industrial effluents and chemicals, and seepage and silage through drainage system [16, 17]. Springs described as «bowls of liquid light» [18], are one of the most wonderful and scenic places in nature. Moreover, springs are the best area for swimming, picnicking and diving; they are one of the oldest tourist attractions [19] for people. A spring is a water resource formed when the side of a hill, a valley bottom or other excavation intersects a flowing body of groundwater at or below the local water table, below which the subsurface material is saturated with water [17]. The turbidity in the groundwater is an indication of pollution of water resulting from deterioration of organic matter and improper disposal of domestic and industrial solid wastes and wastewater. Electrical conductivity (EC) is a measure of the presence of dissolved salts in water which are responsible to conduct electric current [20]. Total hardness (mg/l) is defined as the sum of magnesium and calcium carbonate contents. High magnesium content affects the domestic use of water [21]. High levels of water hardness lead to heart diseases and kidney stone formation [22].

The stable flow rate of spring-run rivers and their relatively constant water temperature make springs ideal habitats for many unique native and migratory species [23]. Water deterioration of springs can be attributed to the strong interaction of surface water and groundwater. It is strongly affected by the hydrogeological conditions and the surrounding environment. Thus, there is a need for intensive, long-term monitoring of groundwater level and water quality. This can lead to a better evaluation of the groundwater contamination [24]. Industrial objects are the source of contamination for natural springs both chemically and ecologically [25].

Water quality influences to human organism positively which contains of minerals and essential substances [26, 27, 28]. Due to this, in 2018-2020, 633 samples from 242 springs of the Jizzakh region were analyzed, and the following goals were achieved:

i. To determine the physical (pH and etc.) quality of the Jizzakh region spring water;
ii. To assess the chemical quality of the Jizzakh spring water;
iii. To analyze and compare all results and select the high quality springs water in the Jizzakh.
iv. To list the essential springs in the Jizzakh.
v. To determine the coordination of location of springs in the Jizzakh.

2. Methodology

2.1. Study Area
The study area (Farish, Bakhmal, Zaamin, Gallaaral) is located in Jizzakh of Uzbekistan. Geographically, Jizzakh region is located in the central part of the Republic of Uzbekistan between the Syrdarya and Zarafshan rivers. It is bordered on the north and northeast by the Republic of Kazakhstan and the Syrdarya region, on the southeast by the Republic of Tajikistan, on the west by the Navoi region and on the southwest by the Samarkand region [29]. The peculiarity of the region is that it does not form a single natural-geographical district; it covers a certain part of the natural-geographical regions of Kyzylkum, Mirzachul and Zarafshan, and is also located between the desert and the mountains. Jizzakh region is divided into two very different parts. The northern part of the region is represented by lowlands, and in the southern part - by the mountain ranges of Turkestan from east to west and northwest.

2.2. Research Design
The research was an experiment. Water samples were collected from Farish, Bakhmal, Zaamin and Gallaaral in Jizzakh region and tested at the State Unitary enterprise of the Uzbekhydrogeology laboratory. As an external control, about 10% of the samples taken were examined at the "Central Chemical Laboratory" of the State Committee for Geology. Analysis accepted for 14 months - in 2018 - 3 months (August, September, October), in 2019 - 8 months (March - October), in 2020 - 3 months (March, April, May) with a cyclic of 1.5 years of springs quality control. The instrumental GPS was used to measure the coordinates of location each source (topographic indicator).
2.3. Sampling Procedure
Samples were taken in polyethylene bottles (500 ml). A total of 633 water samples from 242 sources were timely analyzed in the laboratory for physical (pH and hardness) and chemical analysis, respectively.

2.4. Data collection and Analysis
All samples were analyzed physically and chemically. The data were analyzed using Microsoft excel computer software.

2.4.1. Physical Quality Analysis Methods
The physical examinations focused mainly on pH and water properties. The table pH meter was used to measure the pH level of the Jizzakh region spring water. The electrode was immersed in the sample. Reading was taken after 20-30 seconds after the water readings have stabilized.

2.4.2. Chemical Quality Analysis Methods
Hardness, free content of CO$_2$, Fe (Fe$^{2+}$ + Fe$^{3+}$), Br, J, silicic acids (H$_2$SiO$_3$ + HSiO$_3^-$), organic substances, and total mineralization was determined.

3. Results and Discussion
Of the 242 selected sources, 107 were found to be qualitatively beneficial to human health. Table 1 shows the main criteria for assessing (determining) the treatment properties of mineral waters in Uzbekistan. All results obtained in the laboratory were analyzed and sources with medicinal properties were selected based on these criteria (Table 1).

| Important indicators | The norm for classifying waters as minerals | Name and subdivision of waters |
|----------------------|-------------------------------------------|--------------------------------|
| General mineralization | 1 g/l | < 1.0 g/l – weak mineralization |
|                       |      | 1.0 – 5.0 g/l – low mineralization |
|                       |      | 5.0 – 10 g/l – normal mineralization |
|                       |      | 10 – 35 g/l – high mineralization |
|                       |      | 35 – 150 g/l – salty |
|                       |      | > 150 g/l – strong salty |
| Content of CO$_2$ free (dissolved) | 0.5 g/l | 0.5 – 1.4 g/l – weakly carbon dioxide |
|                       |      | 1.4 – 2.5 g/l – carbon dioxide with norm concentration |
|                       |      | > 2.5 g/l – strong carbon dioxide |
|                       |      | («carbonating») |
| Content of H$_2$S generally. (H$_2$S +HS$^-$) | 10 mg/l | 10.0 – 50.0 mg/l – weakly hydrogen sulfide |
|                       |      | 50.0 – 100.0 mg/l – hydrogen sulfide with medium concentration |
|                       |      | 100.0 – 250.0 mg/l – strong hydrogen sulfide |
|                       |      | > 250 mg/l – very strong hydrogen sulfide |
| Content of As | 0.7 mg/l | 0.7 – 5.0 mg/l – arsenic |
|                       |      | 5 – 10 mg/l – strong arsenic |
|                       |      | > 10 mg/l – very strong arsenic |
| Content of Fe(Fe$^{2+}$ + Fe$^{3+}$) | 10 mg/l | 10.0 – 40.0 mg/l – ferruginous |
|                       |      | 40.0 – 100 mg/l – strong ferruginous |
|                       |      | > 100.0 mg/l – very strong ferruginous |
The content of free CO₂, Fe (Fe²⁺ + Fe³⁺), Br, J, silicic acids (H₂SiO₃ + HSiO₃⁻), organic substances, and total mineralization were determined. These criteria help to determine healing water in spring significantly.

3.1. Physical Quality Results (pH)

| Springs name | Farish district | Bakhmal district |
|--------------|----------------|-----------------|
| Mujrumsay 2 – 7.2; Andigansoy 7.2; Hayot (Uxumsay) 6.4; Asrofsay 6.7; Old Farish 1 – 6.7; Old Farish 4 – 6.5; Kakmishsay 2 – 6.7; Kamishsay 5 – 6.6; Kamishsay 6 – 6.7; Kamishsay 9 – 6.6; Akbulak 7.7; Tangisay 7.2; Yotokkishtak 7.2; Yotokkishtol 2 – 7.15; Kurukkishtay 6.9; Kurukkishtak 2 – 7.05; Middle village spring 7.2; Kuybulaksay 7.0; Yamchi 1 – 6.9; Yamchi 2 – 7.0; Yangisay 6.8; Eshansisay 6.7; Yamchisay 7.0; Khujursay 1 – 6.8; Khujursay 2 – 7.0; Khujursay 3 – 7.2; Ilonchisay 6.7; The rest area spring of «Zangori olov» 7.0; Akbulak ota 6.9; Matlubotchi 1 – 7.4; Tangibuloq 6.6; Bandalosmon 1 – 7.1; Bandalosmon 2 – 7.3; Kayragach 1 – 7.1; An – Muna 2 – 7.1; A – Muna 3 – 7.3; A – Muna 4 – 7.1; Karatas 1 – 7.4; Karatas 2 – 7.2; Karatas 3 – 7.7; Karatas 4 – 7.2; Khujabogbon ota 7.1; Kutirbulak 7.8; Egizbulak 1 – 7.8; Egizbulak 2 – 7.4; Egizbulak 3 – 7.4; Egizbulak 5 – 7.4; Egizbulak 6 – 7.3; Egizbulak 7 – 7.8; Garasha 1 – 6.4; Garasha 2 – 6.4; Garasha 3 – 6.55; Jandakhor ota 6.7; Khaydar ota 1 – 6.8; Khaydar ota 2 – 6.8; Khaydar ota 3 – 6.6; Khaydar ota 4 – 6.3; Yassikechuv 4 – 6.55; Koraabdol ota 2 – 6.5; Akbulak 7.4; Doriston 6.5; Sovurdovon 7.4; Mikhin 1 – 7.8; Mikhin 3 – 7.6; Yamchisoy 7.2; Yamchisoy (Kutirbulak) 7.5; Sayyod Uratepa 7.5; Korakhon 7.4; Korakhon 2 – 7.4; Katartol 6.5; Vadigan 5.1; Tangitopdi 3.0; Akkurangsay 1 – 3.1; Akkurangsay 2 – 6.3; Olim bogi spring 1 – 5.6; Olim bogi spring 2 – 6.65; Kirkkishtak spring 1 – 6.25; Kirkkishtak spring 2 – 6.5; Kukjarkishtak spring 1 – 6.1; Kukjarkishtak spring 2 – 6.5; Bakhmalsay 2.8; Palakhmansay 6.7; Ak-Mulla (Jilbulak) 1 – 6.25 |
3.2. Chemical Quality Results

a). General mineralization (1 g/l)

The general index of mineralization in the spring of Farish district is different: Kamysay - 6 - 1.04, Kamishsay - 9 - 1.04, Jandakhor ota - 1.35, Karashakshak - 1.01, Garasha - 1.5, and also mineralization indicators were obtained for the Tamtumsay - 1 - 1.36, the Tamtumsay - 2 - 1.33, Suvlisay - 0.91, Shurbulak - 2.39 in the Zaamin district, which means that the highest mineralization index was obtained. It can be seen that Shurbulak (2.39) is the best indicator, but Farish is in the lead as an area with springs that meet the established rate of total mineralization. General mineralization is from 2.39 to 0.91 in the different areas in the Jizzakh region.

b) Fe (Fe²⁺+Fe³⁺) (10 mg/l)

When analyzed the iron content in the water of the Andigan located in the Farish region was 11.0 mg / l. In all other sources, the chemical element iron was below the established norm. The best indicator with Fe (Fe²⁺+Fe³⁺) is Andigansay in the Zaamin region.

c) Br (25 mg/l)

Mujrumsay - 2 - 54, Andigansay - 110, Eski Forish - 1 - 41.0, Eski Forish - 4 - 34.0, Karashakshak - 2 - 70.2 in the Farish district. It can be concluded that Br has a high content of chemical elements in the Farish.

d) J (5 mg/l)

It can be seen that the iodine content in the water of the Karamazor spring in the Zaamin is much closer to the established normative norm - 4 mg / l compared to 5 mg / l (normative).

e) CO₂ (0.5 g/l)

1. Bakhmal district springs: Katortol – 0.53, Vadigan – 0.57, Tangitopdi – 0.53, Dangara Akkurgansay – 0.7, Dangara Akkurgansay – 2 – 0.79, Olim bog – 1.06, Olim bog – 2 – 1.06, Kirkkishlak – 0.53, Kukjar – 0.62, Kukjar – 2 – 0.75, Baxmalsay – 0.97, Poloxmonsay – 0.62, Jibulak – 0.88, Ak – Mulla – 1.1, Korongusay – 0.96, Kizilsuv – 1.76, Supikishlak – 0.75, Supikishlak – 2 – 1.06, Muzbulak (Korashakshak) – 1 – 2.95, Muzbulak – 2 – 0.88, Muzbulak – 5 – 1.06, Nishonsuv – 3.78; Qizilsuv temirli – 5.7.

2. Zaamin district springs: Karakhan - 2 - 1.3, Garasha - 2.2.

According to the results of the analysis, it can be seen that the Bakhmal district is the leader in terms of area with the largest number of free CO₂ in the springs. There are different indicators from 5.7 to 0.53.

These results indicate that water of springs is different with pH indicators in every district. Springs of Farish indicate from 6.3 to 7.8 and springs of Bakhmal from 2.4 to 7.4, springs of Zaamin from 2.9 to 7.9. Finally, Gallaral spring is 7, 3 the indicator of pH.
The following table shows the healing properties of springs distributed in the territory of Jizzakh region in Bakhmal district.

| Table 5. The indicators of organic substances in spring of Jizzakh |
|---------------------------------------------------------------|
| Farish district | Springs name |
| Tangisoy - 20.41; Yotokkishlak - 16.14; Yotokkishlak – 2 - 19.46; Kurukkulsoy - 17.56; Kurukkulsoy – 2 - 18.04; Urta kishlak – 1 - 20.41; Kuybulaksay - 13.76; Yomchi – 1 - 20.88; Yomchi – 2 - 18.98; Yangisoy - 16.61; Eshonlisay - 5.22; Yomchi - 22.31; Khujursay - 19.94; Khujursoy – 2 - 21.42; Khujursoy – 3 - 18.75; Ilonchisoy - 20.35; Zangori olov - 20.35; Akbulak ota - 21.42; Matlibotchi - 16.06; Tangibulak - 13.92; Balandosmon – 1 - 19.28; Balandosmon – 2 - 18.75; Kayragach - 17.14; Kurbonxuja – 2 - 15.53; Kurbonxuja – 3 - 15.53; Kurbonxuja – 4 - 17.99; Korajon – 1 - 17.99; Korajon – 2 - 18.99; Korajon – 3 - 16.49; Korajon – 4 - 20.99; Khujabogbon - 15.49; Kuturbulak - 10.49; Egizbulak – 1 - 11.99; Egizbulak – 2 - 19.49; Egizbulak – 3 - 15.99; Egizbulak – 5 - 15.99; Egizbulak – 6 - 7.49; Egizbulak – 7 - 18.49; Garasha – 1 - 7.57; Garasha – 2 - 5.68; Garasha – 3 - 13.3; Garasha - 9.46; Khaydar ota – 1 - 7.22; Khaydar ota – 2 - 7.2; Khaydar ota – 3 - 6.06; Khaydar ota – 4 - 5.68; Davlan – 4 - 5.25; Uzunbulak – 2 - 6.65; Diriston - 8.06 |
| Bakhmal district | Supi kishlak - 1 - 5.1 |
| Zamin district | Taylonsoy - 5.07; Karinkishlak - 19.25; Uvolsoy - 6.42 |
| Gallaorl district | Khovuzbulak – 2 - 10.06 |

The table describes that the maximal indicator of organic substances is 22.31 in Yomchi spring in Farish district and the minimal indicator is 5.07 in spring of Zaamin district. Farish dominates with springs which saturated with organic substances in water than other area. Khovuzbulak is only spring in Gallaorl and Supi kishlak spring one source in Bakhmal district with rich organic substances in water. 49 spring are located in Farish district, 3 in Zaamin, 1 is Gallaorl and Bakhmal.

g). H$_2$SiO$_3$+HSiO$_3$ (50 mg/l)

Table 4 shows the results of H$_2$SiO$_3$+HSiO$_3$ in water of spring in Farish and Bakhmal district.

| Table 4. H$_2$SiO$_3$+HSiO$_3$ in water of spring in Farish and Bakhmal district |
|---------------------------------------------------------------|
| Farish district | Springs name |
| Hayot – 52; Asrofsay – 44.2; Kamishsay – 5 – 49.4; Korasuv – 52; Kizilsuv – 52; Sovurdovon – 60; Mikhin - 1 - 62; Mikhin 3 - 69; Yamchisoy – 60; Yamchisoy (Kutirbulak) – 51; Sayyod Uratepa – 64; Yamchisoy – 51; Kattabogdon – 55; Ana – Muna – 1 – 55; Koraxon – 1 – 55; Koraxon – 2 – 60 |
| Bakhmal district | Kukjar – 1 – 51; Kukjar – 2 – 60; Ak – Mulla – 1 – 64; Ak – Mulla – 3 – 64; Korasuv – 1 – 60; Jadik – 60; Oykor – 64; Kizilsuvsoy-temirli – 83; Kizilsuvsoy-temirli – 2 – 83 |

The indicators show the different results from 69 to 44.2 respectively. 24 springs are rich with H$_2$SiO$_3$+HSiO$_3$, however Farish is first with 15, and Bakhmal has 9. There are 16 springs in Farish and 9 in Bakhmal district.

The following table shows the healing properties of springs distributed in the territory of Jizzakh region (Table 5).
Table 5. Treatment springs and their characteristics located in the Farish district

| №  | Spring name                                | The factor that determines the healing properties of the sources (springs) | №  | Spring name                                | The factor that determines the healing properties of the sources (springs) |
|----|--------------------------------------------|------------------------------------------------------------------------|----|--------------------------------------------|------------------------------------------------------------------------|
| 1  | Kamishsay – 6                              | General mineralization                                                  | 35 | Kurbonkuja – 3                             | Organic substance                                                      |
| 2  | Kamishsay – 9                              | General mineralization                                                  | 36 | Kurbonkuja – 4                             | Organic substance                                                      |
| 3  | Jandakhor ota shrine spring                | General mineralization                                                  | 37 | Karajan – 1                                | Organic substance                                                      |
| 4  | Koraobdol                                  | General mineralization                                                  | 38 | Karajan – 2                                | Organic substance                                                      |
| 5  | Garasha                                   | General mineralization                                                  | 39 | Karajan – 3                                | Organic substance                                                      |
| 6  | Andigansay                                | Fe (Fe²⁺+Fe³⁺), Br                                                     | 40 | Karajan – 4                                | Organic substance                                                      |
| 7  | Mujrmsay – 2                               | Br                                                                      | 41 | Khujabogbon ota shrine                     | Organic substance                                                      |
| 8  | Eski Farish – 1                           | Br                                                                      | 42 | Kuturbulak                                 | Organic substance                                                      |
| 9  | Eski Farish – 4                           | Br                                                                      | 43 | Egizbulak                                  | Organic substance                                                      |
| 10 | Korakhon – 2                              | Br                                                                      | 44 | Egizbulak – 2                             | Organic substance                                                      |
| 11 | Tangisay                                  | Organic substance                                                      | 45 | Egizbulak – 3                             | Organic substance                                                      |
| 12 | Yotokkishlak                              | Organic substance                                                      | 46 | Egizbulak – 5                             | Organic substance                                                      |
| 13 | Yotokkishlak – 2                         | Organic substance                                                      | 47 | Egizbulak – 6                             | Organic substance                                                      |
| 14 | Kurukkulsay                               | Organic substance                                                      | 48 | Egizbulak – 7                             | Organic substance                                                      |
| 15 | Kurukkulsay – 2                          | Organic substance                                                      | 49 | Garasha – 2                                | Organic substance                                                      |
| 16 | Urta kishlak – 1                         | Organic substance                                                      | 50 | Garasha – 3                                | Organic substance                                                      |
| 17 | Kuybulaksay                               | Organic substance                                                      | 51 | Khaydar ota – 1                           | Organic substance                                                      |
| 18 | Yomchi – 1                                | Organic substance                                                      | 52 | Khaydar ota – 2                           | Organic substance                                                      |
| 19 | Yomchi – 2                                | Organic substance                                                      | 53 | Khaydar ota – 3                           | Organic substance                                                      |
| 20 | Yangisay                                  | Organic substance                                                      | 54 | Khaydar ota – 4                           | Organic substance                                                      |
| 21 | Eshonlisay                                | Organic substance                                                      | 55 | Davlan – 4                                | Organic substance                                                      |
| 22 | Yomchi                                    | Organic substance                                                      | 56 | Uzunbulak – 2                             | Organic substance                                                      |
| 23 | Khujursay                                 | Organic substance                                                      | 57 | Deriston                                  | Organic substance                                                      |
| 24 | Khujursay – 2                            | Organic substance                                                      | 58 | Hayot                                     | $H_2SiO_3+HSiO_3$                                                        |
| 25 | Khujursay – 3                            | Organic substance                                                      | 59 | Arsofsay                                  | $H_2SiO_3+HSiO_3$                                                        |
| 26 | Ilonchisay                                | Organic substance                                                      | 60 | Kamishsay – 5                             | $H_2SiO_3+HSiO_3$                                                        |
| 27 | Zangori olov rest area spring             | Organic substance                                                      | 61 | Sovurdovon                                | $H_2SiO_3+HSiO_3$                                                        |
| 28 | Aqbulak ota shrine spring                 | Organic substance                                                      | 62 | Mikhin – 1                                | $H_2SiO_3+HSiO_3$                                                        |
| 29 | Matlibotchi rest area spring              | Organic substance                                                      | 63 | Mikhin – 3                                | $H_2SiO_3+HSiO_3$                                                        |
| 30 | Tangibulak                                | Organic substance                                                      | 64 | Yamchisay children rest area              | $H_2SiO_3+HSiO_3$                                                        |
| 31 | Balandosmon – 1                          | Organic substance                                                      | 65 | Sayyod Uratepa                            | $H_2SiO_3+HSiO_3$                                                        |
| 32 | Balandosmon – 2                          | Organic substance                                                      | 66 | Kattabogdon mosque spring                | $H_2SiO_3+HSiO_3$                                                        |
| 33 | Kayragoch                                 | Organic substance                                                      | 67 | Ana – Muna – 1                            | $H_2SiO_3+HSiO_3$                                                        |
| 34 | Kurbonkuja – 2                           | Organic substance                                                      | 68 | Korakhon – 2                              | $H_2SiO_3+HSiO_3$                                                        |
The spring waters in Farish often contain large amounts of organic matter, followed by silicon and its compounds, and followed by total mineralization and finally, the element of Br.

**Table 6.** Healing springs and their characteristics located in the Bakhmal region

| № | Spring name | The factor that determines the healing properties of the source (springs) |
|---|-------------|---------------------------------------------------------------------|
| 1 | Katartal | CO₂ |
| 2 | Vadigan | CO₂ |
| 3 | Tangitopdi | CO₂ |
| 4 | Dangara Akkurgansay | CO₂ |
| 5 | Dangara Akkurgansay – 2 | CO₂ |
| 6 | Olim bog | CO₂ |
| 7 | Olim bog – 2 | CO₂ |
| 8 | Kirkkishlak | CO₂ |
| 9 | Kirkkishlak – 2 | CO₂ |
| 10 | Kukjar | CO₂ |
| 11 | Kukjar – 2 | H₂SiO₃+HSiO₃ |
| 12 | Baxmalsay | CO₂ |
| 13 | Polokhmansonay | CO₂ |
| 14 | Jilbulak | CO₂ |
| 15 | Ak – Mulla | CO₂ |
| 16 | Karangusay | CO₂ |
| 17 | Karasuv | CO₂ |
| 18 | Supikishlak | Organic substances |
| 19 | Supikishlak – 2 | CO₂ |
| 20 | Muzbulak (Karashakshak) - 1 | CO₂ |
| 21 | Muzbulak – 2 | CO₂ |
| 22 | Muzbulak – 5 | CO₂ |
| 23 | Nishansuv | CO₂ |
| 24 | Kizilsuv temirli | CO₂ |
| 25 | Ak – Mulla – 2 | H₂SiO₃+HSiO₃ |
| 26 | Ak – Mulla – 3 | H₂SiO₃+HSiO₃ |
| 27 | Jadik | H₂SiO₃+HSiO₃ |
| 28 | Aykar togbulak | H₂SiO₃+HSiO₃ |
| 29 | Kizilsuv say – temirli – 2 | H₂SiO₃+HSiO₃ |

Springs in the Bakhmal district are characterized by a high content of readily soluble CO₂, followed by sources with silicon and its compounds.

**Table 7.** Healing springs in the Zaamin district and their characteristics

| № | Spring name | A factor determining the healing properties of the spring |
|---|-------------|-------------------------------------------------------|
| 1 | Tamtumsay – 1 | General mineralization |
| 2 | Tamtumsay – 2 | General mineralization |
| 3 | Suvlisay – 1 | General mineralization |
| 4 | Shurbulak | General mineralization |
| 5 | Karamazar | J (iodine) |
High content of total mineralization prevail in the Zaamin district, followed by springs saturated with organic matter, and then free CO₂, and, finally, springs rich with iodine (J).

Table 8. Healing springs located in the Gallaorol district and their characteristics

| №  | Spring name       | The factor that determines the healing properties of the source |
|----|-------------------|--------------------------------------------------------------|
| 1  | Khovuzbulak – 2   | Organic substance                                           |

In the Gallaorol region, it was discovered that 1 source, rich in organic matter, has treatment properties.

Table 9. Treatment springs of Jizzakh region

| №  | Spring name       | Location    | №  | Spring name       | Location    |
|----|-------------------|-------------|----|-------------------|-------------|
| 1  | Kamishsay – 6     | Farish district | 54 | Khujursay         | Farish district |
| 2  | Kamishsay – 9     | Farish district | 55 | Khujursay – 2     | Farish district |
| 3  | Tamtumsay – 1     | Zaamin district | 56 | Khujursay – 3     | Farish district |
| 4  | Tamtumsay – 2     | Zaamin district | 57 | Ilonchisay        | Farish district |
| 5  | Suvlisay – 1      | Zaamin district | 58 | Zangori olov      | Farish district |
| 6  | Jandakhor ota     | Farish district | 59 | Akbulak ota      | Farish district |
| 7  | Karaobdol         | Farish district | 60 | Matlibotchi      | Farish district |
| 8  | Garasha           | Farish district | 61 | Tangibuloq        | Farish district |
| 9  | Shurbulak         | Zaamin district | 62 | Balandosmon – 1  | Farish district |
| 10 | Andigansay        | Farish district | 63 | Balandosmon – 2  | Farish district |
| 11 | Mujrumsay – 2     | Farish district | 64 | Kayragach         | Farish district |
| 12 | Eski Farish – 1   | Farish district | 65 | Kurbankhuja       | Farish district |
| 13 | Eski Farish – 4   | Farish district | 68 | Karajan – 1      | Farish district |
| 14 | Karakhon – 2      | Farish district | 69 | Karajan – 2      | Farish district |
| 15 | Karamazar         | Zaamin district | 70 | Karajan – 3      | Farish district |
| 16 | Katartal          | Bakhmal district | 71 | Karajan – 4      | Farish district |
| 17 | Vadigan           | Bakhmal district | 72 | The shrine of    | Farish district |
|    |                   |              |    | Kujabogbon ota   |              |
| 18 | Tangitopdi        | Bakhmal district | 73 | Qo’urbulak        | Farish district |
| 19 | Dangara Akkurgonsay | Bakhmal district | 74 | Egizbulak – 1   | Farish district |
| 20 | Dangara Akkurgonsay | Bakhmal district | 75 | Egizbulak – 2   | Farish district |
| 21 | Olim bog          | Bakhmal district | 76 | Egizbulak – 3   | Farish district |
| 22 | Olim bog          | Bakhmal district | 77 | Egizbulak – 5   | Farish district |
| 23 | Kirkkishlak       | Bakhmal district | 78 | Egizbulak – 6   | Farish district |
| 24 | Kirkkishlak – 2   | Bakhmal district | 79 | Egizbulak – 7   | Farish district |
| 25 | Kukjar            | Bakhmal district | 80 | Garasha – 2     | Farish district |
| 26 | Kukjar – 2        | Bakhmal district | 81 | Garasha – 3     | Farish district |
| 27 | Baxmalsay         | Bakhmal district | 82 | Khaydar ota – 1 | Farish district |
| 28 | Poloxmonsay       | Bakhmal district | 83 | Khaydar ota – 2 | Farish district |
| 29 | Jibulak           | Bakhmal district | 84 | Khaydar ota – 3 | Farish district |
| 30 | Ak – Monsay       | Bakhmal district | 85 | Khaydar ota – 4 | Farish district |
| 31 | Karangusay        | Bakhmal district | 86 | Davlan – 4      | Farish district |
| 32 | Karasuv           | Bakhmal district | 87 | Uzunbulak – 2   | Farish district |
Analysis of chemical and physical properties (total mineralization of the sampled water, iron, silicon compounds, bromine, iodine, carbon dioxide content, organic matter, pH, hardness, etc.) showed that 107 out of 242 sources are sources for human health was recognized as a source of healing water.

Table 10. Coordination of the location of some sources (springs) located in the Jizzakh region

| Place and name of the spring | X                     | Y                     | Absolute /Mark |
|------------------------------|-----------------------|-----------------------|----------------|
| Bakhmal district Nauka ota   | 39°44’23,42610“      | 67° 42’41,32512“     | 1155,756       |
| Bakhmal district Usmansay    | 39°40’26,37945“      | 67° 36’24,77773“     | 1281,894       |
| Bakhmal district Lattavan    | 39°38’24,66958“      | 67° 33’25,85887“     | 1207,843       |
| Bakhmal district Dangara     | 39°41’23,28724“      | 67° 54’36,92918“     | 1533,97        |
| Bakhmal district Kirkkishlak | 39°43’08,25875“      | 68° 00’19,90233“     | 1303,144       |
| Bakhmal district Supikishlak | 39°42’45,75540“      | 68° 08’00,88518“     | 1529,804       |
| Bakhmal district Muzbulak    | 39°42’54,11695“      | 68° 07’47,61584“     | 1522,672       |
| Bakhmal district Muzbulak    | 39°42’59,26387“      | 68° 07’45,32498“     | 1520,524       |
| Location                  | Latitude   | Longitude  | Population |
|--------------------------|------------|------------|------------|
| Muzbulak /2              | 39°43'01,99676″ | 68° 07’28,30263″ | 1509,062   |
| Muzbulak /3              | 39°43'06,26855″ | 68° 05’38,08546″ | 1450,997   |
| Supikishlak /2           | 39°43'03,76652″ | 68° 05’35,08960″ | 1443,306   |
| Supikishlak /3           | 39°44'11,18279″ | 68° 05’56,18413″ | 1545,832   |
| Bakhmal district Ak – Mulla | 39°41'58,04189″ | 68° 01’56,89994″ | 1385,736   |
| Bakhmal district Kukcha  | 39°39'46,16007″ | 68° 03’53,02511″ | 1548,698   |
| Bakhmal district Teraklisay | 39°39'06,93524″ | 68° 06’23,46072″ | 1684,9     |
| Bakhmal district Bakhmal sanatorium | 39°39'33,08730″ | 68° 06’06,62644″ | 1645,884   |
| Bakhmal district Rest area for children | 39°44'51,90928″ | 67° 56’30,58060″ | 1183,805   |
| Bakhmal district Korbulak | 39°42'16,63092″ | 67° 42’51,84508″ | 1604,132   |
| Bakhmal district Kizilsuv | 39°49'22,14225″ | 68° 09’41,67576″ | 1094,613   |
| Zaamin district Karimkishlak | 39°47'50,80215″ | 68° 09’09,56370″ | 1394,538   |
| Zaamin district Karamazar | 39°45'55,79781″ | 68° 14’50,79932″ | 1197,945   |
| Zaamin district Uvalsay  | 39°45'53,47730″ | 68° 14’52,09581″ | 1205,632   |
| Zaamin district Uvalsay/2 | 39°38'14,59427″ | 68°28’39,07173″ | 2319,231   |
| Zaamin district Sherbulak | 39°37'43,86796″ | 68°29’34,45126″ | 2006,13    |
| Zaamin district Sharshara | 39°39'33,67443″ | 68°29’59,45158″ | 1722,039   |
| Farish district Osmansoy | 40°19'12,93680″ | 67°27’08,46003″ | 618,57     |
| Farish district Egizbulak | 40°17'48,81235″ | 67°24’54,54810″ | 817,905    |
| Farish district Egizbulak /2 | 40°19'43,24664″ | 67°19’56,69203″ | 905,127    |
| Farish district Korakhon  | 40°19'42,07571″ | 67°19’59,11462″ | 908,669    |
| Farish district Korakhon /2 | 40°21'27,48439″ | 67°22’29,06049″ | 738,217    |
| Farish district Khojibobo  | 40°21'35,92025″ | 67°22’49,59730″ | 681,181    |
| Farish district Kutirbulak | 40°20’59,39644″ | 67°20’15,08575″ | 699,482    |
| Farish district Korakhon  | 40°20’58,50371″ | 67°20’18,32977″ | 700,603    |
| Farish district Korakhon /2 | 40°21’38,44836″ | 67°20’14,76019″ | 647,112    |
| Location          | Latitude         | Longitude         | Population |
|-------------------|------------------|-------------------|------------|
| Ana – Muna        | 40°20'07.08762"  | 67°13'33.23695"   | 961,861    |
| Farish district   |                  |                   |            |
| Kattabogdon       | 40°19'54.55893"  | 67°14'31.57518"   | 870,226    |
| Okbulak           | 40°19'53.76558"  | 67°14'31.34297"   | 871,853    |
| Okbulak /2        | 40°19'54.55893"  | 67°14'33.31877"   | 873,546    |
| Matlubotchi       | 40°19'54.74519"  | 67°14'36.40002"   | 876,815    |
| Matlubotchi /2    | 40°19'54.56312"  | 67°14'36.07961"   | 874,865    |
| Matlubotchi /3    | 40°35'06.03403"  | 66°43'44.89469"   | 704,369    |
| Majrum            | 40°35'00.47857"  | 66°43'34.87839"   | 717,942    |
| Majrum /2         | 40°31'35.27795"  | 66°46'21.83868"   | 962,548    |
| Hayot             | 40°31'34.18877"  | 66°46'19.11083"   | 970,307    |
| Hayot /2          | 40°31'35.54675"  | 66°46'22.30430"   | 964,695    |
| Hayot /3          | 40°31'32.97308"  | 66°48'12.94787"   | 855,209    |
| Ukhum             | 40°33'07.45343"  | 66°50'25.12488"   | 681,658    |
| Asrafay           | 40°33'03.97929"  | 66°50'25.49828"   | 687,716    |
| Asrafay /2        | 40°31'23.72852"  | 66°56'34.33527"   | 550,471    |
| Birlashgan        | 40°31'20.26567"  | 66°56'31.78199"   | 552,135    |
| Birlashgan /2     | 40°28'53.32917"  | 67°01'53.51324"   | 596,787    |
| Kizilkishlak      | 40°25'54.43892"  | 67°02'35.91643"   | 786,506    |
| Uchumsay          | 40°26'45.18370"  | 67°02'30.90119"   | 667,553    |
| Uchumsay /2       | 40°27'35.60504"  | 67°03'04.93560"   | 593,928    |
| Uchumsay /3       | 40°26'26.52318"  | 67°04'27.73356"   | 637,193    |
| Itron             | 40°25'56.62877"  | 67°05'22.72894"   | 652,5      |
| Abdukarim         | 40°24'59.83237"  | 67°05'27.28852"   | 785,812    |
| Dirston           | 40°22'18.86469"  | 67°05'33.00555"   | 958,734    |
| Kelvasoy          | 40°22'18.49549"  | 67°05'34.60066"   | 957,222    |
| Kelvasoy /2       | 40°22'10.08354"  | 67°06'03.40629"   | 889,865    |

**Note:** The coordinates and population data are approximate and may vary slightly.
| Location          | Latitude         | Longitude        | Population |
|-------------------|------------------|------------------|------------|
| Kelvasoy /3       | 40°21'00.53052"  | 67°06'42.05234"  | 952,793    |
| Saurdovon         | 40°20'29.32068"  | 67°06'46.62944"  | 1076,769   |
| Saurdovon /2      | 40°18'16.42394"  | 67°04'43.64502"  | 924,065    |
| Sanatorium        | 40°22'01.42726"  | 66°54'23.79015"  | 978,502    |
| Jondakhur         | 40°23’46.65092"  | 66°53’55.29417"  | 1140,769   |
| Ingichka          | 40°24’31.71550"  | 66°55’16.88859"  | 1111,901   |
| Mikhin            | 40°24’14.54028"  | 66°55’25.94758"  | 1076,919   |
| Mikhin /2         | 40°23’34.59407"  | 66°55’08.71976"  | 1028,738   |
| Mikhin /3         | 40°21’36.47319"  | 66°56’39.66009"  | 1033,672   |
| Mirab             | 40°19’50.88705"  | 66°57’16.84849"  | 907,202    |
| Ilonli            | 40°21’50.30699"  | 67°00’08.50831"  | 1057,232   |
| Khaydarota        | 40°21’33.28153"  | 66°59’28.98689"  | 1054,804   |
| Khaydarota /2     | 40°22’15.43182"  | 67°01’56.24703"  | 1042,799   |
| Kattasay          | 40°23’44.05187"  | 67°00’32.74209"  | 1312,783   |
| Kattasay /2       | 40°23’45.63885"  | 67°00’21.75116"  | 1341,15    |
| Kattasay /3       | 40°17’08.90150"  | 67°07’01.06904"  | 970,768    |
| Uzunbulak         | 40°17’40.30429"  | 67°07’34.31013"  | 1029,514   |
| Uzunbulak /2      | 40°16’43.70435"  | 67°05’17.72697"  | 861,676    |
| Shokhusman        | 40°16’49.25593"  | 67°17’20.30877"  | 1362,684   |
| Narvon            | 40°16’47.14592"  | 67°17’22.60986"  | 1362,12    |
| Narvon /2         | 40°16’39.71007"  | 67°17’07.98601"  | 1642,464   |
| Narvon /3         | 40°16’37.83386"  | 67°16’17.06526"  | 1231,078   |
| Narvon /4         | 40°16’36.78848"  | 67°16’14.46344"  | 1226,342   |
| Narvon /5         | 40°16’17.26071"  | 67°15’21.13762"  | 1177,022   |
| Narvon /6         | 40°13’56.37401"  | 67°13’01.68451"  | 1020,519   |
Table 10 shows that the absolute mark is different among the districts and coordination data will help us to make a map of treatment springs in Jizzakh region.

4. Conclusions
It turned out that the Jizzakh region is rich in groundwater sources - springs. It was found that most of the springs studied in the regions have medicinal properties. Their most common medicinal feature is that they are rich with organic matter. It became clear that organic rich sources are the leaders in the Farish district. The next place is occupied by the amount of free CO₂ in water, and such sources are most common in the Bakhmal district. It was found that Farish and then springs in Bakhmal districts contain large amounts of H₂SiO₃ + HSiO₃. Chemical elements important for human life, such as bromine, iron, iodine, were found in four districts: Farish, Bakhmal, Zaamin, Gallaaral. Considering the importance of identifying and depth study of healing springs and their preventive role for human health and diseases, plays an important role the construction of sanatoriums near the springs or the development of local and international tourism.

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