Exploration of the springs of the northern part of the Chuvash Republic, Russia

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Abstract. The paper presents the reasons for the appearance of a dense network of well-maintained springs on the territory of the Chuvash Republic. Materials on the study of the quality of spring water in the northern part of the Chuvash Republic are presented. Parameters such as the physical properties of water, chemical composition, environmental condition of the surrounding area, safety of landscaping facilities, type of use of the spring, frequency of use are described. A total of 20 springs from 10 municipalities were examined. The chemical analysis of spring water included a description of 10 parameters, no excess of permissible parameters in terms of pollutants was detected. The main types of use of springs have been established: economic and drinking, religious, and environmental. The frequency of use of springs is analyzed: from abandoned to regularly used. The recreational potential of springs has been calculated. The main factors influencing the value of the recreational potential of the springs of the Chuvash Republic are described.

1 Introduction

Orographically, the Chuvash Republic is a plateau divided by a dense ravine-girder network. When moving from south to north, the density and depth of erosive fragmentation increases. In this regard, the number of groundwater outlets is also increasing. In most cases, groundwater discharge is carried out in the form of descending and ascending sources. It should also be noted the high density of rural settlements in the Chuvash Republic. This was facilitated by the factor of the old development of the region – a network of settlements has been formed since the 10th century. Due to the fact that springs were the main source of drinking water supply in rural areas until the end of the 20th century, a significant proportion of the sources are purified and landscaped. However, the introduction of central water supply has led to the fact that springs have lost their leading economic and drinking role [9]. The last 30-40 years have been characterized by a decrease in the demand for springs. This leads to the deterioration and destruction of the capital devices, cluttering up the nature reserve area. Such a problem can become critical if tap water cannot be used, and you will have to limit yourself to spring water: power outages, pump failures, lack of water in dry years. In this case, springs act as alternative,

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replacement sources of drinking water. Therefore, regular monitoring of the ecological state of spring water and adjacent landscapes is necessary.

Springs are also of great importance in feeding the surface watercourses of the Chuvash Republic. The groundwater outlets are the sources of small rivers. The density of the river network in the north of the region reaches 1.2 km per square kilometer. All of them belong to the Volga basin. The quality of water in rivers directly depends on the chemical composition of groundwater. The need to monitor the ecological state of groundwater is due to the demand for Volga River water for drinking water supply in numerous cities along this river.

2 Materials and methods

Monitoring of the ecological status of springs should be carried out on a regular basis. As part of the public monitoring in the autumn of 2024, expeditions were carried out in the municipalities of the Chuvash Republic with the aim of a comprehensive study of the springs. The following parameters were described: 1) location of the spring; 2) description of the physical properties of the spring water [1,2]; 3) sampling of water for chemical analysis [6]; 4) description of the level of landscaping; 5) study of the ecological condition of landscapes adjacent to the springs; 6) types of economic use of springs.

The location of the springs was described by specifying the exact coordinates, address (locality, street), and toponymic name.

The description of physical properties included: determination of temperature, flow rate of water, taste, smell, color.

Water samples with a volume of 1.5 liters were taken for chemical analysis and a sampling report was drawn up [8]. Water sampling was carried out no more than a day before the transfer of samples to the laboratory. Coordinates, weather conditions, and the exact time of selection were recorded. All samples were transferred to the licensed laboratory "Analytical Center" in Cheboksary. The following water quality indicators were determined in the laboratory: turbidity, total mineralization, total water hardness, hydrogen index, permanganate oxidizability, iron ion content, nitrates, chlorides, sulfates, and ammonium.

The level of improvement of the springs was also determined. Most scientists identify 3-4 levels of well-being of springs:

1) not well–maintained - unused springs that do not have centralized unloading. Water leaks out of the aquifer;

2) low level – there is a centralized outlet for water intake, there is no capital device and other landscaping elements.;

3) medium level – water flows out of the drain device through a pipe or gutter;

4) well–maintained - in addition to the elevator, there are equipped places for recreation, baptismal font, access roads.

The ecological status was determined by analyzing the littering of the surrounding area and the degree of oppression of landscapes. The presence of household waste, the depressed state of the grass cover, and the presence of invasive species proved the deterioration of the ecological condition [4].

Until the middle of the 20th century, all well-maintained springs were regularly used for drinking and household water supply [3]. Some of the springs belong to specially protected natural areas. A special environmental protection regime has been introduced in the areas adjacent to them, prohibiting intensive economic use. Cult and religious springs are used for religious rituals, ablutions are performed. In recent decades, there has been a tendency to include springs in ecological trails. Interactive lessons and guided tours are actively conducted on them. In some cases, mass events of an ecological and patriotic nature are

held in the springs. This leads to an increase in the recreational role of springs. To increase the recreational potential, the springs are equipped with gazebos, benches, tables, playgrounds, and mangalas. Springs associated with outstanding historical events and facts have historical and cultural significance. Excursions are often conducted on their adjacent territory among tourists and the adult population [5,10]. Thus, springs are divided according to the type of economic use.:

1) household and drinking water supply;
2) specially protected natural areas;
3) cultic and religious;
4) educational and educational;
5) Recreational;
6) historical and cultural [3,7,8].

It is also possible to assess the demand for springs. Due to the introduction of centralized water supply in urban and rural settlements, the demand for springs is steadily decreasing. The proportion of completely abandoned springs is growing. Some of the springs are used periodically: on the Epiphany holiday or in the summer. In this regard, there are 3 groups of springs in terms of demand.:

1) used regularly;
2) seasonally used;
3) abandoned [11].

In order to draw public attention to the problem of preserving springs and attracting investments for the reconstruction of capital buildings, it is necessary to assess the recreational potential of the source. For this purpose, the methodology of Novykh L.L., Raevskaya M.V., Orekhova G.A. was used (Novykh L.L. et al., 2022). The following factors were taken into account: the architectural integrity of buildings, the aesthetic perception of spring improvement facilities, the presence of a font, water quality, flow rate, access roads, equipped recreation areas, the presence of capital devices, the presence of garbage. The recreational significance of springs is determined by the sum of the points obtained when evaluating each of the indicators:

0-2 points – very low (unsatisfactory);
2.5–4 points – low;
4.5–6 points – average;
6.5–8 points – high;
8.5–10 points – very high.

3 Results

In the fall of 2024, as part of public monitoring to study the ecological state of springs, a physico-chemical description of 20 springs was carried out in 10 municipalities of the region.

The water samples selected for chemical analysis were delivered to a licensed laboratory "Analytical Center" in Cheboksary. The main results of the chemical analysis are presented in Table 1.

Table 1. The main chemical parameters of the studied spring water

Names of springs	pH	PO	Turbidity	Iron	Mineralization	Rigidity	Ammonium	Nitrates	Chlorides	Sulphates
Ishley	7	0.52	0	0	430	6.9	0	0	19.8	16
Ishaky	7.2	0.6	1.16	0	449	5.7	0	1.5	11.5	18
Oslaba	7	0.74	0.5	0	450	6.3	0	0.19	12.5	12
Yumanlykhi	7.4	3.2	2.66	0	506	6	0.51	3.8	61.3	41
Nigniye Tatmysh	6.9	1.7	0.5	0	342	6.5	0	2.5	25.8	20
Sirikkasi	7.3	0.74	0	0	318	6	0	0.85	5	20
Salugino	7.6	0.6	1.1	0	602	7.4	0	3.2	69	26
Laprakassy	7	0.76	0	0	803	9.1	0	3	59	49
Bolshoe Churashevo	7.2	2.5	0	0	429	6.9	0	0.78	35	41
Yalchiki	7	0.34	1.24	0	383	6.3	0	2.1	18	42
Shordaushi	7.2	0.52	0	0	322	5.2	0.19	1.6	26	12
Buldeevo	7.1	0.76	1.3	0	451	6.9	0.25	2	36	26
Chelkasi	7	0.74	0	0	368	6	0.31	1.9	11.5	17
Stariy Urmary	7.2	0.88	0	0	572	7.2	0.23	3.4	71	40
Kudesners	7.3	1.6	0	0	685	8.9	0.25	2.4	71	36
Podlesnoye	6.9	0.44	0	0	370	5.35	0.27	0.14	12	27
Russkiye Norvashi	7	0.88	0	0	427	7.6	0.21	1.4	18	20
Noviye Turmyshi	7.1	0.82	0	0	692	9.7	0.22	3.8	57	50
Maliye Bikshiki	6.8	0.68	0	0	458	6.2	0.12	3.6	30	29
Elbaruowl	7.1	0.6	0	0	626	8.8	0.25	2.7	45	48

All the investigated springs were landscaped and equipped with capital buildings. This proves that all of them were or are being used for domestic and drinking water supply. In addition, chapels with baptismal fonts are installed at most springs (12 out of 20 springs). This is proof of their use for religious and religious purposes. Of the 20 springs, 2 springs are specially protected natural areas. These are the springs of Shordaushi and Buldeevo, natural monuments of local importance. Among the investigated springs, there are no identified ones that relate to recreational, educational, and historical-cultural.

The completely abandoned springs include the source of the village of Yumanlikhi and the village of Yalchiki. A tree fell on him, destroying the drainage pipe. Some of the springs are used seasonally: during Epiphany or during the summer by shepherds. There are 4 seasonally used springs: these are water sources in Kudesner, Podlesnoye, and Novye Turmyshy. Salugino (Fig. 1).

There are no unsettled springs among the investigated ones. All 20 springs have captive devices. 7 springs are well-maintained, 5 springs belong to the group with an average level of landscaping. The remaining 8 springs are characterized by a low level of landscaping.

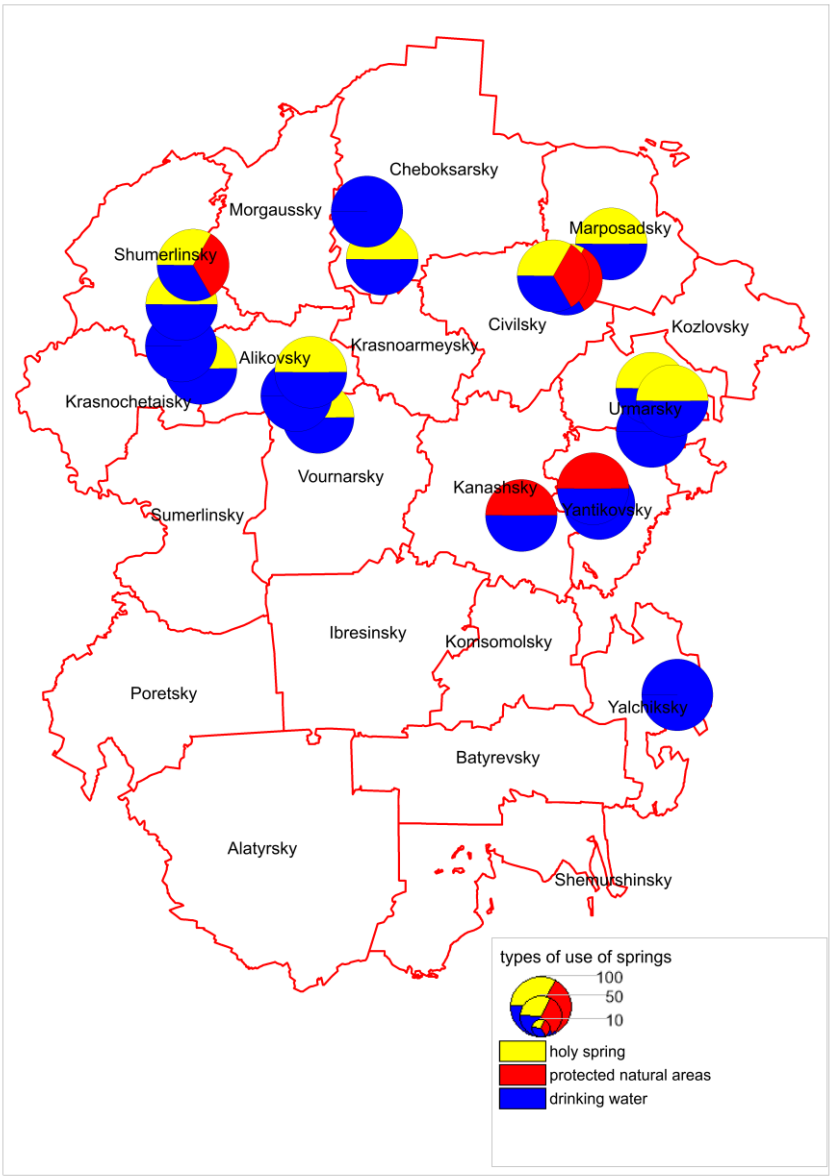

Fig. 1. Using the springs of the Chuvash Republic

4 Discussion

The analysis of the ecological condition of the territory adjacent to the springs and the technical condition of the landscaping facilities made it possible to determine the recreational potential of the sources studied.

A distinctive feature of all the springs studied is the presence of drainage devices. Most springs are equipped with fonts, which also increases the recreational attractiveness of these facilities. The analysis of the chemical composition of the spring water showed full compliance with the requirements. 19 of the 20 springs studied are characterized by low

flow rates. This worsens their aesthetic perception. The average transport accessibility of the springs also influenced the total number of points of recreational attractiveness. Paved roads lead to only a few springs.

An analysis of Table 2 showed that the sources studied are characterized by average values of recreational attractiveness – 6.03. The maximum values are typical for springs – holy springs, which are equipped with recreation areas. The minimum points are inherent in abandoned, polluted springs (0.5-1.5 points). Despite this, there are no unsatisfactory sources among the sources studied. In general, springs can be classified as aesthetically attractive.

Table 2. Recreational attractiveness of the springs of the Chuvash Republic

Names of springs	Architecture	Aesthetics	Swimming pool	Water quality	Landscape value	Flow rate	Access to the spring	Recreation facilities	Water quality	Garbage	Total
Ishley	0.5	0.5	0	1	1	0	0.5	0	1	1	5.5
Ishaky	1	1	1	1	1	0	1	1	1	1	9
Oslaba	1	1	1	1	1	0	0.5	0	1	1	7.5
Yumanlykhi	0	0.5	0	0.5	1	0	0	0	0.5	1	3.5
Nigni-ye Tatmysh	1	1	1	1	1	0	0.5	0.5	1	1	8
Sirikkasi	0.5	0.5	1	1	1	0	0.5	0	1	1	6.5
Saluginо	0	0.5	0	1	0.5	0	0	0	1	1	4
Laprakassy	1	1	1	1	1	0	1	1	1	1	9
Bolshoe Churashevo	0.5	0.5	1	1	1	0	1	0	1	1	7
Yalchiki	0	0	0	1	1	1	0	0	0	1	4
Shordaushi	0.5	0.5	0	1	0.5	0	0.5	0	1	1	5
Buldeevo	1	1	1	1	0.5	0	0.5	1	1	1	8
Chelkasi	1	1	1	1	0.5	0	0.5	0.5	1	1	7,5
Stariy Urmary	1	1	1	1	1	0	1	1	1	1	9
Kudesners	0	0	0	1	0.5	0	0	0	1	0.5	3
Podlesnoye	0	0	0	1	0.5	0	0.5	0	1	0.5	3
Russ-kiye Norvashi	0.5	0.5	1	1	0.5	0	0.5	0.5	1	1	6.5
Novi-ye Turmyshi	0	0.5	0	1	0.5	0	0	0	1	0.5	3.5

Names of springs	Architecture	Aesthetics	Swimming pool	Water quality	Landscape value	Flow rate	Access to the spring	Recreation facilities	Water quality	Garbage	Total
Mali-ye Bikshiki	0.5	0.5	1	1	0.5	0	0.5	0	1	1	6
El-barusow	0.5	0.5	0.5	1	0.5	0	0.5	0	1	0.5	5

5 Conclusion

Summing up, it can be noted that all the springs studied meet the requirements for the quality of drinking water. No excess of the permissible parameters for the content of pollutants was detected.

All 100% of the springs are in use (or have been used before) for drinking water supply. The second place in terms of usage is occupied by holy springs (60%). Some springs belong to specially protected areas (10%). Completely abandoned springs occupy 10% of the total. Seasonally used springs – 20%, the remaining 70% are used regularly.

The average value of the recreational potential for the studied springs was 6.03 points (average level). The maximum values (8-9 points) are typical for springs with a high level of landscaping. The minimum values are typical for abandoned springs.

In general, the investigated springs are in a satisfactory and good ecological condition. There is a need to restore landscaping facilities. That is why it is necessary to emphasize that the possible contamination of the hydrographic network of the region has nothing to do with the discharge of groundwater. Deterioration of water quality occurs through the ingress of reagents through temporary watercourses. This is the flushing of fertilizers from fields, stormwater outlets of cities.

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