Study and assessment of qualitative indicators of water sources in the Issyk-Kul mountain ecosystem

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Abstract. In the work for the subsequent creation of models for forecasting and assessing the quality of water sources using machine learning methods on the basis of the obtained data, the selection and justification of research objects (water resource of the Issyk-Kul region) was carried out. Systematization of water resource objects (lake, river, waste, surface and groundwater) was carried out. Data collection for water quality testing in the Issyk-Kul region was carried out, including organoleptic indicators of investigated water samples from different sources (color, taste, odor, turbidity), determination of water hardness, assessment of heavy metal pollution - cation content (total iron), pH and temperature of water samples from each source. The qualitative characterization and systematization of the obtained data on water samples of different sources were studied and systematized to contribute to the database of future machine learning algorithms, which can be used as tools for analysis and prediction of water resources results.

1 Introduction

Nowadays, the search for ways to solve the main ecological problem, which is related to the protection of the environment from the impact of increased growth in the level of technogenic load on various sectors of our life activity, is becoming more urgent. A comprehensive approach to solving this problem includes new approaches to the use of estimation models and machine learning algorithms for the possible prediction of geo- and biological resources and their distribution [1- 4].

The group of such resources includes: raw materials, biodiversity, coal and oil deposits, soil, water and others. The range of these resources, their internal interrelation, as well as the issues of rational use are quite relevant and in demand both for us and the whole region of Central Asia. This relationship is determined primarily by the fact that the presence of a large number of technogenic zones, in general, determines the state of the entire mountain ecosystem, its stability, the state of parameters of basic resources and processes responsible for the livelihood of the population of mountain territories [5-6].

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Climate change has a great contribution and influence on the state of mountain ecoterritories, which is characterized by the complication of this problem, namely through a certain impact on the main parameters of human activity, among which a special place is taken by the problem of water resources: their qualitative indicators, resource quantity, consumption, purification and others. It should be noted that among all these issues, great attention is also paid to the issues of assessing the quality of consumed water, since its use is determined by a number of factors, among which we can highlight: pollution through chemical/biological factors, uneven distribution, poor control and irrational use [7-8].

In this regard, taking into account a set of environmental issues and the possibility of further construction of model systems of analysis and monitoring using methods and algorithms of machine learning, we selected water resources of the Issyk-Kul region as a test one. The choice of these water resource objects as test objects is also due to the fact that they very accurately and actively reflect all possible changes associated with climate change. The study of these issues with subsequent assessment and the possibility of building forecasting and monitoring models on the example of water resources of the Issyk-Kul region, as the main natural resource, will allow solving a number of problems not only of environmental orientation, but will also affect the social part of the tasks, namely the issues of normal life activity of the population and their relationship with the entire mountain ecosystem as a whole.

A special place among the resources of mountain territories, in particular Issyk-Kul province, is occupied by river waters, which play a significant role in the transport of nutrients and pollutants, affecting other areas of the general mountain ecosystem. Water systems as a special segment of resource provision are characterized by a number of functions, the nature of which determines its demand. Thus, on the one hand - this resource is a means of delivery of dissolved form of nutrients, and on the other hand - provides chemical protection from dissolved, diluted or degraded pollutants. Another factor in the selection of these sites was the study of the impact of the main pollutants of water resources, taking into account their location along the river channels, including domestic, industrial and agricultural sources [7-9].

In this regard, the main objective of this study is the selection of test sites, chemical and biochemical monitoring, and assessment of the impact of changes in climatic parameters on water resources of the Issyk-Kul region. Within the framework of this study, some of the key tasks were selection of territorial geographical points, collection of samples of water resource samples of rivers, lakes as sources for water quality analysis and creation of a database for further use of these results in machine learning methods and algorithms for building prediction models, evaluation of the obtained water data.

2 Materials and methods

The objects of the study were selected series of water samples from different territorial points of Issyk-Kul region (lake, river, surface and groundwater), in particular, water samples of spring and summer sampling were considered.

The objectives of the study were outlined in the framework of the set goal:

- Data collection for water quality testing for the Issyk-Kul region, including nitrogen content, cations, dissolved oxygen, heavy metal pollution assessment, water pH.
- Collection of data to determine COD, conductivity and its salinity for a wide range of waters.
- Temporary monitoring and analysis of water samples in the Issyk-Kul region; including analysis of selected water samples.

For the collected samples a series of analyses on organoleptic indicators and qualitative reactions for cations dissolved in the selected water samples were carried out.

Turbidity of the studied water samples was determined using a portable turbidity meter HI-93703-11, corresponding to ISO, with the possibility of data recording and connection to a personal computer.

Water hardness was determined according to GOST 31954- 2012.

Total iron content in water was determined by photometric method, using photocolorimeter Spectrophotometer - 721G with violet light filter (2, = 400 - 430 nm), cuvette with the thickness of the working layer 2 - 5 cm. The general range of measurement of total iron content without sample dilution is 0.10 - 2.00 mg/dm^3. For this range the total error of measurement with probability P = 0.95 is within the range 0.01 — 0.03 mg/dm^3.

3 Results and Discussion

Since the objects of research were water samples from different sources of Issyk-Kul region (spring and summer sampling), each mode included sample preparation for the analysis process depending on the experimental conditions. The next stage was a series of analyses on organoleptic indicators of these samples.

For this purpose, an initial evaluation was carried out in the field (field expedition) and laboratory conditions through the determination of organoleptic parameters (color, odor, odor at T° change, taste).

It is known that organoleptic indicators characterize the main qualitative properties of the water used, so the assessment of these water quality parameters should be considered as a basic procedure necessary for sanitary and chemical control of this resource. When conducting this type of analysis, a reference scale of tables is used as a test scale, which includes systematic and correct data and can be correlated with the results of conducted studies. Since the water samples obtained were from different sources, some of which are not used for drinking purposes, such as lake samples, this parameter was used only for some of the sampling samples. As a result of determining the experimental points of the water samples, it was found that the value of chromaticity in the waters of these samples, does not meet the minimum value required for water used for drinking purposes. In particular, water used for drinking purposes should be characterized by a maximum permissible value of 35 degrees of color on the platinum-cobalt scale. However, for a sample of individual water sources it reached values much higher than this threshold (50 - 80 and 80 - 120 degrees), which confirmed the conclusion that they cannot be used for drinking purposes (Table 1).

Table 1. Chromaticity values for different water samples (sampling from different water sources in Issyk-Kul region).

No.	Samples	Colorfulness	Units of measurement, degree of platinum-cobalt scale
1.	S - I	Very small	< 25
2.	S - II	Small	25 < 50
3.	S – III	Medium	50 < 80
4.	S – IV	High	80 < 120
5.	S – V	Very high	120 <
6.	S – VI	Very small	< 25
7.	S – VII	Small	25 < 50
8.	S – VIII	Medium	50 < 80
9.	S – IX	High	120 <
10.	S – X	Medium	50 < 80

The results obtained for turbidity of river water samples showed that for a sample of nine samples the value of this parameter lies within the range and only for #9-10 samples can be characterized as very turbid (Table 2).

Table 2. Turbidity values of water samples.

No.	S - I	S - II	S - III	S - IV	S - V	S - VI	S - VII	S - VIII	S - IX	S - X
FTU (formazin units)	0.87	2.88	1.65	2.31	1.84	1 .23	1.83	1.93	21.74	21.15

The use of Trilon B as a titrant allowed the determination of dissolved cations in the studied water samples. Its use is determined by the possibility of formation of stable complex compounds for a wide range of cations: Ca, Mg, Cu, Co, Ni, Zn, Fe, Mo, Al. Eriochrome black was chosen as an indicator for titration, which indexes the formation of reaction products due to a sharp change in the color of the solution and shows the presence of their trace amounts in water.

Analysis of water hardness (WH) showed that the results obtained are consistent with the main indicators and repeat their values depending on the source. Since the sampling was carried out from different sources and at different times of the year, the values of water hardness show corresponding values. At the same time, it should be noted that the LOD for the same water source can change during the year. All analyses were carried out for spring and summer samples, which is more related to the flooding period due to snow melting and rain influence, so water hardness, especially in surface sources, decreases characterizing these samples as samples with medium hardness (Table 3.).

Table 3. Water hardness values of investigated water samples.

No.	Samples	Water hardness values, 0H
1.	S - I	8.65
2.	S - II	8.75
3.	S – III	9.50
4.	S – IV	10.55
5.	S – V	9.85
6.	S – VI	9.45
7.	S – VII	10.10
8.	S – VIII	9.85
9.	S – IX	10.25
10.	S – X	10. 05

In water, iron is usually present in the form of various compounds: sulfates, chlorides, phosphates, humus compounds or in the form of complexes with organic ligands. It should be noted that the presence of iron ions also deteriorates the organoleptic properties of water through the active development of iron-containing bacteria, as a result, the large colonies of these microcolonies formed are the main cause of overgrowth of water supply networks, which is a painful issue of water supply systems for the population of mountainous areas (Table 4).

Table 4. Values of total iron in the studied water samples.

No.	Samples	Values of total iron, mg/dm^3
1.	S - I	0.155
2.	S - II	0.125
3.	S – III	0.145
4.	S – IV	0.176
5.	S – V	0.175
6.	S – VI	0.180
7.	S – VII	0.165
8.	S – VIII	0.160
9.	S – IX	0.164
10.	S – X	0.184

It is revealed that for the investigated water samples the content of total iron lies in the range up to 10 mg/dm^3, as the increase in water samples of iron ions more than 10 mg/dm^3 leads to a shift in the color change of the solution at the equivalence point, which is characterized by overestimation of titration results and large errors in measurement.

4 Conclusion

Thus, the selection and justification of research objects (water resource of mountain ecosystem of Issyk-Kul region) was carried out in the work. Systematization of water resources (mountain rivers, river, waste, surface and groundwater) was carried out and search and definition parameters were determined. Data collection was carried out to check water quality in the Issyk-Kul region, including organoleptic indicators of investigated water samples from different sources (color, taste, odor, turbidity). Data on certain values of water hardness, assessment of heavy metal pollution - cation content (total iron), pH and temperature were collected. As temporal monitoring samples were prepared and sample data from different sources of water resources of Issyk-Kul region were analyzed and correlation of the obtained results was carried out taking into account time and place of sampling for entering into the general model database. It should be noted that the results presented for the analysis of various water source samples and entered into a common base for the use of subsequent algorithms and model building were obtained before the debris flows that occurred in this region.

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