Study of the effect of permafrost on water transparency in lakes located in the Arctic regions

Alexey Shvetsov 1,2 *

1 Moscow Polytechnic University, 107023 Moscow, Russia
2 Vladivostok State University, 690014 Vladivostok, Russia

Abstract. This study examines the effect of permafrost on water transparency in lakes located in the Arctic regions. A comparison was made of water samples from lakes located on standard soil and from lakes located on permafrost. The observation region is the Republic of Sakha (Yakutia). The results were recorded for two groups of measurements, in which water samples were taken from two lakes located on standard ground and from two lakes located on permafrost.

1 Introduction

Climatic, natural and technical conditions in the Arctic regions are fundamentally different from the usual conditions [1, 2, 3]. At the same time, significant reserves of natural resources necessary for people are located in such regions. The development of the Arctic regions, including natural resources located in such regions, requires the study of the characteristics of Arctic objects, primarily water ones. Lakes located in the Arctic regions make it possible to establish such an activity as fish farming, which is an important factor in the food supply for the inhabitants of the region in the context of a growing population. Also, such lakes are a source of drinking water for people and animals, which also confirms the need for monitoring changes in the state of water in such lakes.

2 Materials and methods

To conduct a series of observations aimed at studying the effect of permafrost on water transparency in lakes located in the Arctic regions, a comparison was made of water samples from lakes located on standard soil and from lakes located on permafrost. Water sampling was carried out in the summer season. Samples were taken from the upper, middle, and bottom layers. In total, samples were taken for sampling from four lakes, including two lakes located on standard soil and two lakes located on permafrost. All four lakes are located in the Republic of Sakha (Yakutia). The measurement region of the Republic of Sakha (Yakutia) belongs to the Arctic regions of the planet [4] with extremely low Arctic air temperatures in winter. In this region there are hundreds of lakes located on permafrost.

* Corresponding author: transport-safety@mail.ru
Sampling was carried out in the middle of the lake from a boat using a standard device for deep water sampling.
To process the results of the performed measurements, methods were used that involve the use of computer programs and mathematical calculations [5-19].

Table 1. Methodological grid of the experiment

<table>
<thead>
<tr>
<th>Constant Factors</th>
<th>Variable factors</th>
<th>Parameters for evaluating the subject of research (output parameter)</th>
<th>Number of measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Meaning</td>
<td>Name</td>
<td>Meaning</td>
</tr>
<tr>
<td>1. Object of study</td>
<td>Water</td>
<td>Object (lake) for sampling</td>
<td>1</td>
</tr>
<tr>
<td>2. Season</td>
<td>Summer</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3. Water layers for sampling</td>
<td>Upper; average; benthic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. External (street) temperature</td>
<td>+20…+30 °C (1 group of measurements)</td>
<td>Water transparency</td>
<td>6 for 2 measurement groups</td>
</tr>
<tr>
<td>5. Sample storage temperature</td>
<td>+15…+18 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Transparency was measured according to the Snellen method [20, 21, 22].

Conditions for measuring water transparency
Ambient temperature (20 +/- 5) °C.
Atmospheric pressure (84 - 106) kPa.
Relative air humidity no more than 80% at t = 25 °C.

3 Results and discussion

3.1 Measurement results

3.1.1 First group of measurements

The results of the first group of measurements (water samples from the first lake located on standard soil and water samples from the first lake located on permafrost) are shown in Figure 1.
3.1.2 Second group measurements

The results of the second group of observations (water samples from the first lake located on standard soil and water samples from the first lake located on permafrost) are presented in Figure 2.

![Fig. 2. Results of the second group of water transparency measurements (water samples from the second lake located on the standard soil - the results are marked in orange, water samples from the second lake located on the permafrost - the results are marked in blue).](image)

The distribution of data in the measurement results was evaluated using two parameters:

- Arithmetic mean value ($M$) according to the formula
  \[
  M = \frac{X_1 + X_2 + X_3 + \ldots + X_i}{n}
  \]

- Standard deviation according to the formula
  \[
  \sigma = \sqrt{\frac{\sum (X_i - M)^2}{n}}
  \]

The results of evaluation by formulas 1 and 2 show that the actual distribution in the obtained data is normal (Gaussian).

3.2 Discussion

The obtained measurement results allow us to conclude that permafrost affects the transparency of water in lakes located in the Arctic regions. The average percentage of water
transparency in lakes located on standard soil and from lakes located on permafrost is shown in Figure 3.

![Graph showing water transparency comparison between standard soil and permafrost locations](image)

**Fig. 3.** The average percentage of water transparency in lakes for the first and second groups of measurements (water samples from lakes located on standard soil - the results are marked in orange, water samples from lakes located on permafrost - the results are marked in blue).

From the data obtained (Fig. 3) it follows that the average increase in water transparency in lakes located on permafrost is 13.7%.

Coefficient of variation characterizing the relative scattering measurement results was calculated by the formula

\[ V = \frac{100 \sigma}{\bar{Y}} \]

where \( Y \) is the result of a single measurement.

### 4 Conclusion

This study presents data on the effect of permafrost on water transparency in lakes located in the Arctic regions. The measurements were carried out under conditions typical for the Arctic regions in the Republic of Sakha (Yakutia). Comparison of water samples from lakes located on standard ground and from lakes located on permafrost shows that in lakes located on permafrost, water transparency is higher by 13.7% (average for two groups of measurements).

### References

3. A. Shvetsov, S. Shvetsova, V. Gromov, *E3S Web of Conferences* 371, 04030 (2023) [https://doi.org/10.1051/e3sconf/202337104030](https://doi.org/10.1051/e3sconf/202337104030)