Situation-Analytical Brief

To: Ministry of Emergency Situations of the Republic of Kazakhstan
From: LLP Akmolasvyazmontazh (AIAUS "GIS ES")

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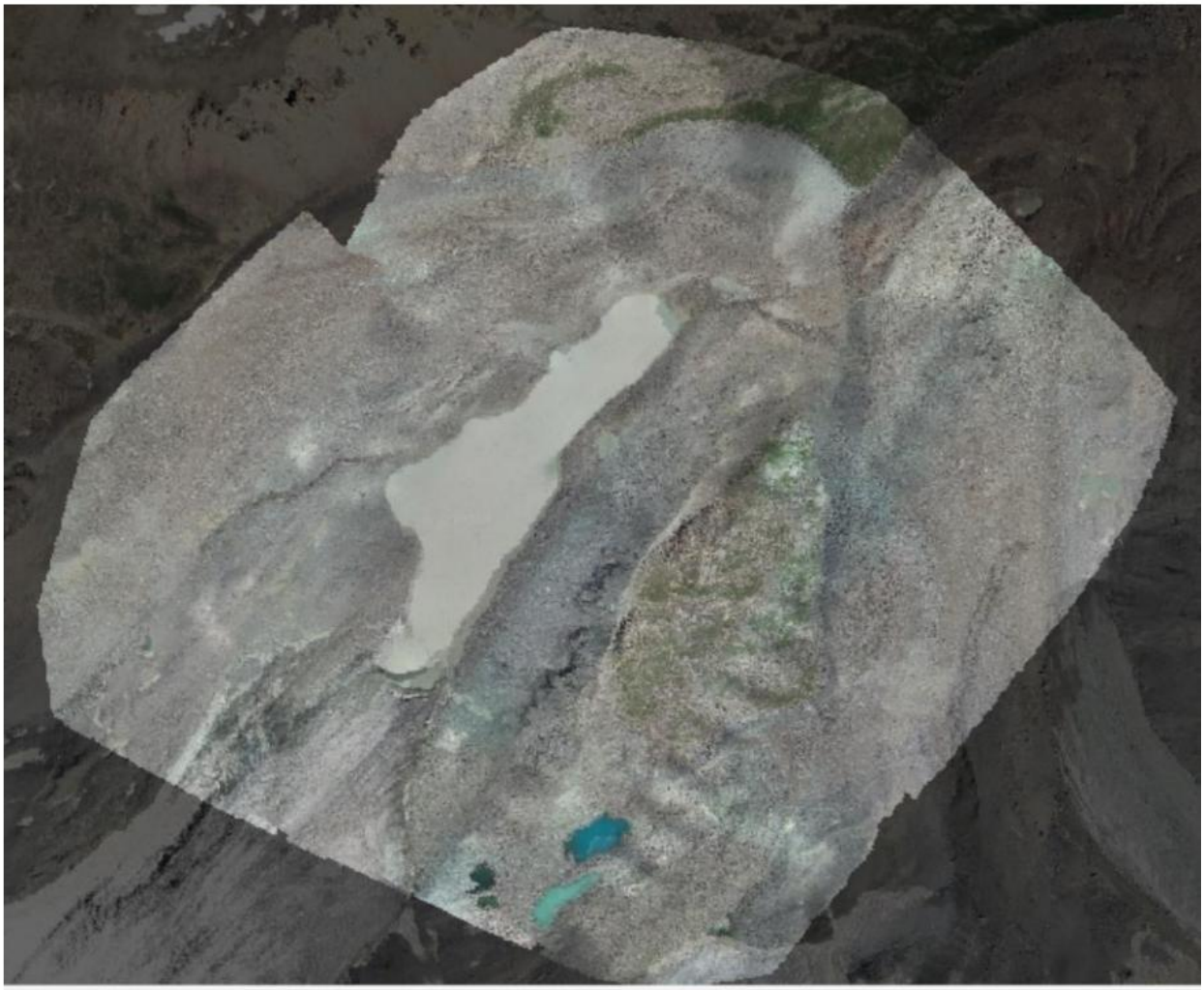
☒ **For information**	☒ Annexes
☒ Action required	☒ Recommendations

Occurrence of incidents caused by combinations of meteorological phenomena creating a hazardous situation, or by other significant weather events

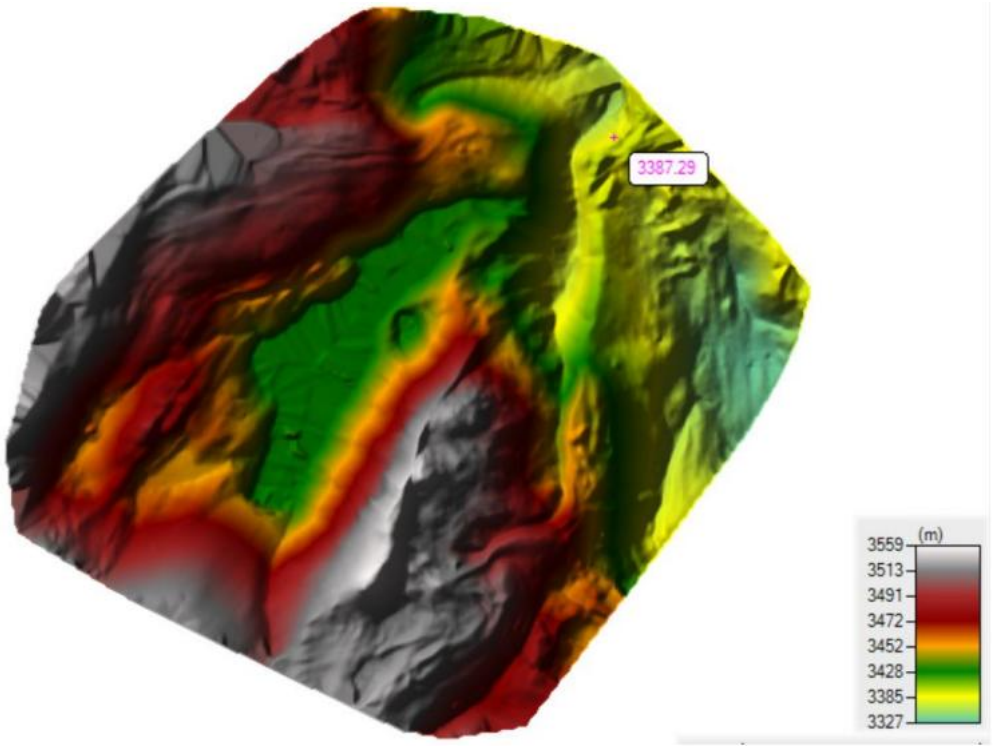
Issue: Potential outburst of Moraine Lake No. 5, Almaty Region
Assessment: Pursuant to requests from the Crisis Management Center of the Ministry of Emergency Situations of the Republic of Kazakhstan and the State Institution *Kazselezashchita*, on 25 July 2024 the Center for Emergency Situations and Disaster Risk Reduction in Almaty conducted an aerial visual survey of Moraine Lakes No. 5 and No. 2 located in the Turgen River basin, utilizing the Center's unmanned aerial vehicles (UAVs).
The survey was carried out for the purpose of assessing the mudflow (debris flow) situation in the area of the Ile Alatau ridge, from the Kaskelen River basin to the Turgen River basin. Within the framework of the assessment, the condition of the glacier was examined, and an orthophotomap as well as a 3D terrain model of Moraine Lake No. 5 were produced. Subsequently, the data were transmitted to the analysts of LLP *Akmolasvyazmontazh*, stationed at the Crisis Management Center of the Ministry of Emergency Situations of the Republic of Kazakhstan, for scenario modeling and calculations aimed at identifying potential risks and threats.

Data:
Aerial surveying of the area over Moraine Lake No. 5 was conducted on 25 July 2024, covering a total area of 1,555 m².



Orthophoto map of the area

The maximum elevation difference is 232 m, ranging from 3,327 m to 3,559 m.

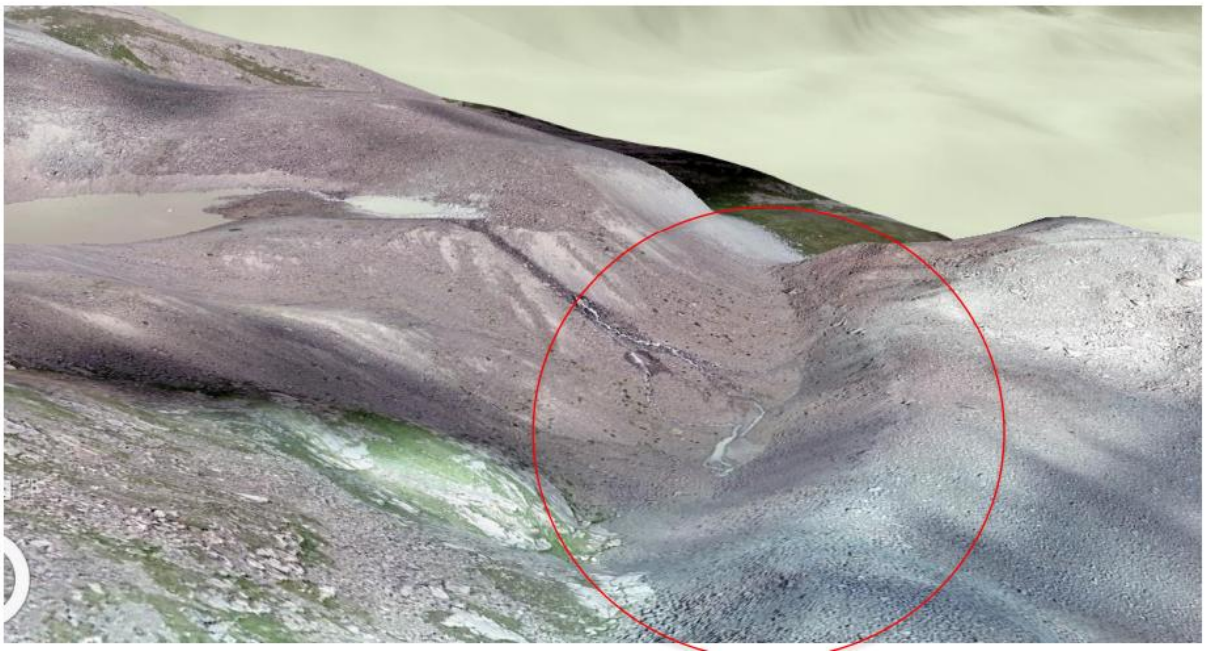


Digital terrain model of the area

General view from north to south

General view from south to north

Enlarged view from southwest to northeast

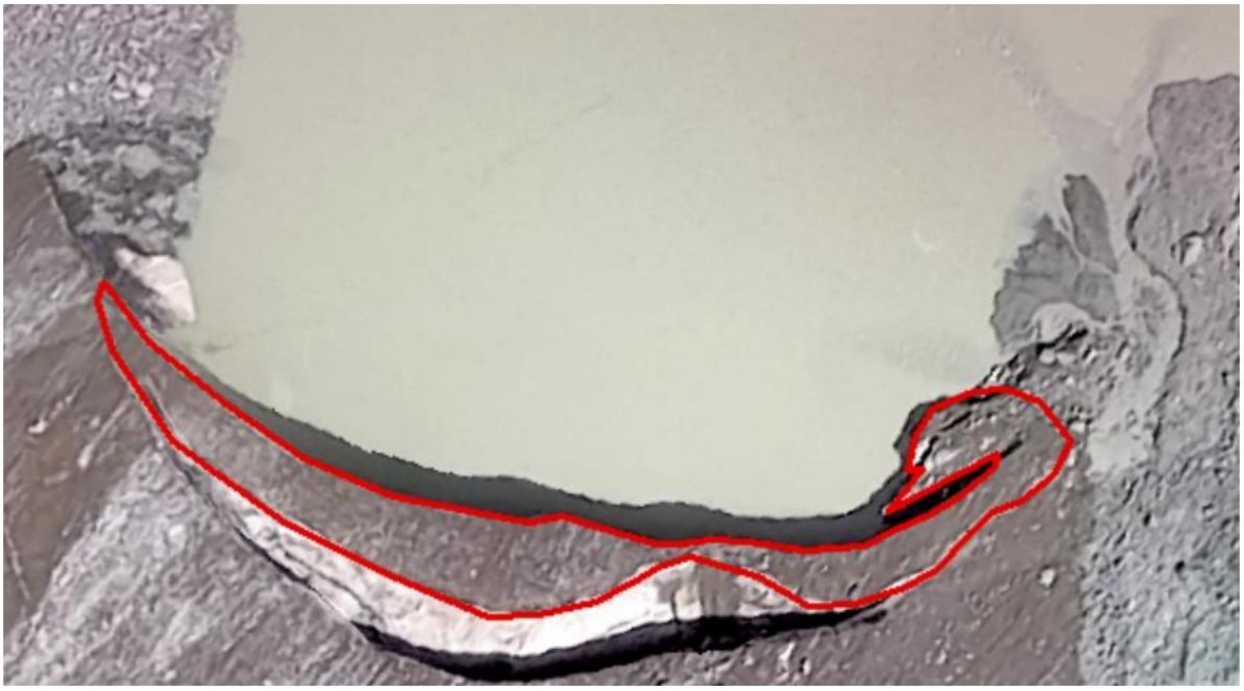


Enlarged view from northeast to southwest

The depression is currently not filled with water.

Analysis:

According to the orthophoto map obtained from the survey, the area of the overhanging section of the glacier at the time of the survey is **680.764 m²**.



Calculation of the area of the overhanging section of the glacier

Height, according to Kazselezashchita data, is **21** m. Accordingly, the volume at the time of the survey is calculated as 680.764 × 21 = **14,296.044 m³**. Considering ice density during melting, the equivalent water volume is **13,152.36 m³**.

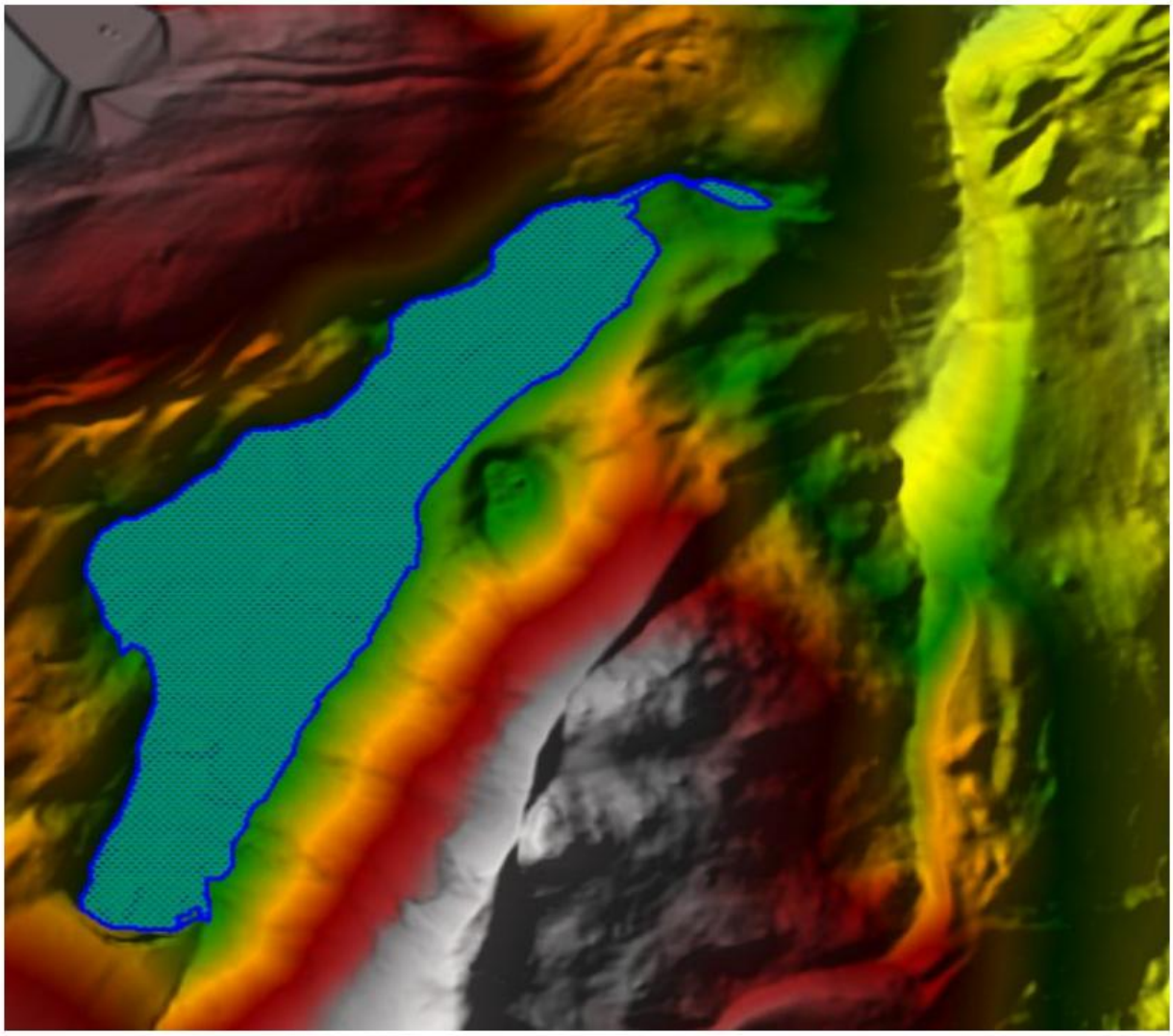
According to the orthophoto map obtained from the survey, the surface area of the lake is **95,194.5 m²**.
The volume, according to Kazselezashchita data, is **988,000 m³**.

Calculation of the current water surface area

Note: Potential inaccuracies may exist, as calculations were performed in the WGS-84 coordinate system.

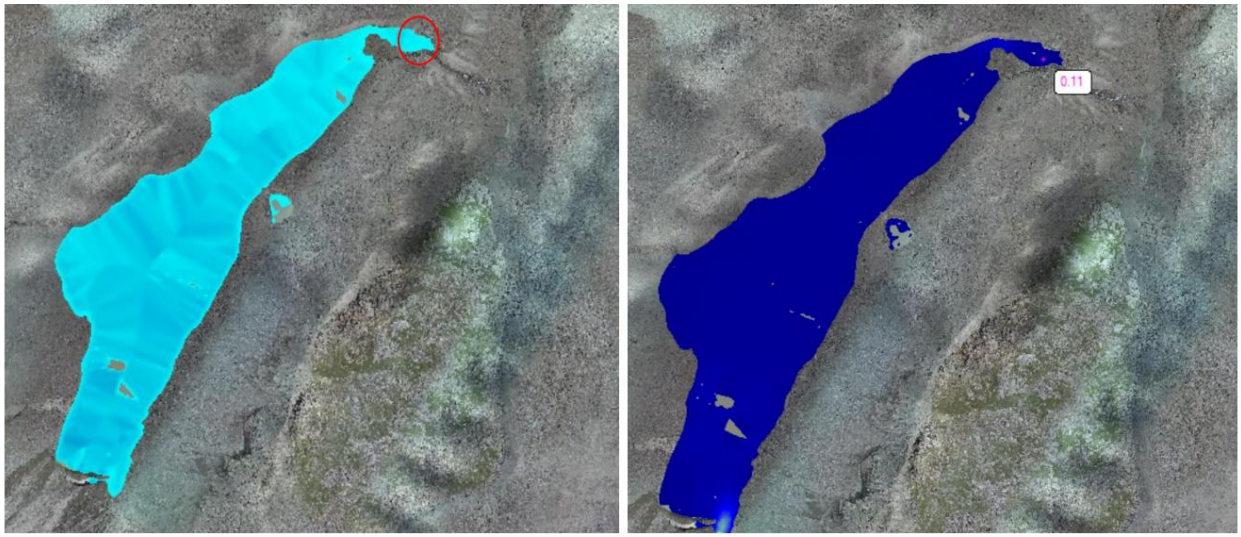
Modeling:
Settings:

- Manning's roughness coefficient applied: 0.2 (for debris flows consisting of mud, stones, etc.; enclosed floodplains, fully forested, taiga-type; basin slopes in natural condition).
- Hydrograph volume: **20,000 m³**.



Current status

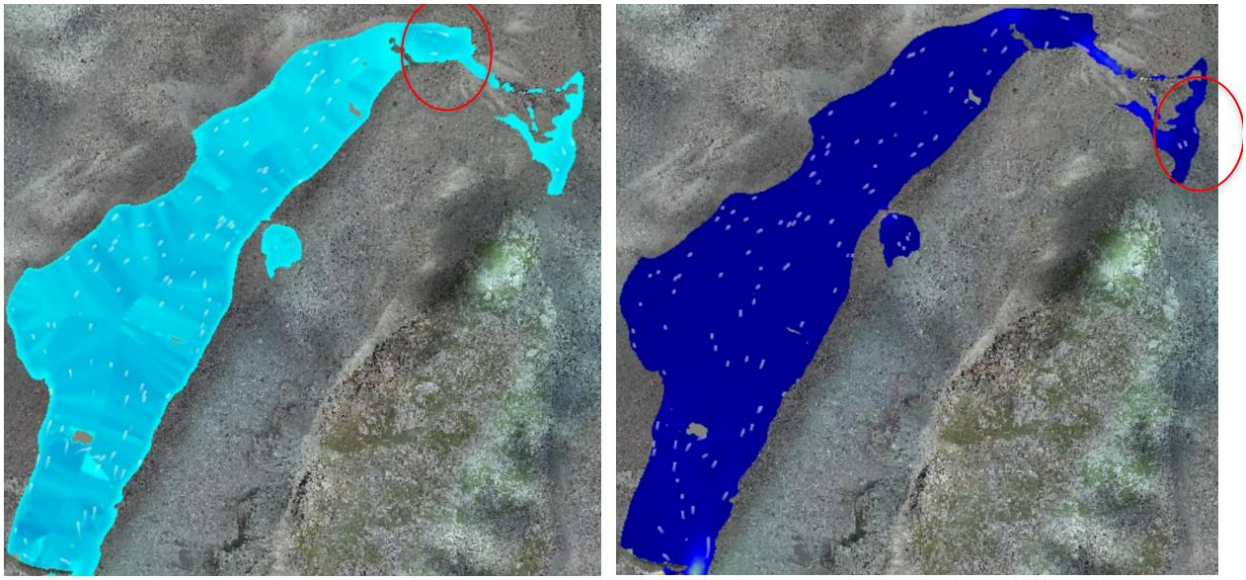
Simulation results:



At the current moment, the flow velocity is 0.11 m/s with a depth of 1 m

Sequence of lake filling in the event of volume increase:

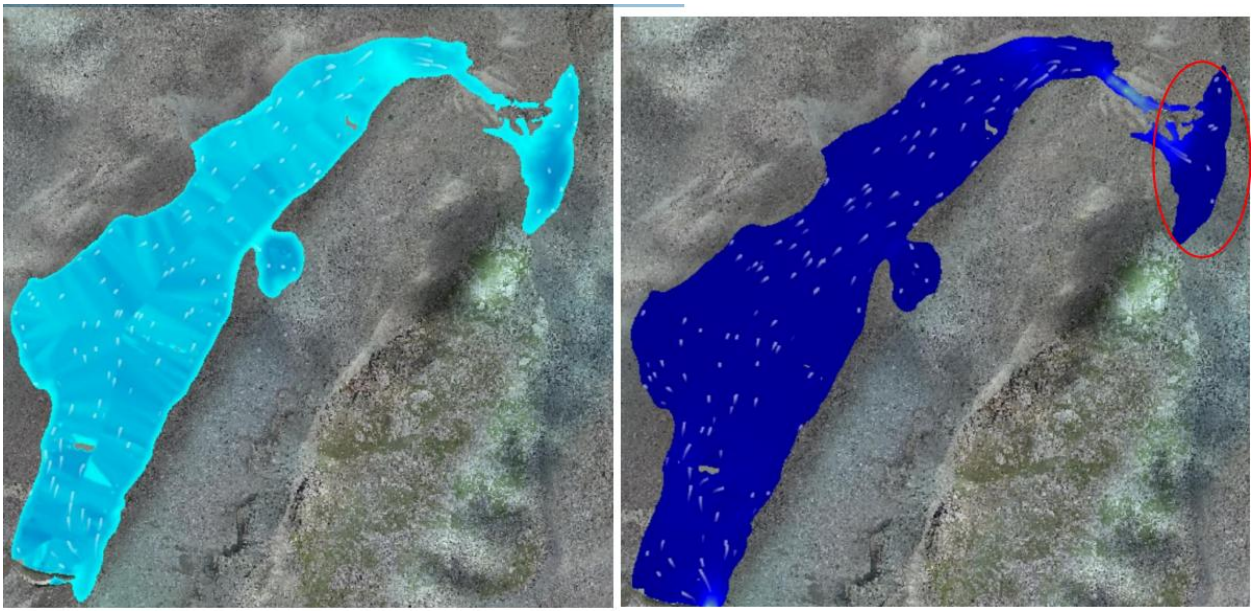
1) *The basin will fill completely, with part of the water overflowing into the depression.*



After 10 minutes:

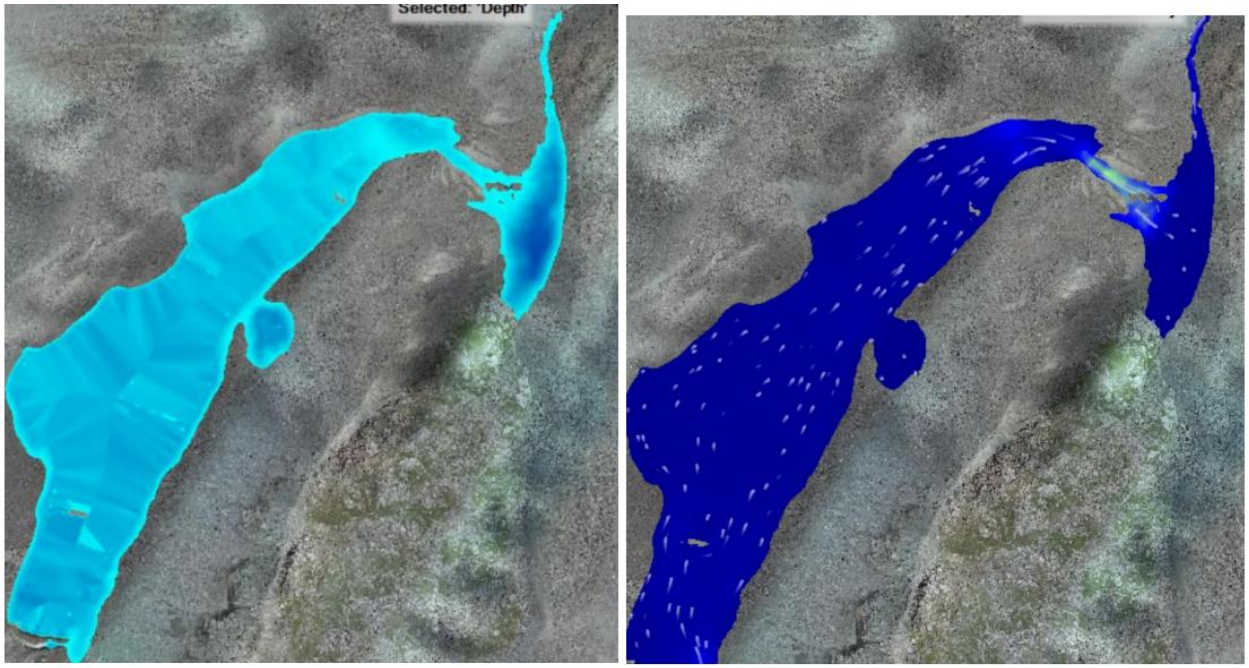
Flow velocity in the depression: 0.18 m/s with a head difference of 25 m.
Flow velocity in the original pond: 0.4 m/s with a depth of 4 m.
Depression area: 4,971.28 m², average depth: 1.5 m, volume: 7,456.92 m³.

2) *The depression and the lake will continue to fill.*



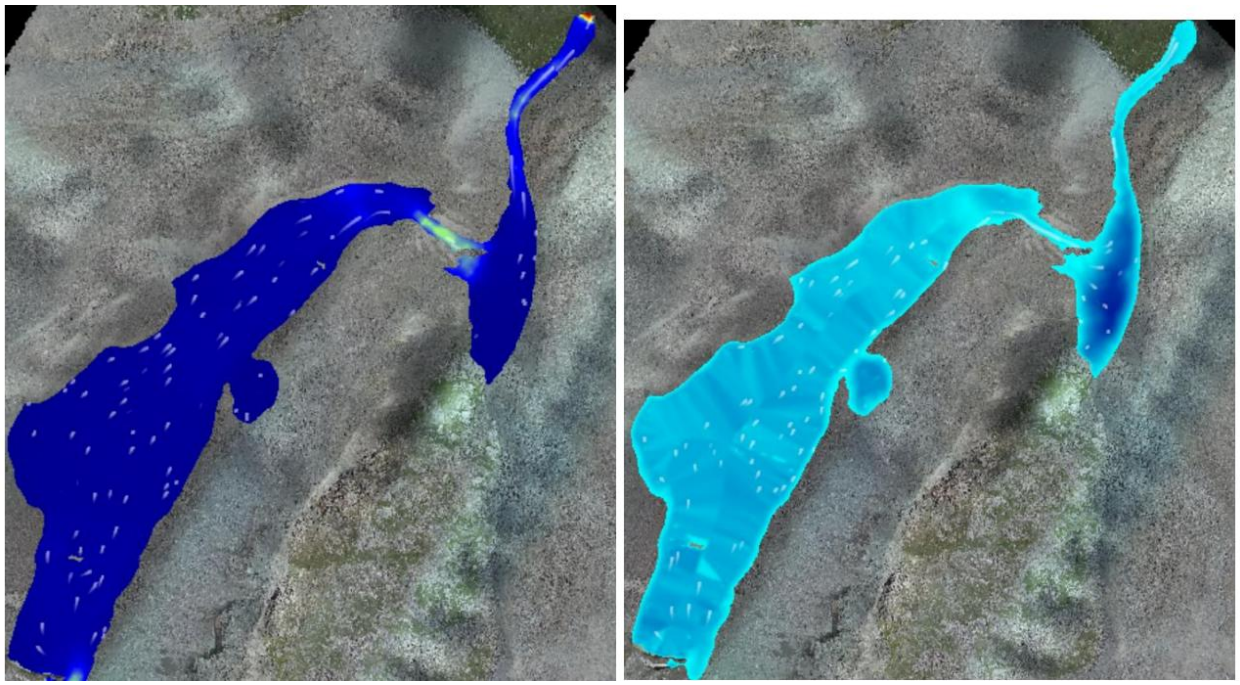
After 20 minutes:
Flow velocity: 0.1 m/s with a head difference of 29 m; average depth in the depression: 2 m.
Total water surface area: 129,471.85 m².
Depression area: 10,025.25 m², average depth: 2 m, volume: 20,050.5 m³.
This volume of the depression, excluding the lake, exceeds the volume of the overhanging glacier section*; therefore, the glacier does not pose a threat.*

3) *The depression will fill, and part of the water will flow downstream toward the river channel.*



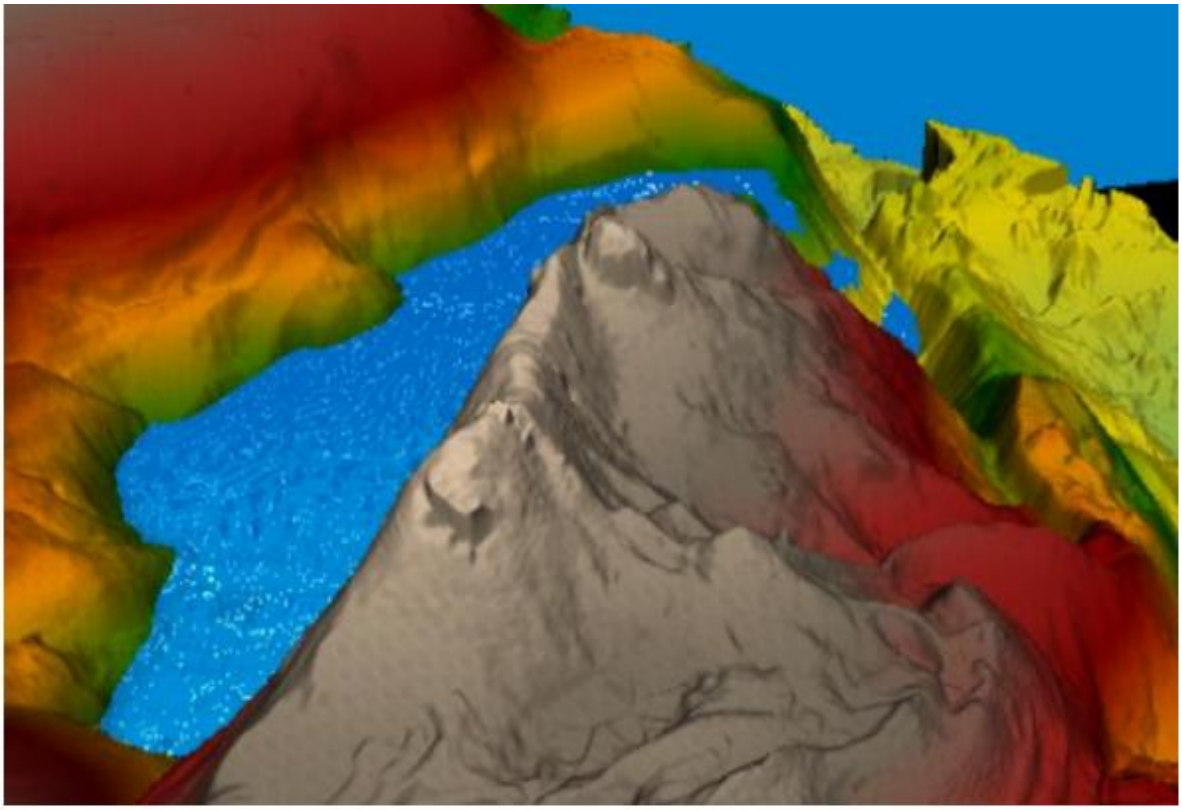
After 30 minutes:
Inflow velocity into the depression: 2 m/s.

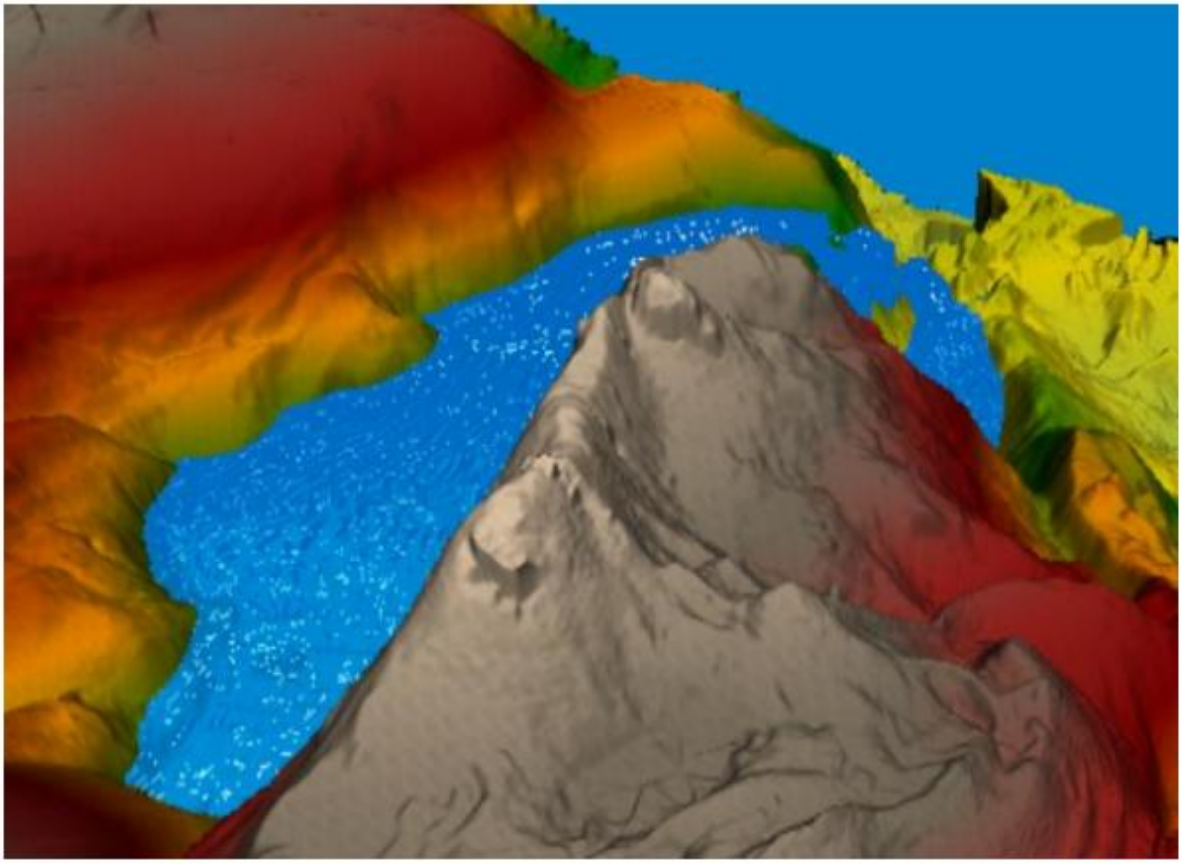
4) *The water flow will proceed downstream into the river channel.*



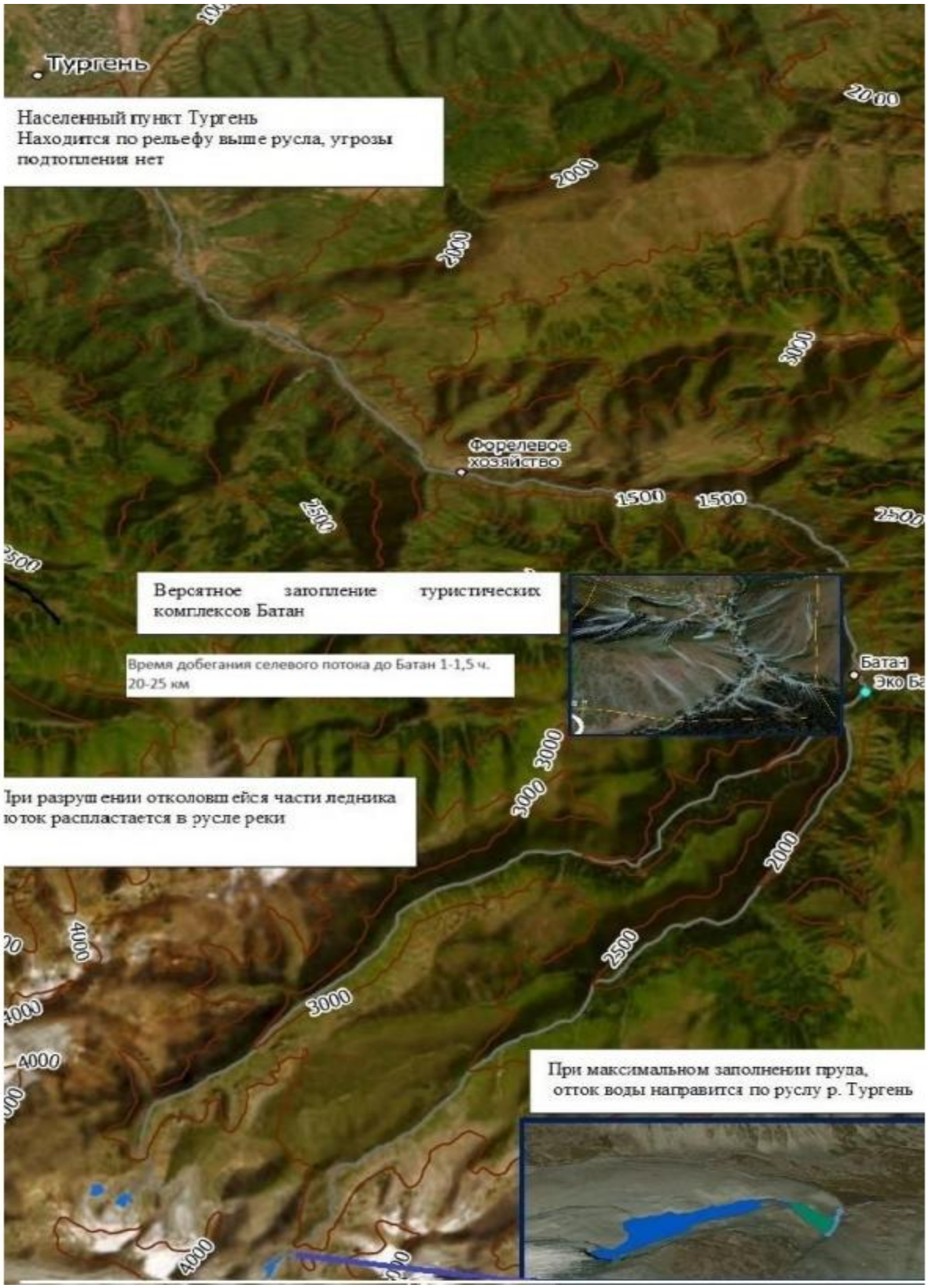
After 40 minutes:
Flow velocity in the main area decreases to 1.4 m/s with a depth of 1 m.
Inflow velocity from the depression reaches 4 m/s.
Total water surface area: 146,455.7 m².

3D overview





Probable direction of water flow from the lake along the river channels



Conclusion:
Analysis of the current hydrological conditions in the area indicates that the risk of debris flow formation is minimal. The riverbed depth and natural barrier structures of the terrain help contain the flow, thereby reducing its kinetic energy and, consequently, the potential threat to the settlement of Turgen. Thus, the likely impact of a debris flow does not pose a significant hazard to this area.

Special attention should be given to the Boran tourist complex, which is located within the potential influence zone of a debris flow. However, based on current assessments, the likelihood of significant impact on this facility is presently low.

It is recommended to continue monitoring hydrological conditions and terrain status to ensure timely detection of any changes that may affect the risk level.