ATLAS
OF GLACIAL LAKES OF TAJIKISTAN

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The Atlas of Glacial Lakes of Tajikistan is presented as a valuable contribution to the High-Level International Conference dedicated to the ***"International Year of Glaciers' Preservation,"*** highlighting the importance of studying and protecting these unique water resources.

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GLOFCA
GLACIER LAKE OUTBURST FLOODS IN CENTRAL ASIA

Contents

Introduction

The Republic of Tajikistan is endowed with abundant natural resources, including clean drinking water and substantial glacier reserves, which give it a unique status in the world. Tajikistan provides more than 60% of Central Asia's water resources.

Approximately 8% of the country's total territory is covered by glaciers, which store an amount of freshwater roughly 13 times greater than Tajikistan's average annual river runoff. The main glaciers of the country are located in the highest mountain ranges, such as the Academy of Sciences, Darvoz, Peter the First, Vanj, Yazghulom, Zarafshon, and other regions. These areas offer favorable conditions for glacier formation, due to their high altitudes and sufficient precipitation. The glacierized area within the basins of the aforementioned rivers exceeds 5,000 km² and includes the largest glacier in Eurasia — the Vanjyakh Glacier (Fedchenko Glacier).

Tajikistan's climate, shaped by its complex geography, is characterized by high variability and sharp contrasts: from hot and dry in the lowlands to harsh and cold in the high-altitude regions of the Pamirs and the Hissor-Alay. The average annual air temperature, especially in mountainous areas, has been gradually increasing, leading to accelerated glacier melting. At the same time, changes in precipitation patterns, a decline in snowfall, and an increase in extreme weather events have intensified the climatic impact on the country's glacial systems.

Under the conditions of a changing climate, glaciers pose particular hazards, including the formation and outburst of glacial lakes (GLOFs), as well as ice avalanches, which can result in significant economic losses and even human casualties in downstream areas.

Relevance of the Problem

During the summer months, increased melting of snow and glaciers is expected, leading to the formation of proglacial lakes in high mountain regions. Some of these lakes, if their natural dams are breached, can trigger powerful mudflows. Other glacial lakes, whose waters seep through moraine deposits or gradually evaporate, pose a lower risk. However, the increasing volume of meltwater within and beneath glaciers raises the likelihood of glacier movement, collapse, and instability.

According to preliminary estimates, the number of glacial lakes in Tajikistan ranges from approximately 500 to 600. This number is believed to vary from year to year (A. Kayumov, 2008–2021).

According to international research, between 1990 and 2019, the global volume, area, and number of glacial lakes increased by 48%, 51%, and 53%, respectively. In Central Asia, lake volume increased by approximately 20% (Shugar et al., 2020). This trend is expected to continue under climate warming conditions, associated with glacier retreat and melting (Shugar et al., 2020).

While glacial lakes are mostly located near glaciers, the southern part of the Pamirs is a primary region for the formation of erosion-type lakes. The number of glacial lakes significantly increased between 1968 and 2009, and this trend is gradually shifting toward higher-altitude catchments.

In the Gorno-Badakhshan Autonomous Region (GBAO), within the basin of the Panj River and its major tributaries (Ghund, Shohdara, Bartang), there are more than 300 lakes. Among the largest lakes in the region are Qarokul, Rangkul, Zorkul, Sarez, and Yashilkul (Pirmamadov et al., 2020).

Monitoring and Research of Glacial Lakes

During the Soviet era, regular monitoring and mapping of lakes were carried out across the territory of Tajikistan, resulting in the compilation of catalogs and registers of lakes. However, following the dissolution of the USSR, scientific research and systematic monitoring in Tajikistan were significantly reduced due to financial constraints. Although the Agency for Hydrometeorology continued limited monitoring of glacial lake conditions, most existing descriptions and publications date back to 1990, and no new materials had been published since then.

Information about glacial lakes remains quite limited, as the data collected by the Agency for Hydrometeorology has primarily been intended for internal use by the government and relevant ministries and agencies. The only publicly available document is the report **"Hazard Assessment for Lake Outburst Floods and Selected Landslides in the Pamir-Alai Region"** (IAG –BOKU, Vienna, May 2010). This report was prepared between April 2009 and May 2010 at the University of Natural Resources and Life Sciences (BOKU) in Vienna (Austria), in cooperation with the Agency for Hydrometeorology of Tajikistan and the organization FOCUS – Humanitarian Assistance in Tajikistan. The project was funded by the Swiss Agency for Development and Cooperation (SDC) and the UK Department for International Development (DFID).

Following the adoption of the **State Program for the Study and Protection of Glaciers of Tajikistan for 2010–2030**, the Agency for Hydrometeorology, as the responsible institution, has intensified research and monitoring of glacial lakes. This includes annual fieldwork, aerial visual surveys, and remote monitoring.

Methodology

- This Atlas is the first publication to present the spatial distribution of glacial lakes larger than 0.01 km^2 across the territory of Tajikistan, based on high-resolution satellite data.
- The Atlas provides detailed information on all glacial lakes within every river basin of Tajikistan. In addition, it includes data on glacial lakes located in border areas.
- The Atlas also contains a complete list of all glacial lakes, using a specialized classification system that includes geometric, geographic, and topographic characteristics.
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Glacial Lake Outburst Floods (GLOFs)

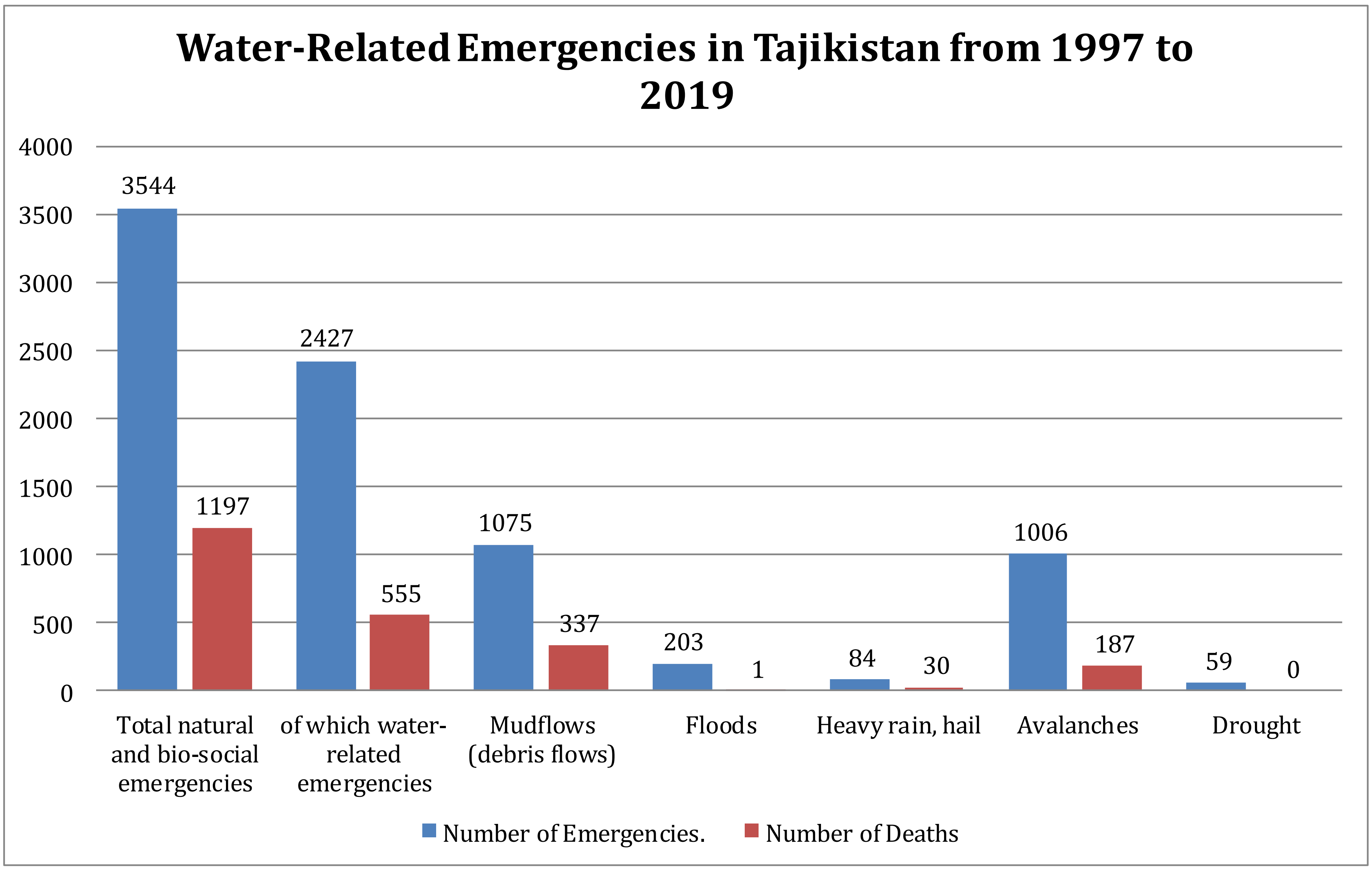
Global changes — including climate change, rapid population growth, and accelerated urbanization — are increasing the risks of water-related natural disasters. Natural catastrophes resulting from climate change cause significant damage every year and negatively affect the economies of many countries.

Most natural disasters occurring in the Republic of Tajikistan are associated with intensified hydrometeorological processes such as mudflows, avalanches, and floods.

Tajikistan's abundant water resources are both a national asset and one of the primary sources of natural hazards. Each year, the country experiences water-related disasters, including floods and mudflows. These emergencies are mainly triggered by heavy precipitation, spring snowmelt, and abnormal glacier melting during the summer months.

Mudflows caused by the outburst of glacial or moraine-dammed lakes pose a serious threat. For example, in 2002, a glacial lake outburst in the Roshtqala District of Badakhshan claimed the lives of 25 people. Glacial and moraine-dammed lakes generally form as a result of intense glacier melting and movement, which can block river channels.

Region caused substantial damage. In July 2017, mudflows blocked the Panj River, resulting in flooding of several households in the villages of Shirgovad and Khostav in the Darvoz District, and the temporary closure of the Dushanbe–Khorugh highway.



Committee of Emergency Situations and Civil Defense under the Government of the Republic of Tajikistan

Glacial Mudflow in the Village of Barsem, GBAO, in 2015

As a result of a glacial mudflow, the villages of Shirgovad and Khostav in Darvoz District, GBAO, were flooded in 2017

Pilot Region for the Study of Glacial Lake Outburst Floods

The GLOFCA project — "Reducing the Vulnerability of Populations in Central Asia to Glacial Lake Outburst Floods in a Changing Climate" — is a regional initiative launched in 2021 in Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan with the support of the Adaptation Fund and under the leadership of UNESCO. The main objective of the project is to reduce risks associated with glacial lake outburst floods (GLOFS) by establishing early warning systems, strengthening community resilience, and enhancing institutional capacity for monitoring and emergency response.

In Tajikistan, the project supports the development of a GLOF risk reduction roadmap, including the implementation of early warning systems and the organization of training courses for specialists and local communities.

As part of the GLOFCA project in the Republic of Tajikistan, the Surkhob Jamoat in the Surkhob River Basin of the Lakhsh District was selected as a pilot area, as natural disasters related to glacial lake outbursts are recorded there annually.

The primary research focus in this area is the Said Nafisi Glacier (Baralmos), classified morphologically as an unstable, actively moving glacier. Over the past five years, the glacier has exhibited irregular movement, resulting in the formation and periodic outburst of lakes of varying volumes on its surface.

Mudflow events in this region have repeatedly destroyed sections of the international highway, damaged power lines, and blocked the Surkhob River.

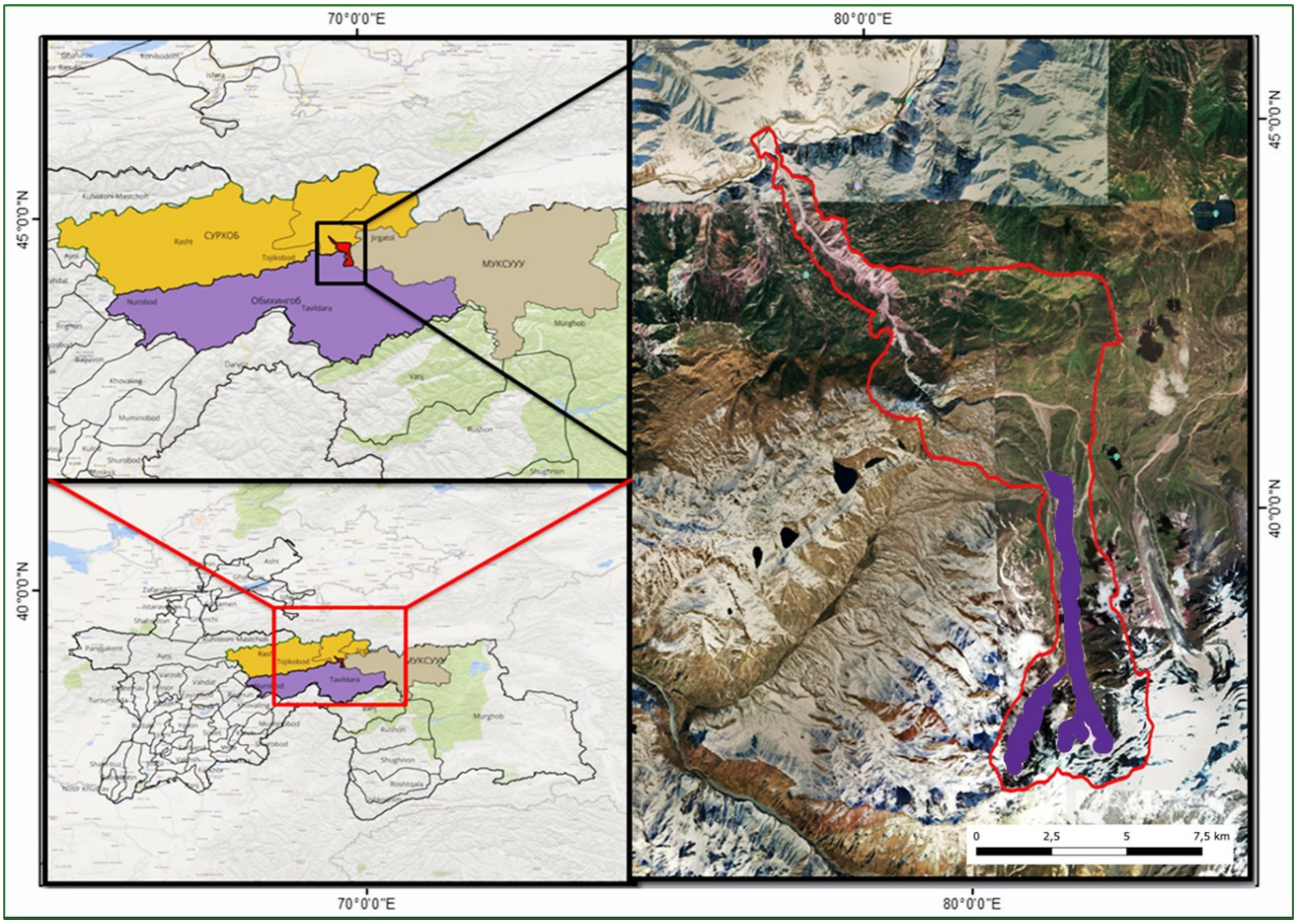
Research results have shown that in the foothills of the Peter the First Range in the Lakhsh District, the frequency and magnitude of mudflow events have increased over the past decades. The northern slopes of this range, particularly within the Lakhsh area, are composed of unstable clay-sand formations, including marbleized limestones and other easily erodible rock types. Due to their low mechanical strength, these rocks disintegrate rapidly under the influence of water, contributing to intense erosion and the formation of debris flows.

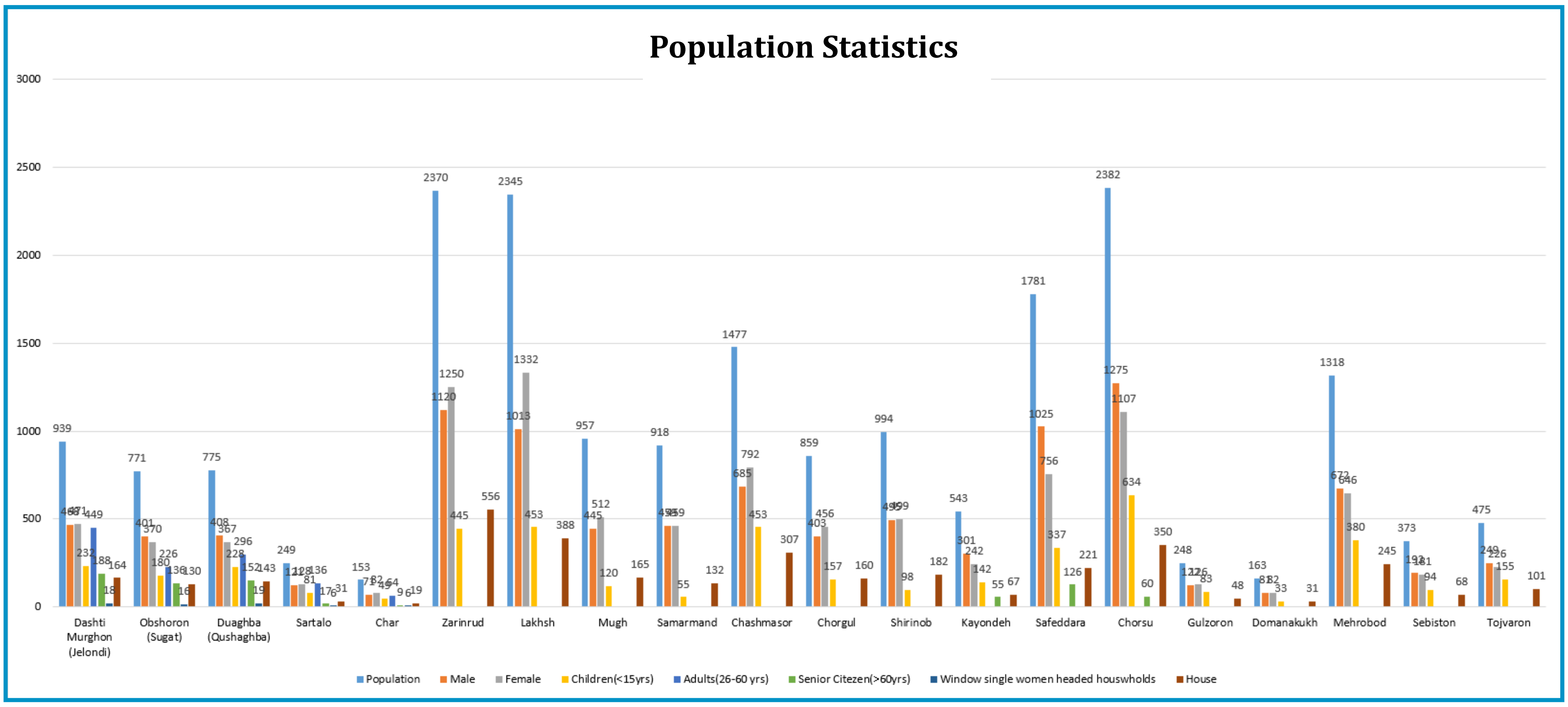
Furthermore, in the area of the Said Nafisi (Baralmos) Glacier, the unstable condition of the glacier and repeated glacial lake outbursts regularly generate debris flows that travel more than 20 kilometers, blocking the Surkhob River. These outbursts cause powerful mudflows that extend dozens of kilometers downstream.

Glacial Lake on the Said Nafisi Glacier, 2023

Destruction of the Dushanbe–Lakhsh–Osh Highway due to a mudflow event, 2023

Map of the Pilot Area Location





Consultative assessments indicated that, as a result of natural disasters related to glacial lakes, more than 3,508 houses and over 20,090 people could be affected.

Glacial Lakes in the Territory of the Republic of Tajikistan

In the context of climate change and the rapid retreat of glaciers, the monitoring of glacial lakes is a critical component in ensuring public safety, protecting infrastructure, and managing water resources. This issue is particularly relevant for Tajikistan, where mountainous regions and glaciers play a key role in the formation of water resources.

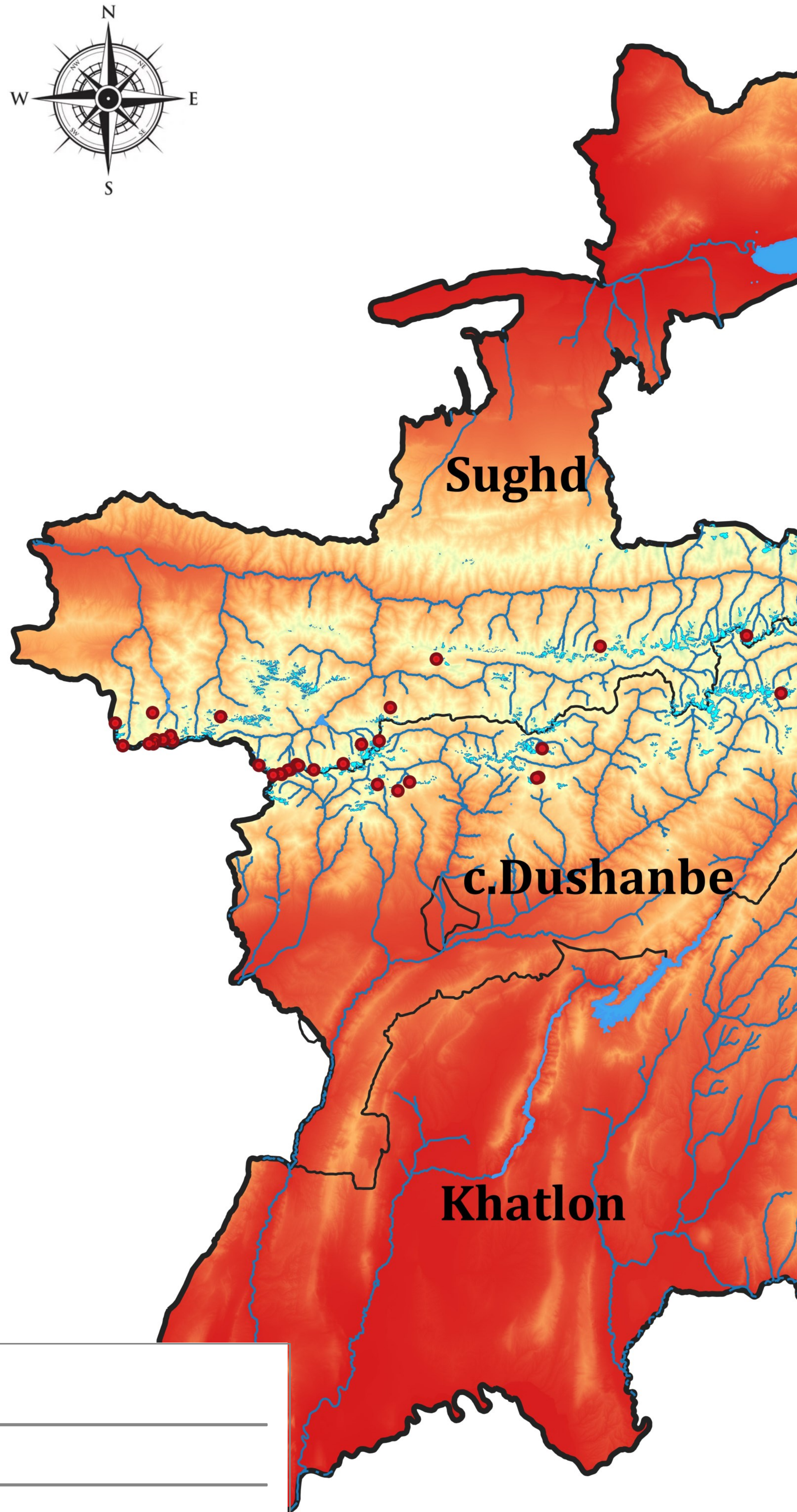
Modern techniques, developed using programming languages (Anaconda, Python modules) and satellite data, provide accurate and efficient means for glacial lake monitoring. These technologies enable timely observations and in-depth analysis, including in remote and hard-to-access mountainous areas.

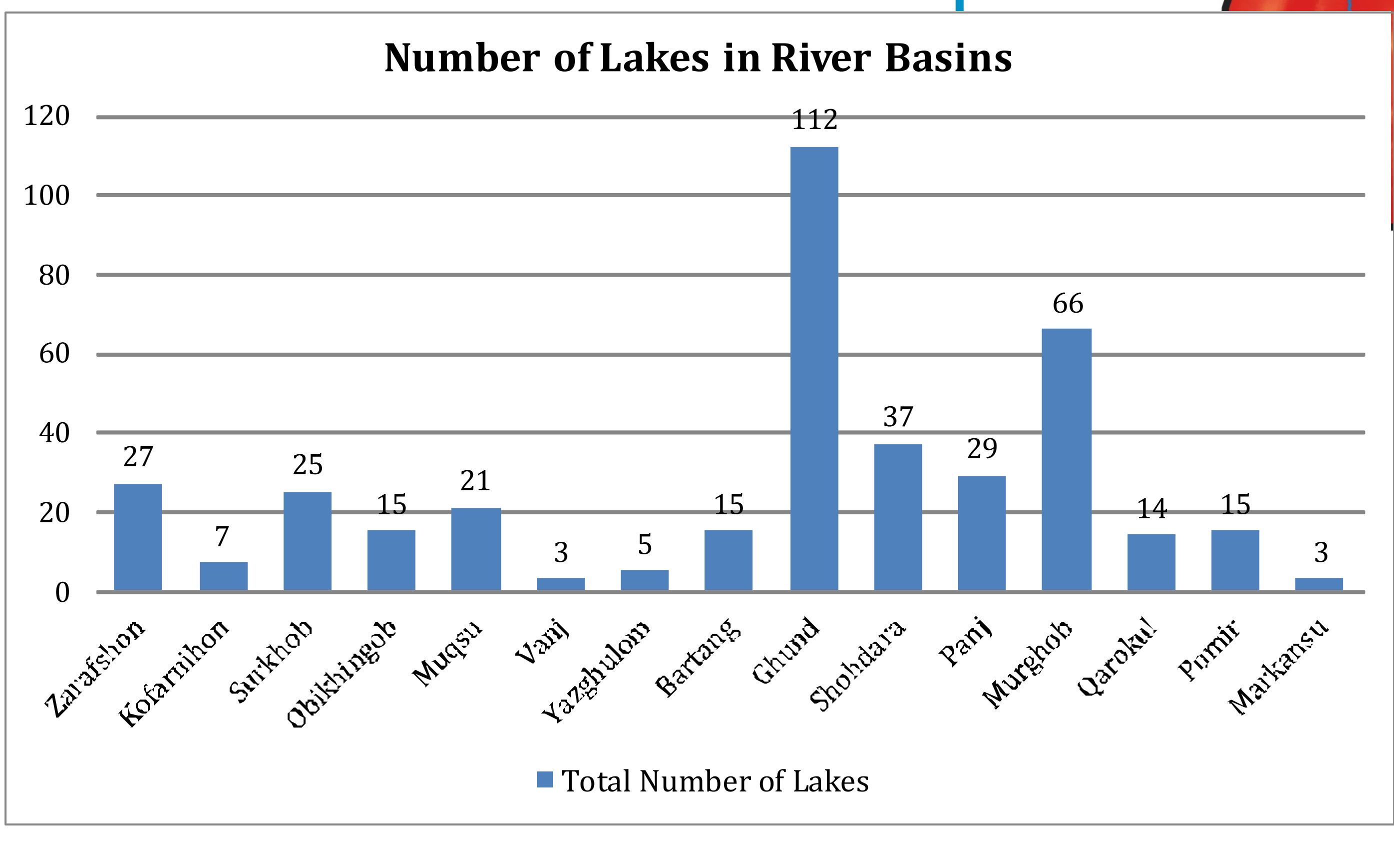
One of the key advantages, in particular, is that with the use of satellite data and modern software tools, mountainous regions — even hard-to-reach areas — can be easily monitored.

One of the major advantages of these methods is that they allow comprehensive monitoring even in inaccessible locations. High-precision identification of glacial lakes using the NDWI (Normalized Difference Water Index) and multispectral satellite data makes it possible to distinguish lakes from snow, ice, moraines, and rock surfaces. Automated algorithms reduce the risk of human error and accurately reflect changes in water bodies.

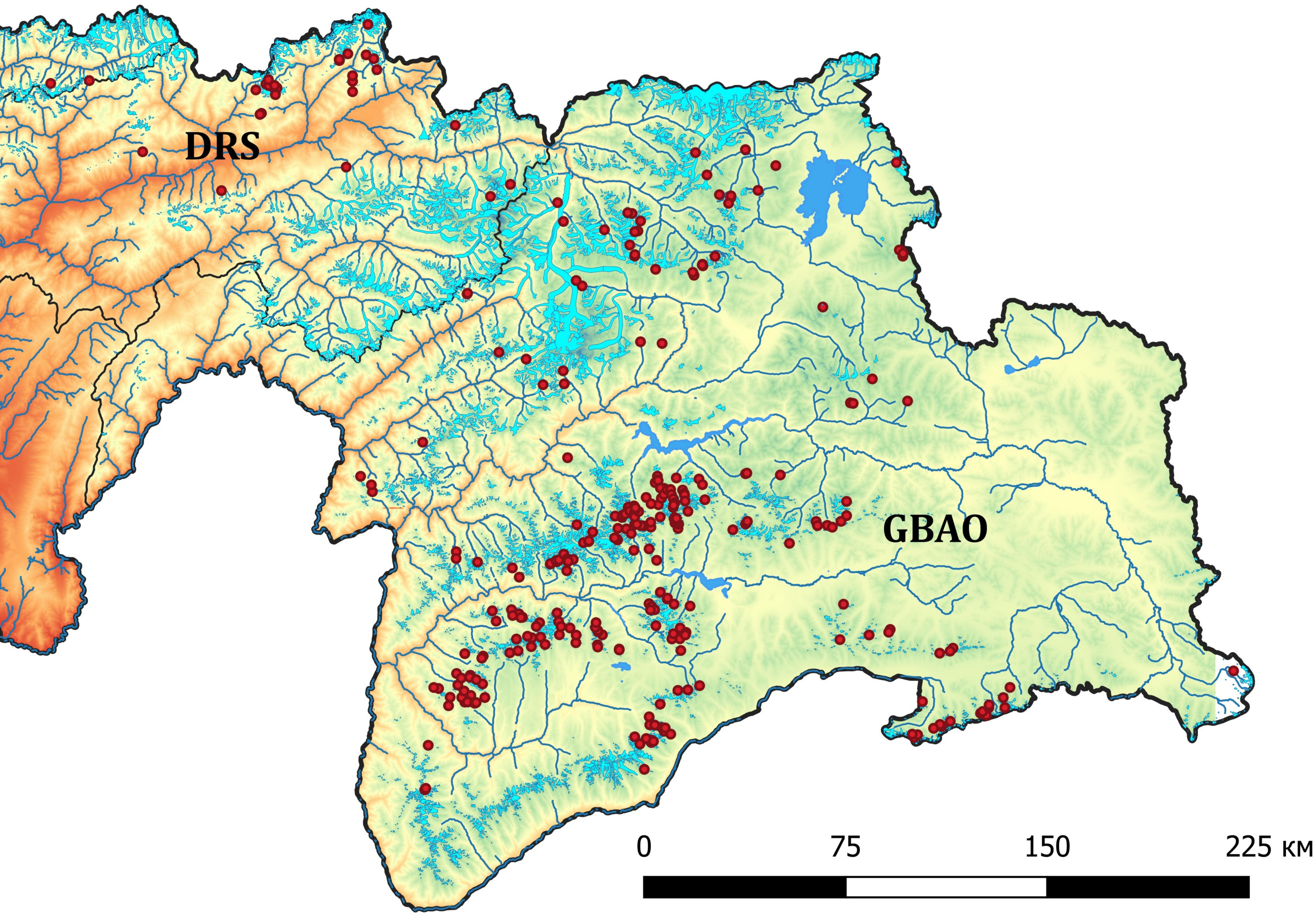
Modern monitoring enables dynamic tracking of changes in the state of glacial lakes. Timely observation and continuous data analysis help detect variations in lake area and glacier melt rates, which is essential for developing hydrological models and assessing natural hazards.

As part of the GLOFCA project, using programming tools, satellite imagery (Sentinel-2021), and GIS technologies, a total of 1,436 glacial lakes were identified across Tajikistan. Among these, 397 lakes have a surface area greater than 0.01 km^2.





Map of the location of glacial lakes in the Republic of Tajikistan



Zarafshon River Basin

The Zarafshon River Basin is located between the Turkestan, Zarafshon, and Gissar mountain ranges, which converge in the east to form the Alay Range. The upper part of the basin is the center of Zarafshon glaciation, where the largest glacier in the basin, the Zarafshon Glacier, is situated. The highest point of the region reaches 5,510 meters above sea level.

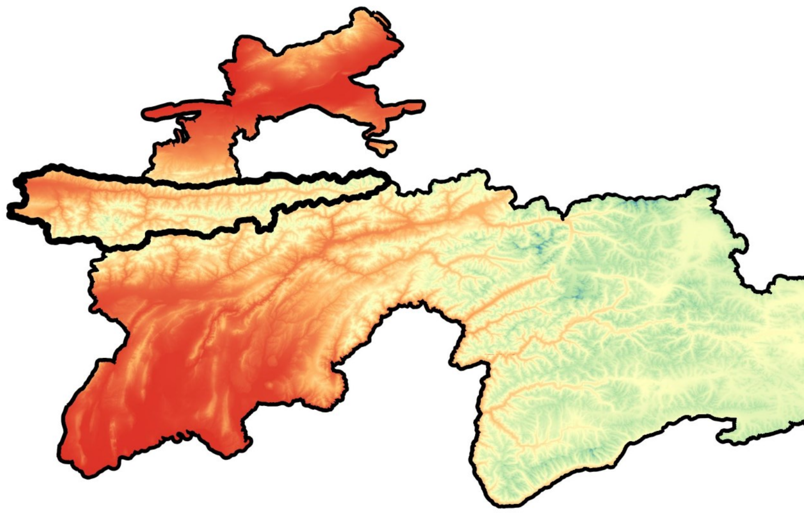
The climate of the Zarafshon Basin is influenced by the Siberian anticyclone, as well as cyclones from Iran and Afghanistan. Summer is dominated by anticyclonic weather with sunny and dry days, while winter is characterized by cloud cover and significant snowfall. The average annual temperature ranges from 12.3°C in the foothills (e.g., in Panjakent) to −1.8°C at the Anzob Pass. The warm period in the foothills lasts about 246 days, while the cold period lasts approximately 119 days. In the high-altitude areas, winter lasts longer and summer is shorter.

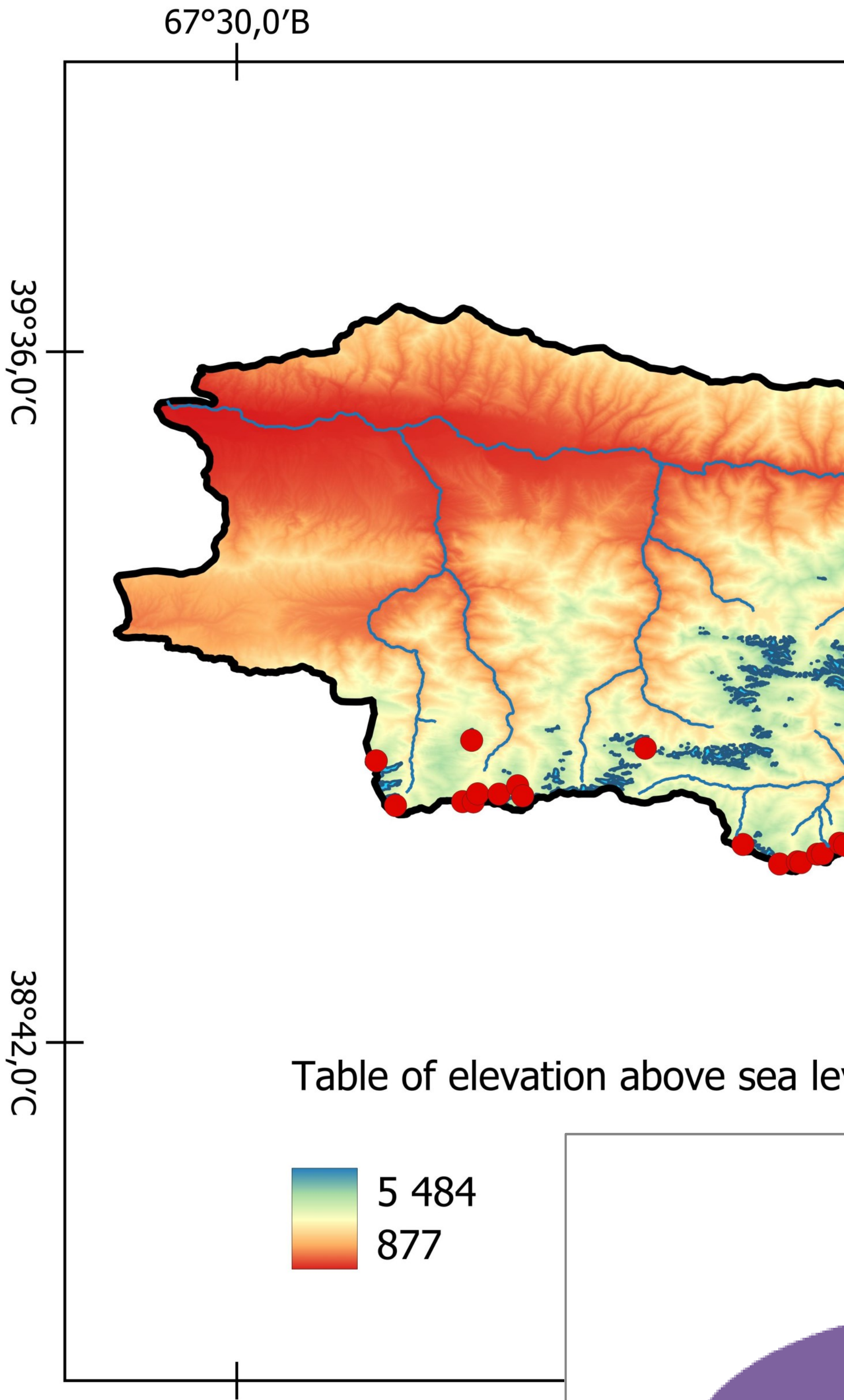
Annual precipitation is unevenly distributed. In the upper part of the basin, in the areas of the Yagnob and Mastcha rivers, more precipitation falls—ranging from 350 to 400 mm per year. Precipitation increases up to 3,500 meters in altitude, reaching a maximum at 4,100 meters, and then decreases. The southern slopes of the mountain ranges receive less precipitation due to their geographic position. The glaciation zone is insufficiently covered by meteorological observations, so climate data is mostly based on expedition results.

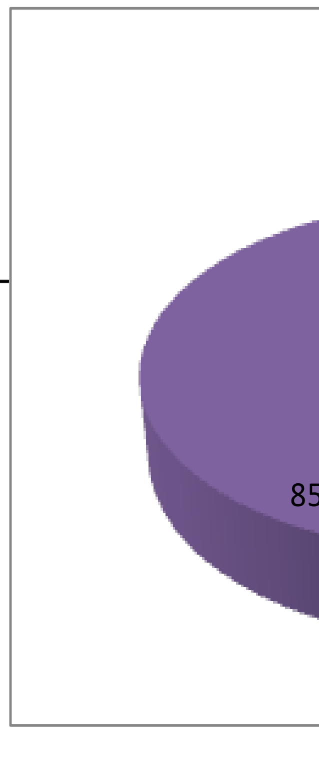
The glaciers of the Zarafshon Basin play a key role in the formation of river runoff. Their melting ensures a stable water balance, especially in the summer when snow and ice reserves are actively used. The largest glaciers located in the Mastcha and Zarafshon mountain ranges contribute most to the water supply of the Zarafshon River.

In recent decades, due to global warming, the area of glaciers in the basin has decreased. This leads to a temporary increase in water runoff, but in the long term, it may cause water shortages in the region. While high-altitude glaciers remain relatively stable, more significant reductions are observed in glaciers located in the lower parts of the mountain ranges, where glacial lakes of various sizes have formed.

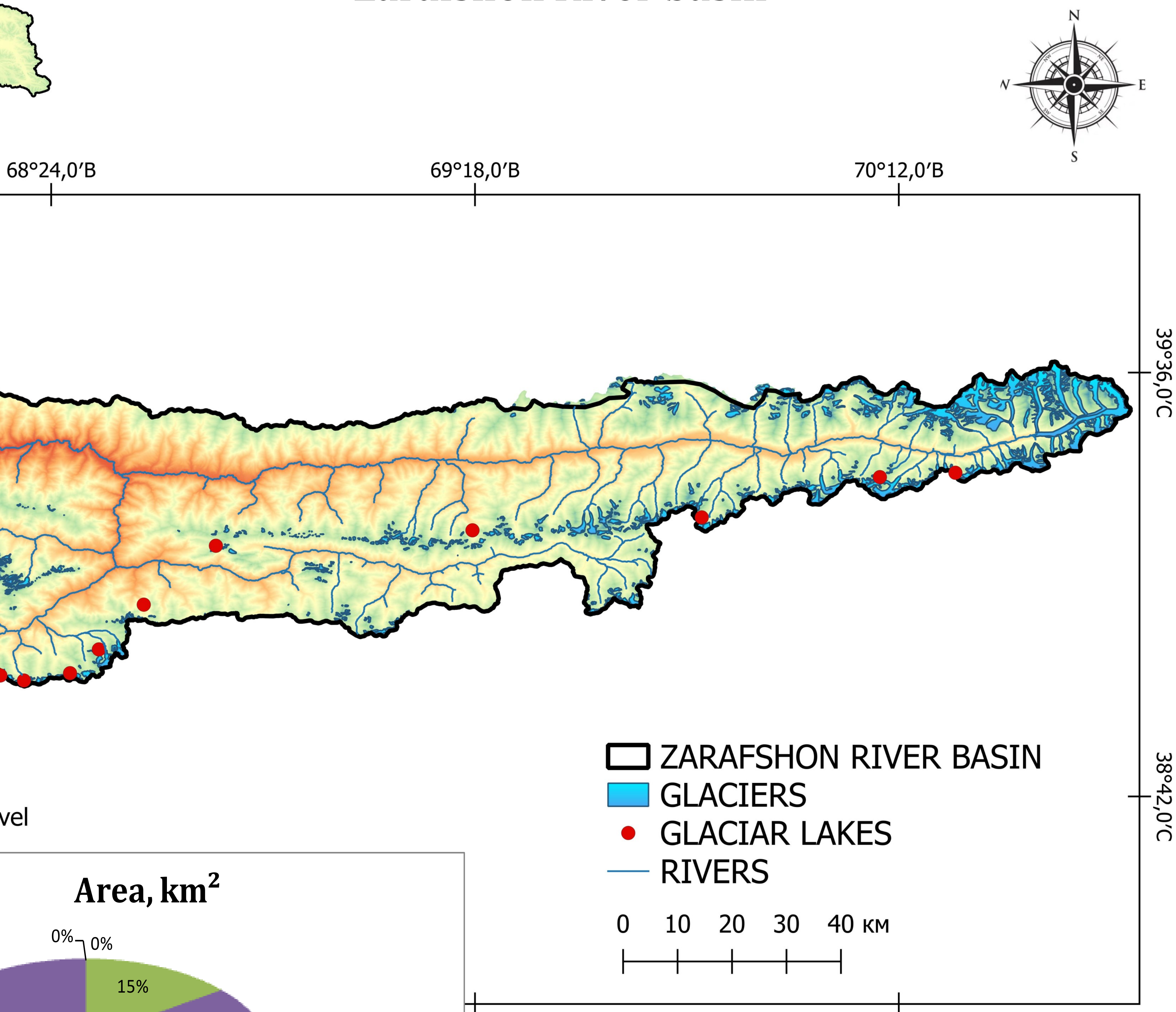
Satellite imagery has shown that there are 27 glacial lakes in the Zarafshon River Basin, 85% of which fall into the category of very small lakes (less than 0.05 km^2 in area).

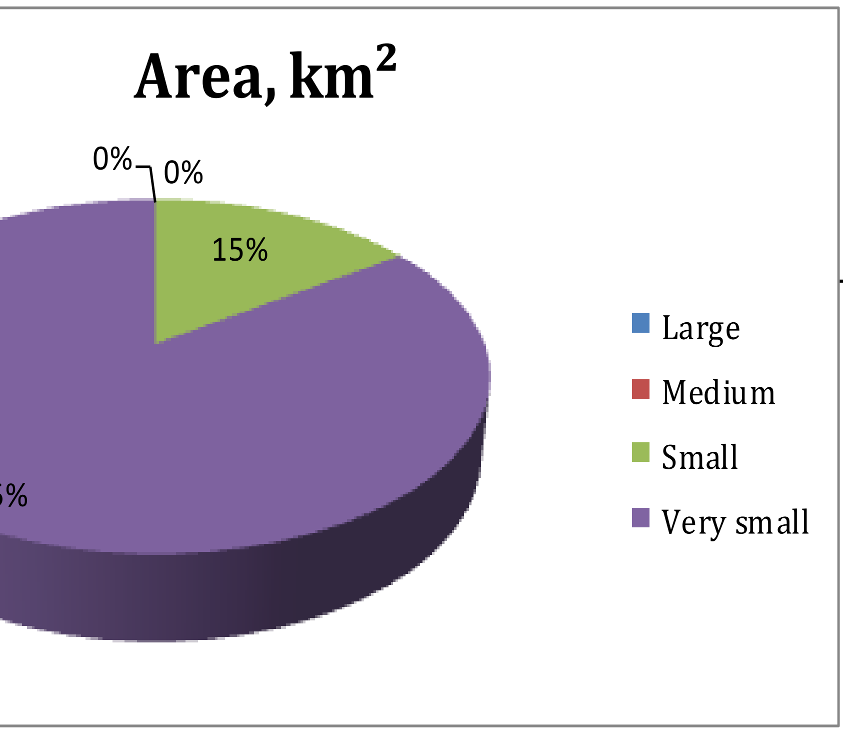


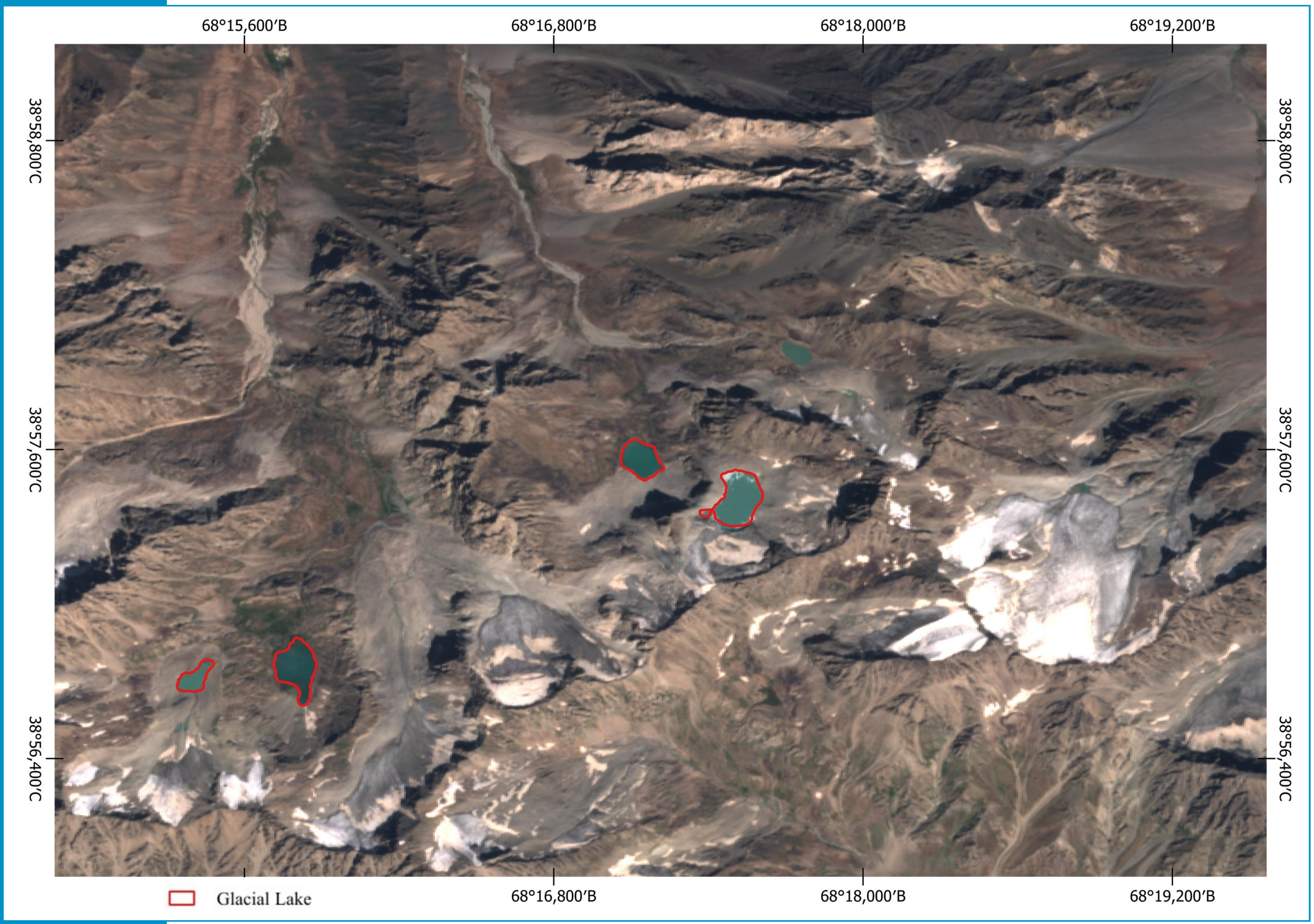




Map of the location of glacial lakes in the Zarafshon River basin







Identification of Glacial Lakes in the upper Zarafshon River Basin

Glacial lake at the terminus of the Zarafshon glacier, 2024

Glacial Lakes of the Zarafshon River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
1	Zarafshon	40	39, 04' 59	68, 01' 55	Kishtut	3676	Glacial	0.04
2	Zarafshon	67	39, 01' 16	67, 52' 20	Darakhtisukhta	3622	Moraine	0.10
3	Zarafshon	71	39, 02' 04	67, 51' 56	Darakhtisukhta	3747	Glacial	0.04
4	Zarafshon	74	39, 01' 24	67, 50' 30	Hazorchashma	3582	Glacial	0.08
5	Zarafshon	78	39, 01' 25	67, 48' 49	Hazorchashma	3586	Glacial	0.03
6	Zarafshon	80	39, 00' 48	67, 48' 29	Hazorchashma	3837	Glacial	0.01
7	Zarafshon	81	39, 00' 49	67, 47' 38	Hazorchashma	3862	Glacial	0.02
8	Zarafshon	88	39, 05' 36	67, 48' 21	Hazorchashma	3983	Moraine	0.03
9	Zarafshon	103	39, 00' 32	67, 42' 22	Suboshi	3683	Glacial	0.10
10	Zarafshon	112	39, 04' 00	67, 40' 53	Suboshi	3888	Glacial	0.09
11	Zarafshon	282	39, 23' 13	70, 19' 13	Zarafshon	3612	Glacial	0.01
12	Zarafshon	307	39, 22' 41	70, 09' 35	Dikhadang	3842	Moraine	0.01
13	Zarafshon	365	39, 17' 33	69, 46' 54	Dimnora	3882	Glacial	0.01
14	Zarafshon	441	39, 15' 56	69, 17' 40	Ghuzn	3080	Moraine	0.09
15	Zarafshon	628	39, 06' 25	68, 35' 48	Ghaberud	2761	Moraine	0.03
16	Zarafshon	648	39, 00' 43	68, 30' 04	Rohib	3911	Glacial	0.06
17	Zarafshon	661	38, 57' 42	68, 26' 23	Angisht	3851	Glacial	0.03
18	Zarafshon	671	38, 56' 45	68, 20' 31	Pariyon	3613	Glacial	0.01
19	Zarafshon	Mura	38, 57' 33	68, 17' 07	Mura	3530	Glacial	0.05
20	Zarafshon	675	38, 57' 24	68, 17' 31	Mura	3727	Glacial	0.08
21	Zarafshon	678	38, 56' 45	68, 15' 48	Dikhondara	3615	Glacial	0.07
22	Zarafshon	679	38, 56' 42	68, 15' 24	Dikhondara	3711	Glacial	0.03
23	Zarafshon	680	38, 56' 03	68, 14' 05	Dikhondara	3758	Glacial	0.02
24	Zarafshon	681	38, 56' 07	68, 13' 50	Dikhondara	3669	Glacial	0.03
25	Zarafshon	684	38, 55' 57	68, 12' 25	Dikhondara	3976	Glacial	0.01
26	Zarafshon	693	38, 57' 28	68, 09' 34	Qirqtanur	3855	Moraine	0.06
27	Zarafshon	-	39, 13' 55	68, 44' 59	Remon	3731	Glacial	0.05

Basin of the Kofarnihon and Shirkent Rivers

The basin of the Kofarnihon and Shirkent rivers is located on the southern slopes of the Gissar and Karatag mountain ranges, covering an area of 8,630 km². The rivers generally flow from the northeast to the southwest and are tributaries of the Amu Daryo River.

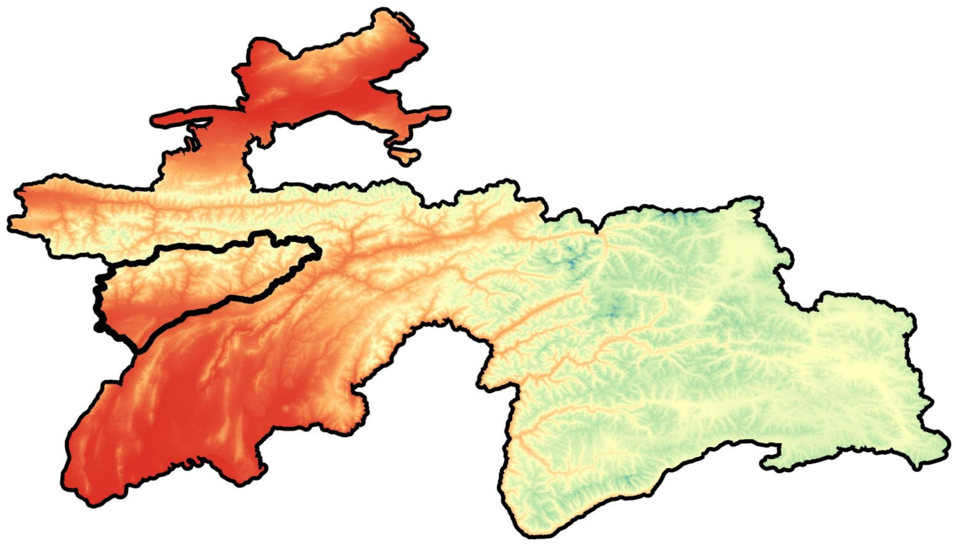
The region of the Kofarnihon and Shirkent river basins is characterized by diverse landscapes and climatic conditions, which are largely determined by the relief of the area. The climate of the basins is continental, with sharp seasonal temperature fluctuations. In winter, temperatures can drop significantly, especially in the high-altitude regions. In summer, temperatures are high, which promotes active glacier melting and increases river flow

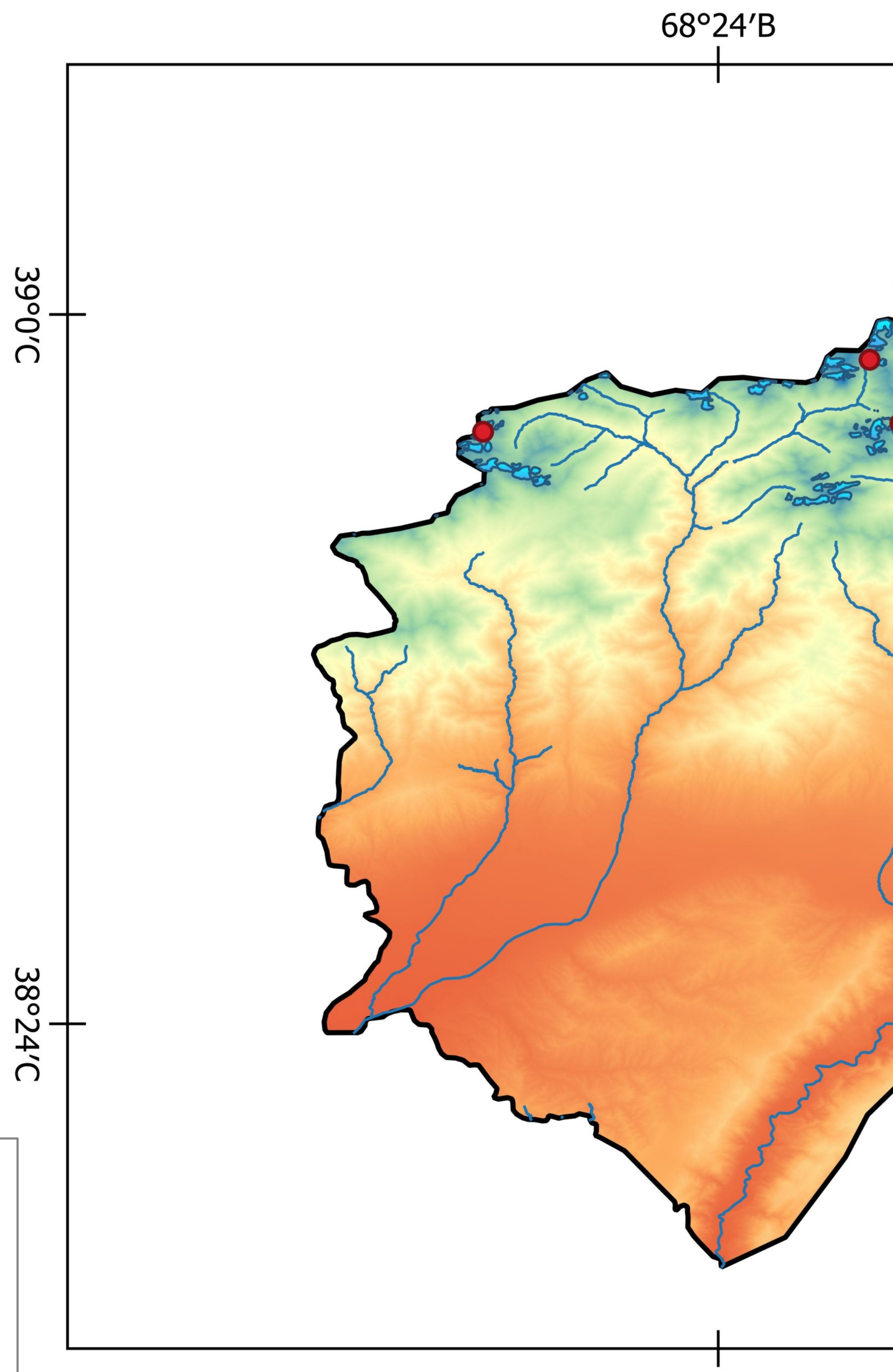
The main factor influencing the climate of the region is the mountain system. The high mountains form permanent snow cover and glaciers, which are the main source of water supply for the rivers, including the Kofarnihon and Qaratogh rivers, during the summer months. These climatic features determine the water balance and hydrological regime of the region.

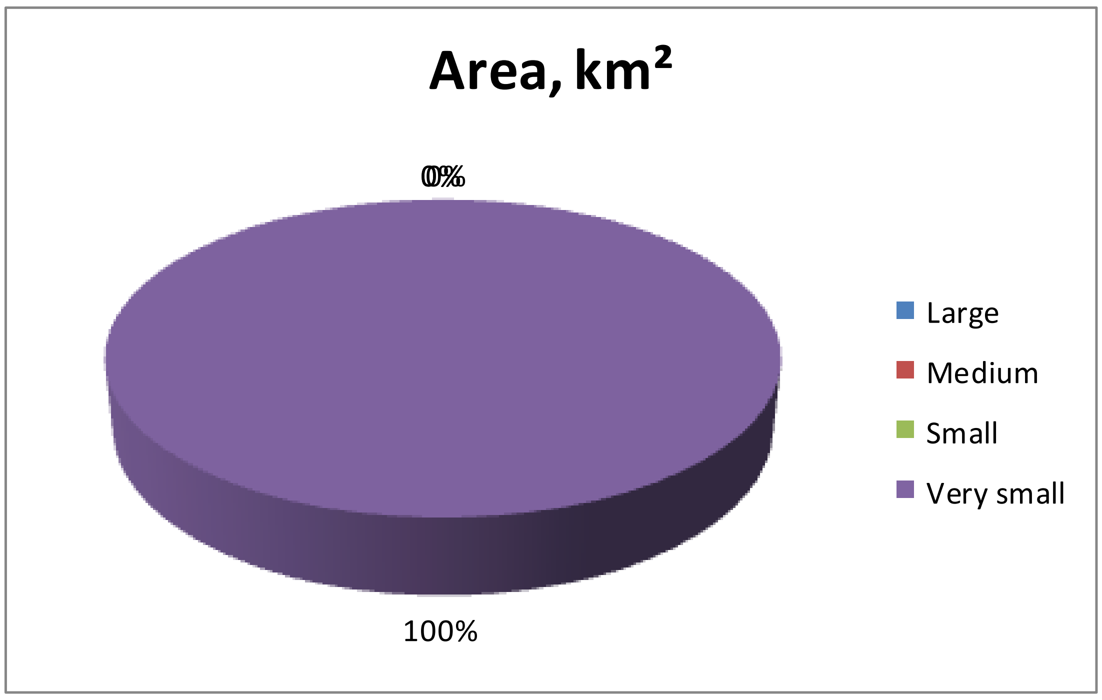
The sources of the Kofarnihon, Qaratogh, and their tributaries are located in the highest areas of the basin. Here, glaciers play a significant role as their melting in the summer constitutes the main source of water supply for the rivers. In the foothills of the mountains, moraines and fluvioglacial deposits are formed, which are important elements of the local landscape. The northern slopes of the mountain range separate the basin of the Fondaryo River, while to the south lies the Hissor Valley, which clearly defines the geographical boundaries of the basin.

The glaciers located at the sources of the tributaries of the Kofarnihon and Shirkent rivers are the main source of water supply for the rivers. The majority of the glaciers in the basin are situated in the foothills of the northern slopes of the Hissor mountain range, where large glacier systems are formed. Among them, large glaciers are located at the sources of the Sarday-Miyona, Khanaqo, and Qaratogh rivers, which are important tributaries of the Kofarnihon and Shirkent rivers.

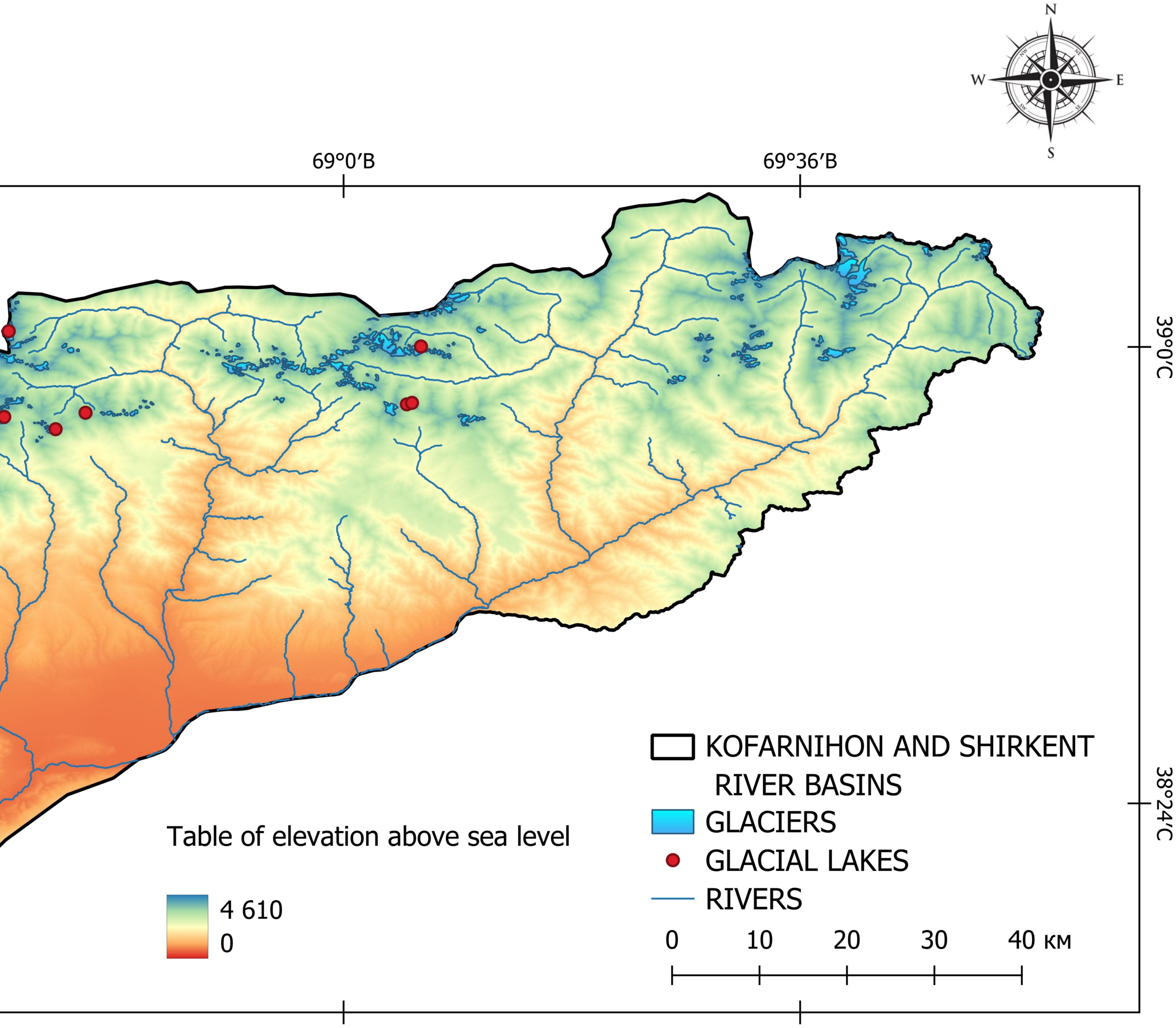
Satellite imagery results have shown that the Kofarnihon and Shirkent river basins contain 8 glacial lakes, all of which fall into the category of very small lakes (less than 0.05 km² in area).







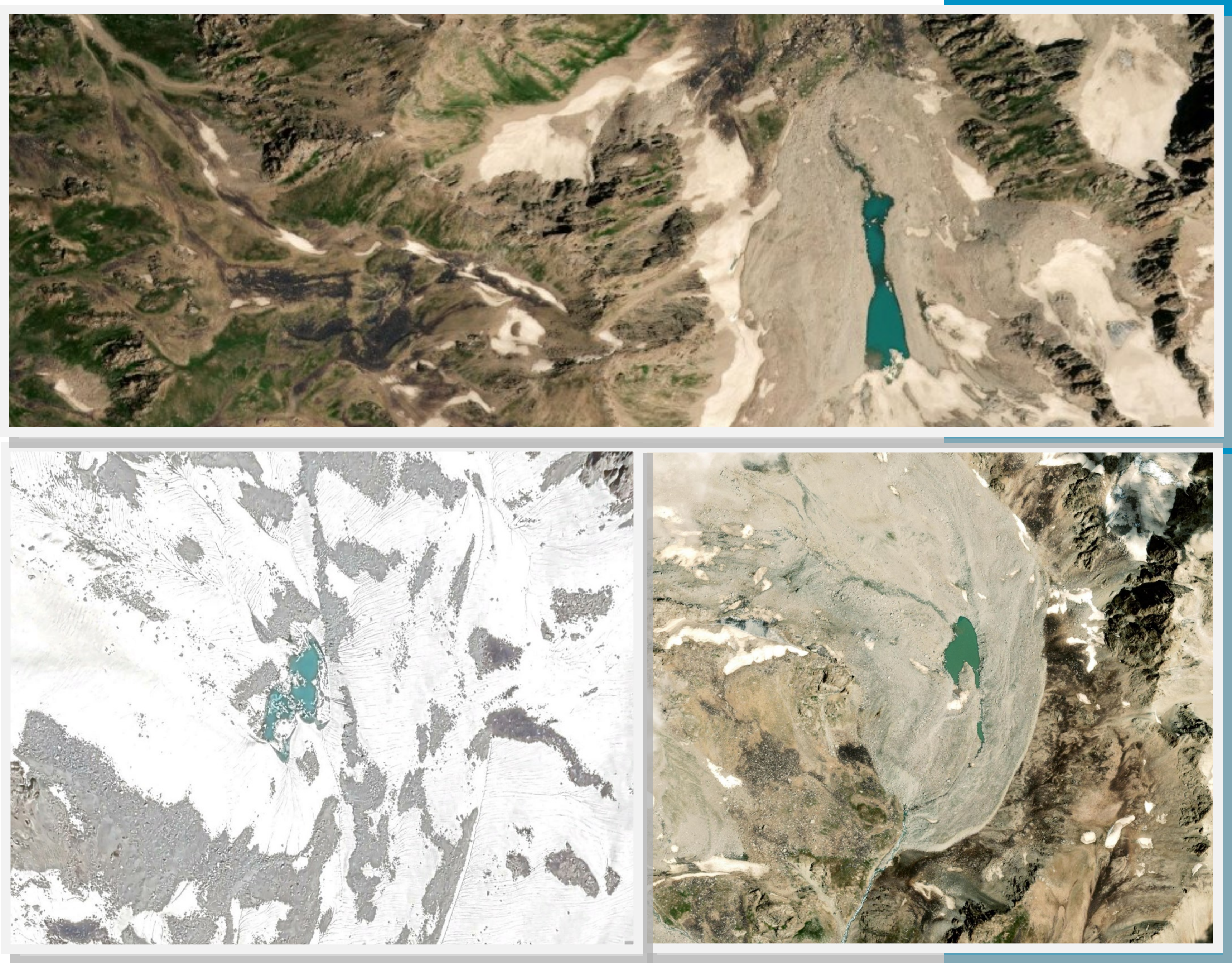
Map of the location of glacial lakes in the Kofarnihon and Shirkent River Basins



Glacial Lakes in the Kofarnihon and Shirkent River Basins

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
1	Kofarnihon	10	38, 54' 29	68, 33' 15	Khonaqoh	3628	Glacial	0.01
2	Kofarnihon	35	38, 54' 48	68, 39' 38	Siyoma	3547	Glacial	0.02
3	Kofarnihon	36	38, 53' 30	68, 37' 17	Siyoma	3636	Glacial	0.05
4	Kofarnihon	78	39, 01' 15	68, 33' 38	Maykhura	4045	Glacial	0.05
5	Kofarnihon	128	38, 55' 35	69, 05' 23	Kafandor	3557	Glacial	0.02
6	Kofarnihon	129	38, 55' 28	69, 04' 58	Kafandor	3512	Glacial	0.01
7	Kofarnihon	150	39, 00' 02	69, 06' 05	Lolakul	3579	Glacial	0.03
8	Kofarnihon	10	38, 54' 29	68, 33' 15	Khonaqoh	3628	Glacial	0.01
9	Shirkent	176	38, 54' 02	68, 12' 04	Diakhandara	3985	Glacial	0,04
10	Shirkent	Qadamshoh	38, 57' 42	68, 31' 40	Qadamshoh	3900	Glacial	0,01


Foothills of the Upper Reaches of the Shirkent River Basin, 2021



Glacial Lakes in the Upper Kofarnihon River Basin, 2022

Glacial Lake in the Upper Shirkent River Basin, 2023

Surkhob River Basin

The basin of the Surkhob River is located in the western part of the Pamir-Alai mountain system, and its main tributaries are the Qizilsu and Muqsu rivers, which merge to form the Surkhob River. This region holds strategic geographical importance, acting as a link between two major mountain systems—Pamir and Alai.

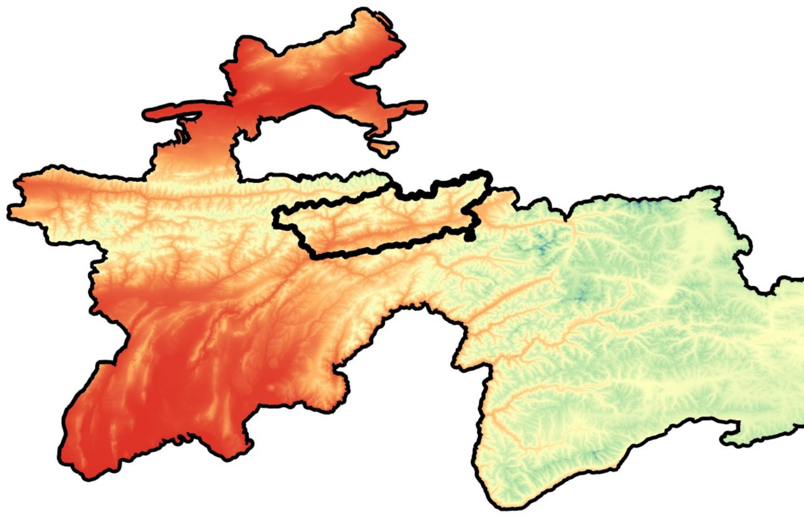
From a geographical perspective, the Surkhob basin covers high-altitude areas, where significant elevation differences are observed, and the presence of mountain ridges forms a unique climate and ecosystem. The main feature of the region is its mountainous terrain, deep gorges, and narrow valleys with gentle slopes and high stone walls. The mountains and local rivers create complex hydrological conditions, which have a substantial impact on the climate and ecosystem of the region.

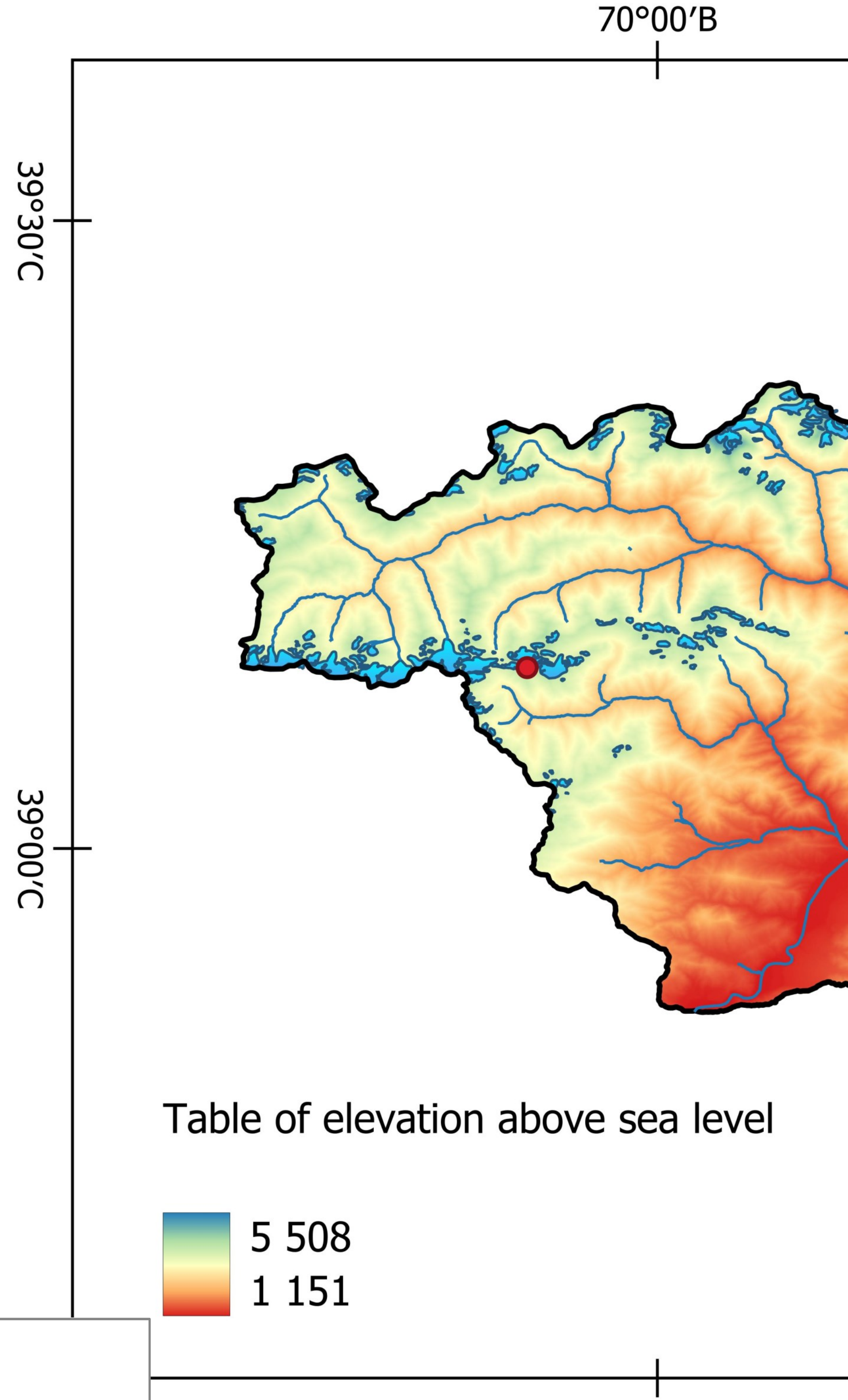
The climate in the region through which the Surkhob River flows is sharply continental, characterized by large temperature fluctuations. The average annual temperature is around 29°C. The coldest months are January, while the warmest are August. Approximately 70–75% of the annual precipitation falls in the summer, while winter can be dry and cold.

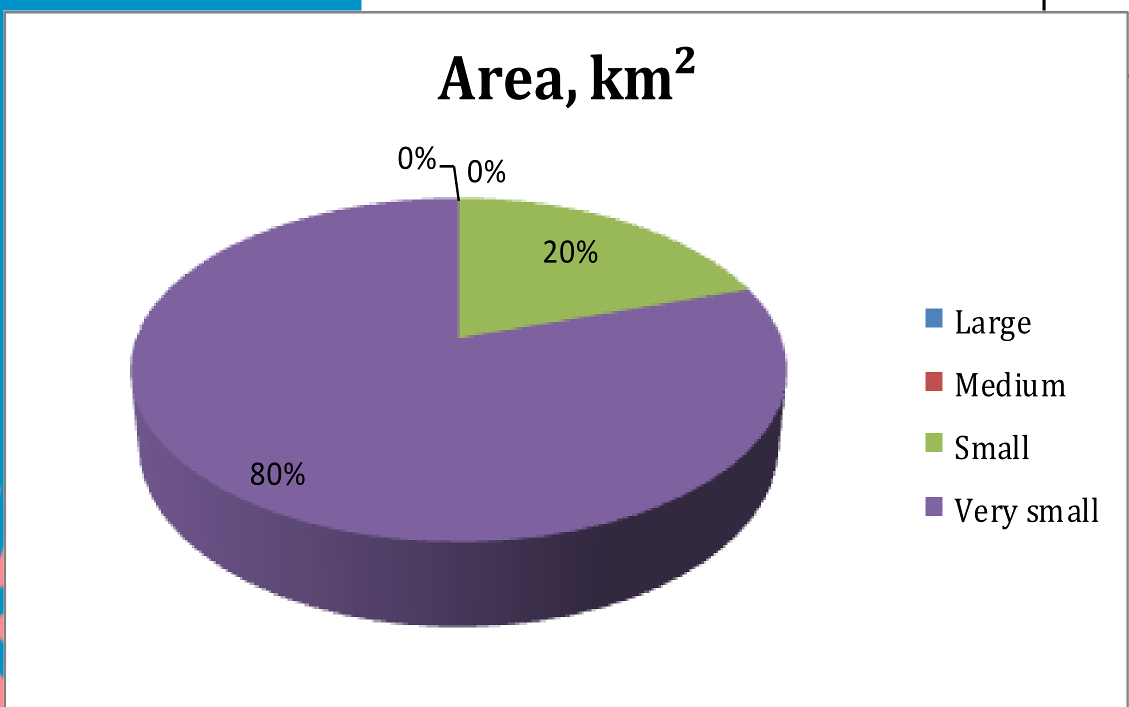
The glaciers located in the right-bank part of the basin play a vital role in supplying water to the rivers and are an important source of moisture for the region. The glacial zone, situated at elevations above 3000 m, exhibits more pronounced glacial activity, which is crucial for maintaining the hydrological regime of the rivers in high-altitude conditions.

In general, the glaciers of the Surkhob River basin are an essential element of the region's geographical and climatic system, significantly influencing its hydrology and ecology. They also represent a valuable resource for studying climate change, providing conditions for assessing long-term climate trends.

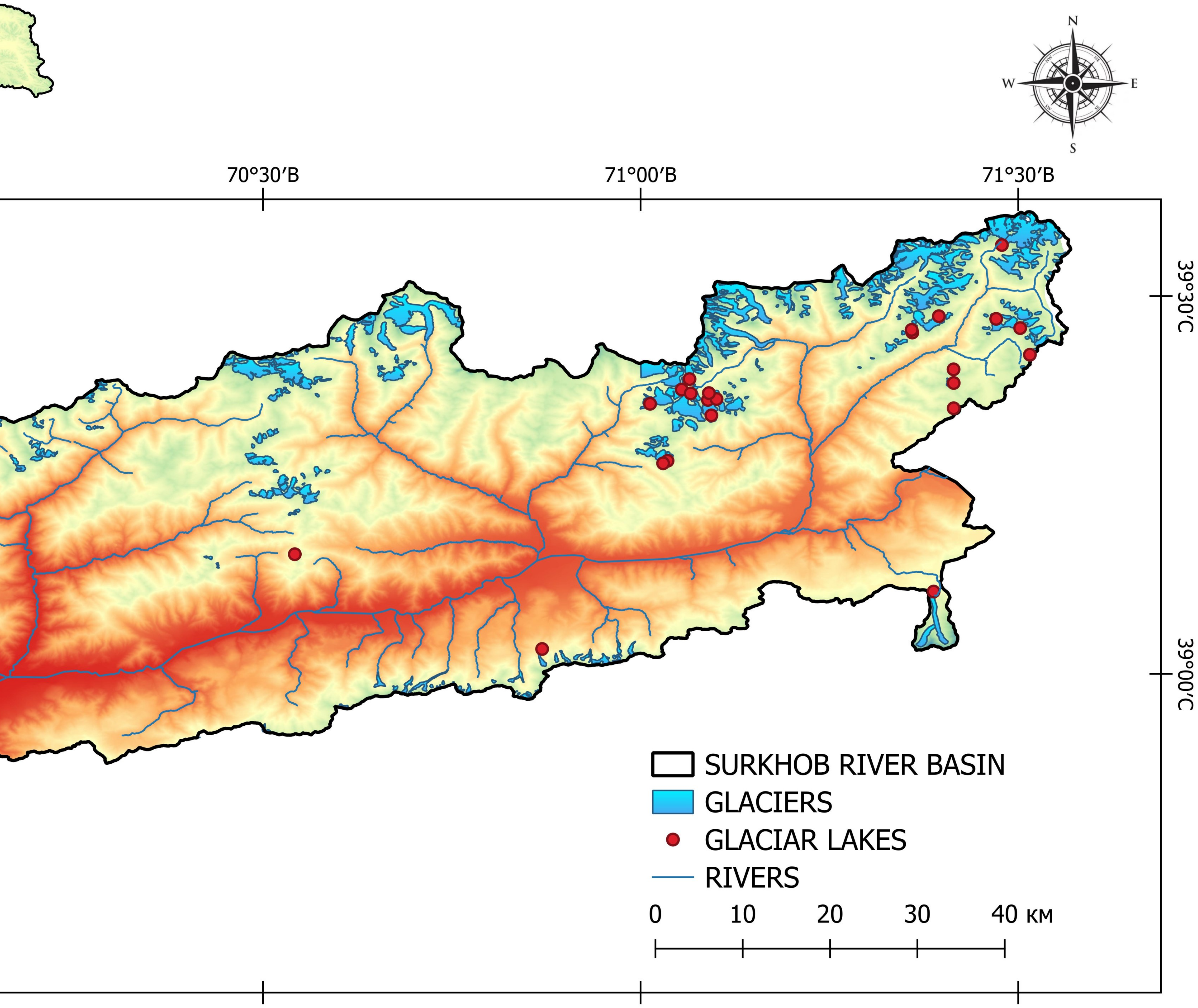
Satellite imagery results have shown that the Surkhob River basin contains 25 glacial lakes, 81% of which fall into the category of very small lakes (less than 0.05 km^2 in area).



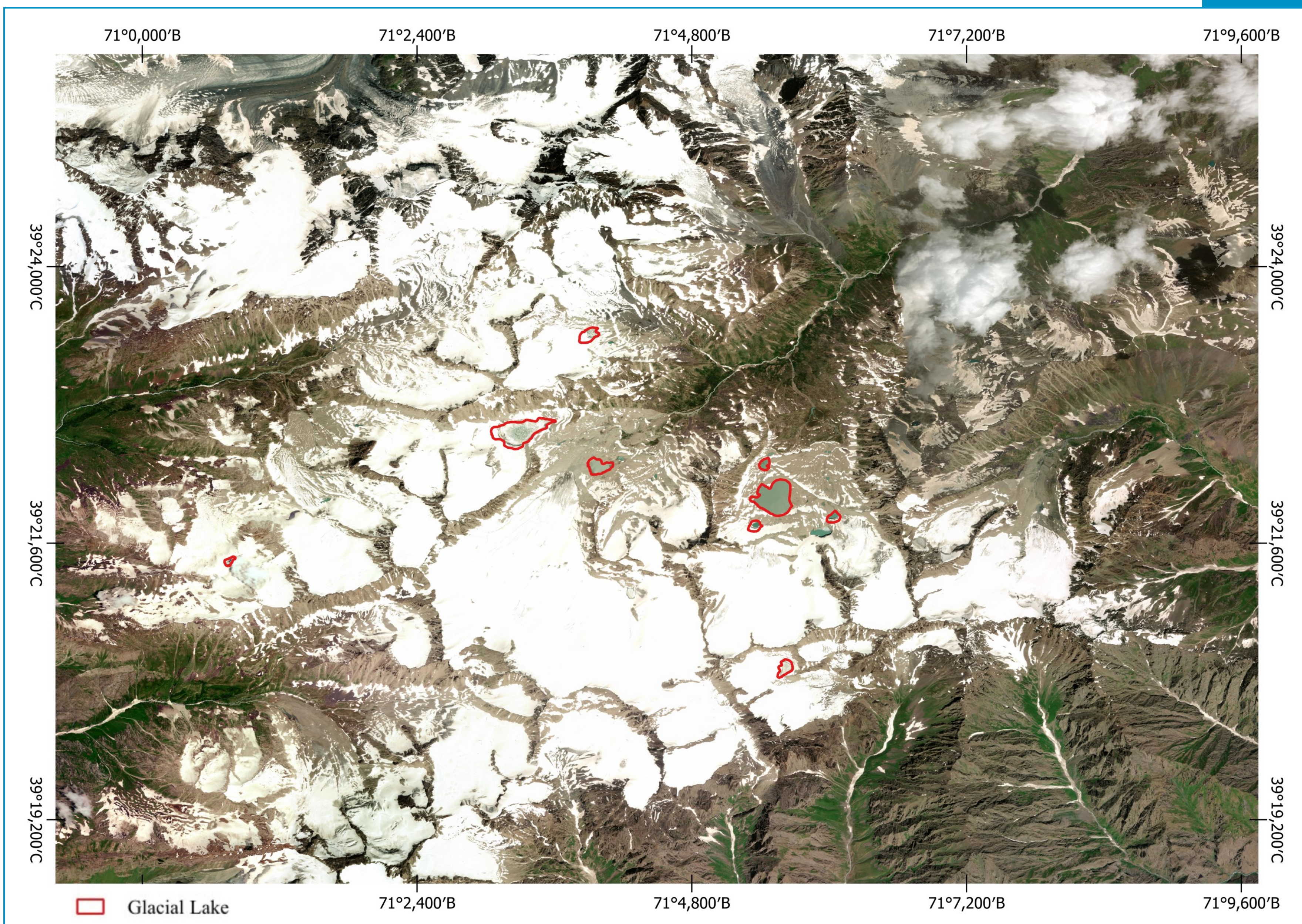




Map of the location of glacial lakes in the Surkhob River Basin



Glacial Lake on the Said Nafisi (Baralmos) Glacier, 2024



Glacial Lakes in the Foothills of the Surkhob River Basin, 2024

Glacial Lakes of the Surkhob River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Surkhob	14	39, 08' 38	69, 53' 46	Daraijazira	4033	Glacial	0.01
2	Surkhob	62	39, 06' 32	71, 23' 18	Surkhob	3577	Glacial	0.01
3	Surkhob	216	39, 09' 30	70, 32' 29	Surkhob	3226	Moraine	0.10
4	Surkhob	346	39, 21' 26	71, 00' 46	Karagushkhona	3720	Glacial	0.01
5	Surkhob	357	39, 16' 46	71, 01' 47	Pizan	3899	Moraine	0.01
6	Surkhob	357	39, 16' 55	71, 02' 07	Pizan	3850	Glacial	0.09
7	Surkhob	363	39, 20' 32	71, 05' 37	Pizan	3971	Glacial	0.03
8	Surkhob	371	39, 21' 41	71, 05' 54	Ishtansaldi	3802	Glacial	0.02
9	Surkhob	372	39, 21' 46	71, 05' 22	Ishtansaldi	3773	Glacial	0.02
10	Surkhob	372	39, 21' 58	71, 05' 31	Ishtansaldi	3724	Glacial	0.20
11	Surkhob	372	39, 22' 17	71, 05' 25	Ishtansaldi	3717	Glacial	0.02
12	Surkhob	375	39, 22' 15	71, 03' 59	Ishtansaldi	3634	Glacial	0.05
13	Surkhob	376	39, 22' 33	71, 03' 16	Ishtansaldi	3739	Glacial	0.21
14	Surkhob	377	39, 23' 25	71, 03' 56	Ishtansaldi	3791	Glacial	0.04
15	Surkhob	438	39, 27' 19	71, 21' 30	Pitovkul	3965	Moraine	0.01
16	Surkhob	Qizilkul	39, 01' 55	70, 52' 11	South Surak	2941	Moraine	0.18
17	Surkhob	-	39, 21' 03	71, 24' 52	Korimdisu	3804	Moraine	0.08
18	Surkhob	-	39, 24' 10	71, 24' 50	Pitovkul	3751	Moraine	0.06
19	Surkhob	-	39, 27' 05	71, 21' 35	Pishavkul	3881	Moraine	0.01
20	Surkhob	-	39, 25' 19	71, 30' 54	Qizilbelsu	3934	Moraine	0.02
21	Surkhob	440	39, 28' 23	71, 23' 41	Pitovkul	3824	Moraine	0.02
22	Surkhob	Chaman-kirchin	39, 34' 01	71, 28' 40	Chamankirchin	3757	Glacial	0.01
23	Surkhob	485	39, 28' 10	71, 28' 15	Pitovkul	3793	Glacial	0.01
24	Surkhob	486	39, 27' 26	71, 30' 10	Qizilbelsu	4010	Glacial	0.04
25	Surkhob	489	39, 23' 05	71, 24' 51	Rorundisu	3858	Glacial	0.01

Glacial Lakes on the Said Nafisi (Baralmos) Glacier, 2024

Muqsu River Basin

The Muksu River basin is located in the northwest of the Pamirs and is one of the regions containing the highest peaks of Central Asia. This basin includes a complex system of mountain ridges separated by deep river valleys. The total area of the basin is 7070 km^2, and it is home to the largest glacier in the region—the Vanjyakh (Fedchenko) Glacier, which is the main center of glaciation in Central Asia.

The source of the Muqsu River is formed by the confluence of the Seldara and Sauksoy rivers, which receive water from avalanches and glaciers of the Vanjyakh system. The river then joins the Qizilsu River, forming the Surkhob River, which in turn merges with the Vakhsh River, creating the largest river in the region—the Amu Darya.

Geographically, the Muqsu River basin is oriented from the southeast to the northwest and is characterized by a complex relief. In its northern part lies the Zaoloy Ridge, which serves as the watershed with the Qizilsu River basin. The Zaoloy Ridge is divided into western and eastern sections. The height of the western part reaches 5630 m, while the eastern part reaches 7130 m (Ibni Sino Peak). Both sectors are sharply dissected, with the upper reaches of the valleys covered by permanent snow.

On the southern part of the basin, the Zulumart and Northern Tanimas ridges are located, also serving as a watershed and separating the Muqsu River basin from other mountain systems of the Pamirs. These areas are dominated by high-mountain terrain with peaks over 6000 m and a complex geological structure.

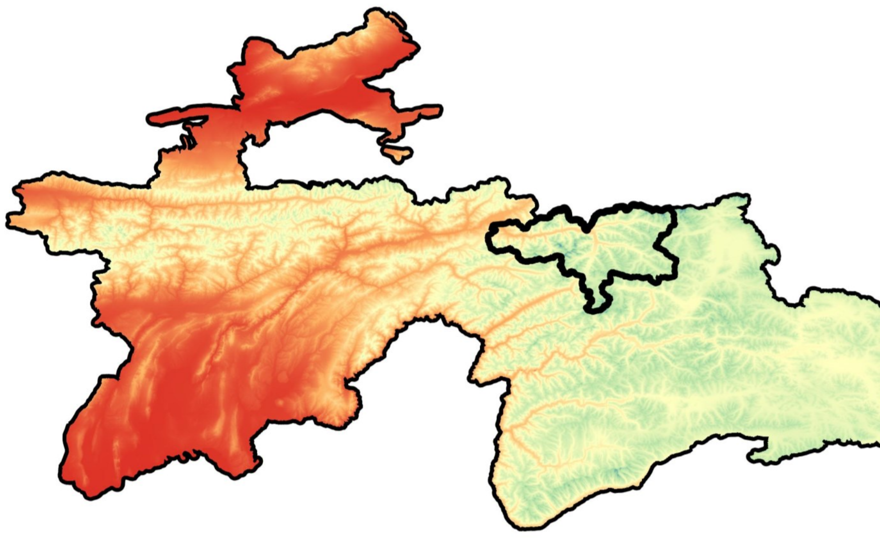
The climate of the Muqsu River basin is characterized as dry, with moderate summers and cold winters. According to the climate classification of M.I. Budiko and A.A. Grigoriev, this region belongs to the area with a dry climate and moderate summers. The main climatic factors include the geographical location, solar radiation, and atmospheric circulation processes, which play an important role in shaping the region's climate conditions.

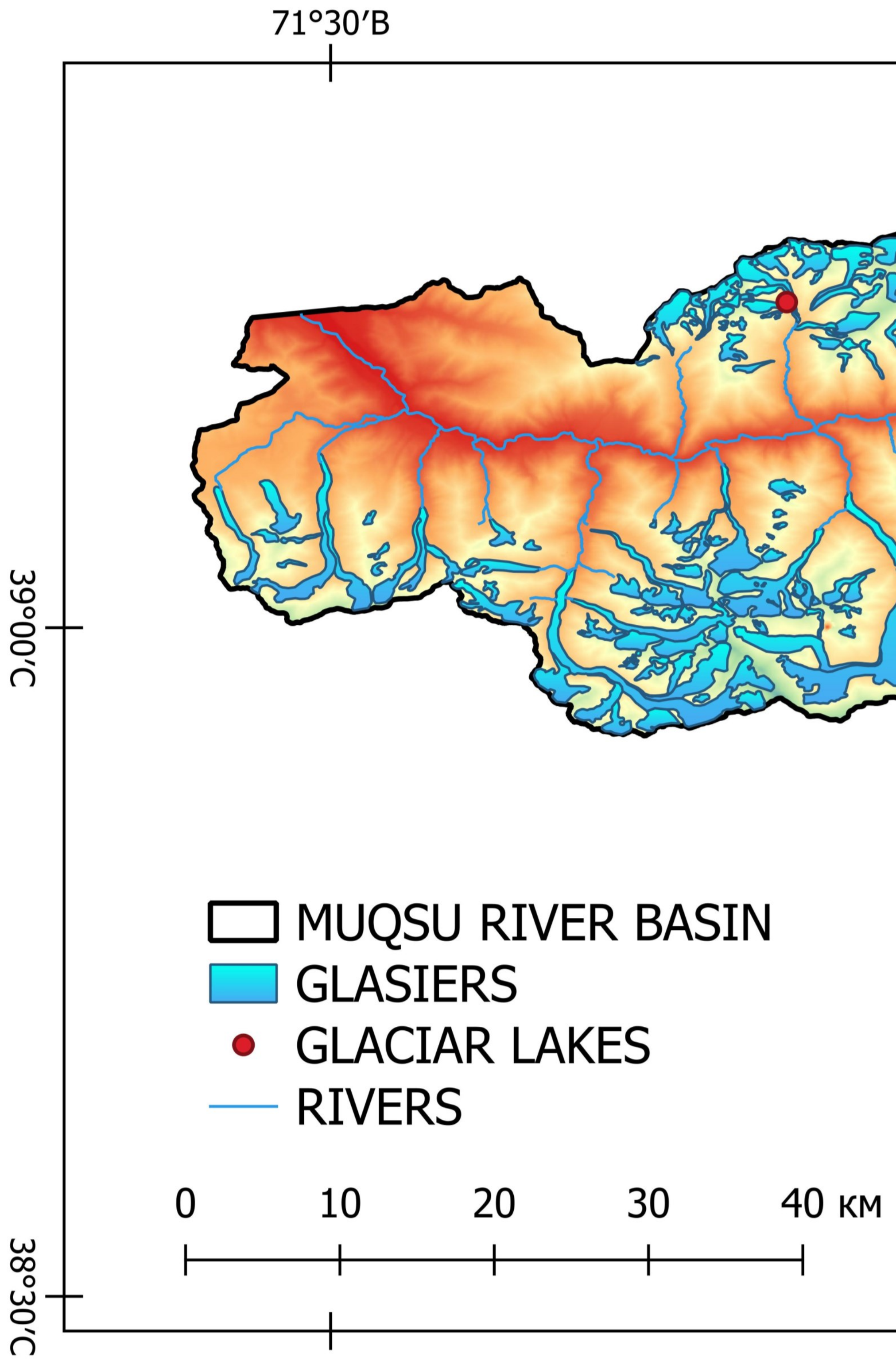
At an altitude above 3000 m, the annual precipitation can reach up to 2000 mm, providing favorable conditions for snow accumulation and glacier development.

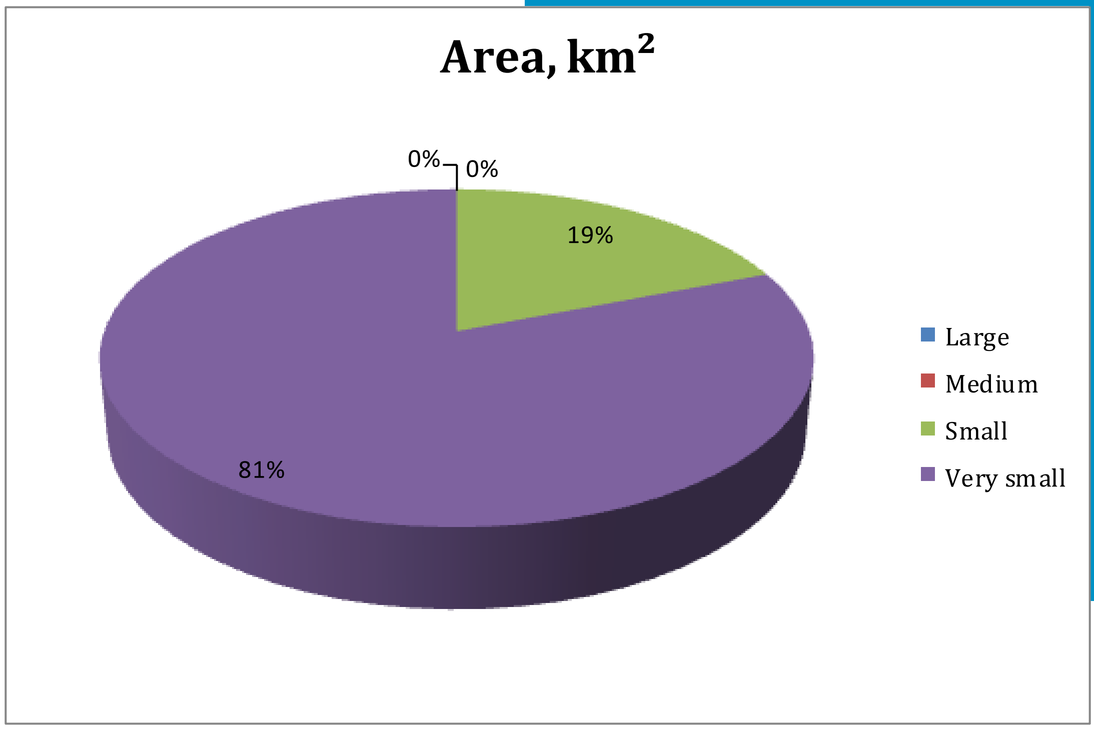
The total area of glaciers in the basin is 2094.9 km^2, and the glacierization coefficient reaches 0.29, one of the highest rates among other river basins of the Pamirs.

The glaciers of the basin vary in size—from large ones, such as the Vanjyakh Glacier, to smaller and medium-sized ones. The Vanjyakh Glacier is the largest glacier in Eurasia, with an area of 156 km^2, making it an important object for glaciological research.

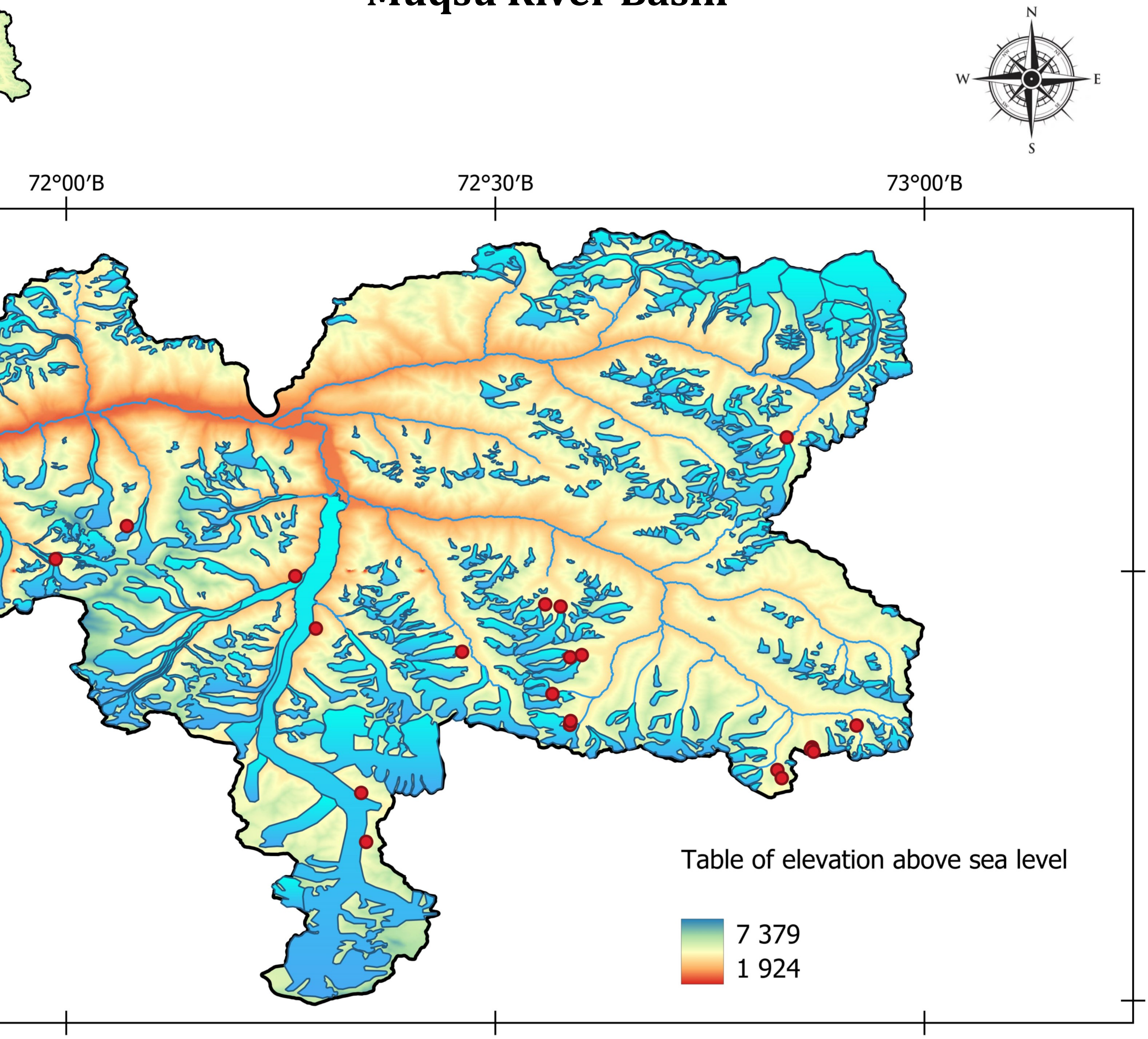
The glacierization area in the basin is distributed in such a way that more than 25% of the territory is in the zone of permanent glaciation, contributing to the formation of a unique relief. In the ridges at elevations over 3000 m, the annual precipitation can reach up to 2000 mm, creating conditions for snow accumulation and glacier formation. However, despite this, the glaciers in this basin are undergoing degradation due to climatic processes, leading to the formation of glacial lakes.
Observation results have shown that in the Muksu River basin, there are 25 glacial lakes, 81% of which fall into the category of extremely small (less than 0.05 km^2).

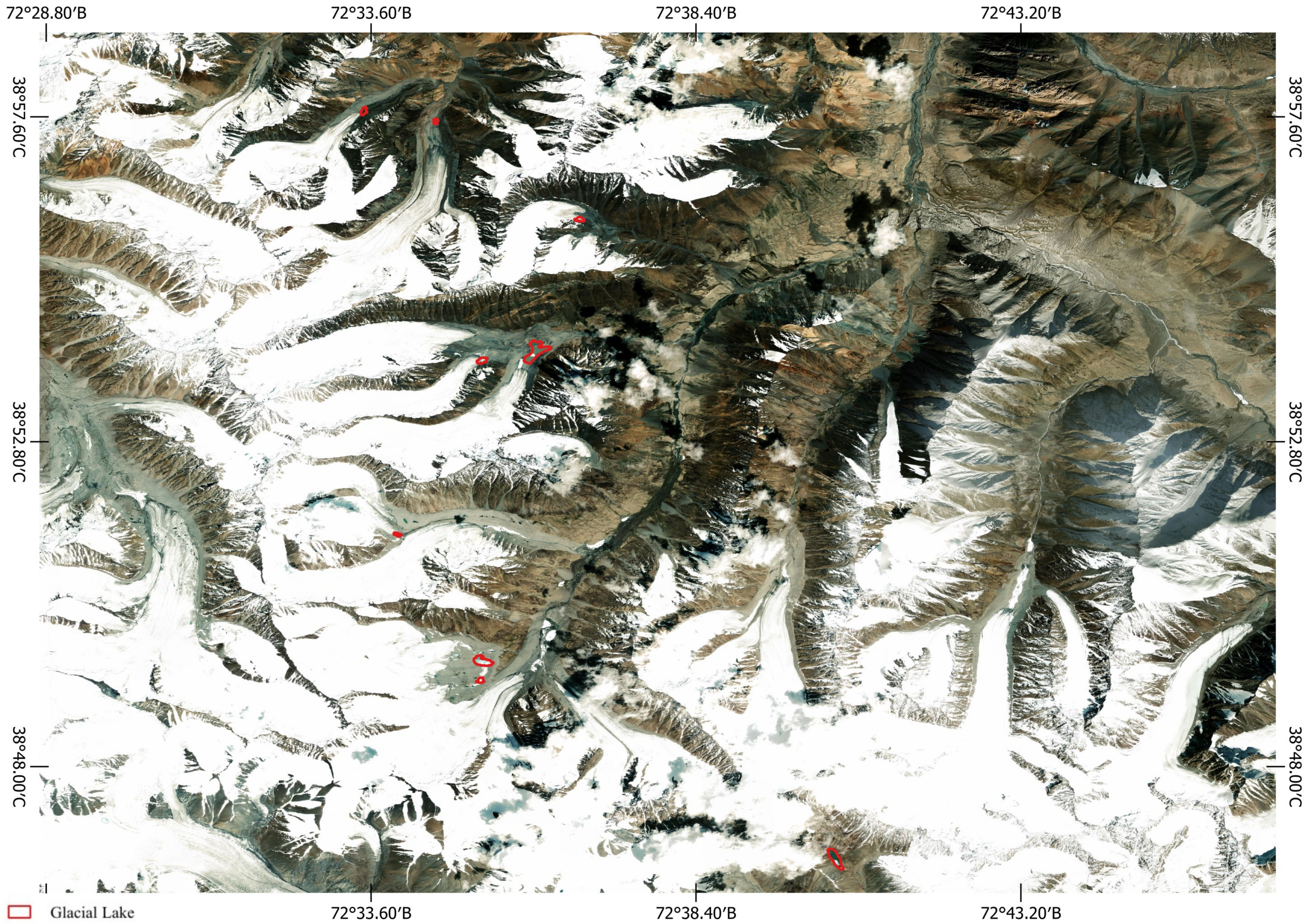






Map of the location of glacial lakes in the Muqsu River Basin





Glacial Lakes in the upper Basin of the Balyankiik–Pisoda River, 2023


Glacial Lake in the upper Part of the Vanjyakh Glacier, 2024

Glacial Lake on the terminus of the Vanjyakh Glacier, 2024

Glacial Lakes of the Muksu River Basin

№	Basin	Glacier name	Latitude	Longi-tude	River	Eleva-tion	Type	Area, km²
1	Muqsu	Vanjyakh	38, 44' 31	72, 20' 36	Seldara	4510	Glacial	0.05
2	Muqsu	14	38, 56' 01	72, 17' 27	Seldara	3659	Glacial	0.02
3	Muqsu	Bivachniy	38, 59' 41	72, 16' 00	Seldara	3412	Glacial	0.12
4	Muqsu	120	39, 14' 36	71, 50' 27	Surkhanob	4162	Moraine	0.02
5	Muqsu	Zulumart	39, 09' 23	72, 50' 23	Sauksoy	4372	Glacial	0.20
6	Muqsu	548	38, 49' 13	72, 55' 14	Balandkiik	4505	Moraine	0.05
7	Muqsu	553	38, 47' 22	72, 52' 14	Balandkiik	4534	Moraine	0.11
8	Muqsu	553	38, 47' 41	72, 52' 07	Balandkiik	4532	Moraine	0.03
9	Muqsu	554	38, 47' 33	72, 52' 03	Balandkiik	4535	Moraine	0.02
10	Muqsu	557	38, 46' 07	72, 49' 42	Yangidavon	4689	Moraine	0.03
11	Muqsu	Jalzvqumsoy	38, 49' 16	72, 35' 13	Jalzvqumsoy	4656	Glacial	0.02
12	Muqsu	Jalzvqumsoy	38, 49' 33	72, .35' 14	Jalzvqumsoy	4631	Glacial	0.07
13	Muqsu	Jalzvqumsoy	38, 51' 25	72, 33' 59	Jalzvqumsoy	4777	Glacial	0.01
14	Muqsu	599	38, 54' 02	72, 35' 56	Dusakasoy	4495	Glacial	0.14
15	Muqsu	600	38, 54' 00	72, 35' 15	Dusakasoy	4632	Glacial	0.03
16	Muqsu	605	38, 56' 04	72, 36' 42	Dusakasoy	4817	Glacial	0.02
17	Muqsu	Karaykashon (south)	38, 57' 32	72, 34' 33	Karaykashon	4467	Moraine	0.01
18	Muqsu	623	38, 57' 40	72, 33' 30	Karaykashon	4639	Glacial	0.02
19	Muqsu	659	38, 54' 22	72, 27' 40	Qushqurghon	4384	Glacial	0.02
20	Muqsu	707	39, 03' 09	72, 04' 14	Ayujilga	4337	Glacial	0.01
21	Muqsu	Valtera	39, 00' 51	71, 59' 16	Fortambek	4361	Moraine	0.02

Obikhingob River Basin

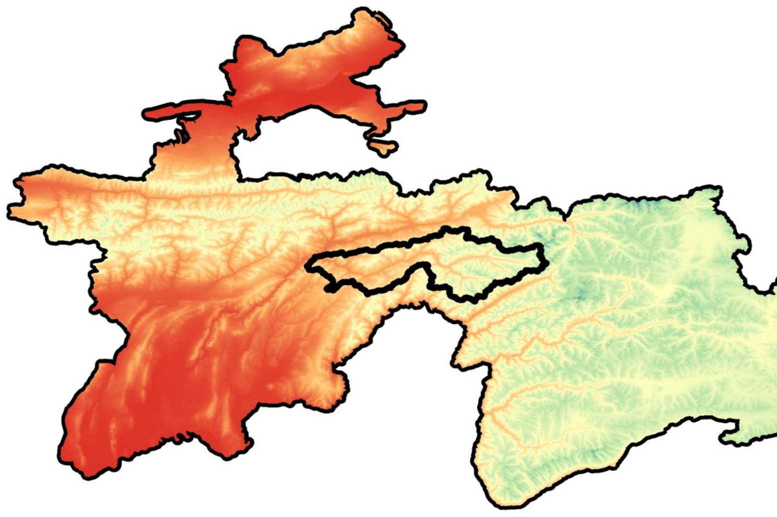
The Obihingob River basin, a tributary of the Vakhsh River, holds a significant position within the glacial system of the Pamirs. This region encompasses the Obihingob River valley, stretching 180 km from west to east and 70 km from north to south. The total area of the basin is 6660 km². To the north, the basin is bordered by the Petra I and Muqsu ridges, to the south by the Darvoz Mountains, and to the east by the Academy of Sciences ridge, which separates the Obihingob basin glaciers from those of the Vanjyakh system. These mountain ranges and their elevations have a significant impact on the extent of glaciation in the region, which covers approximately 11% of the total area.

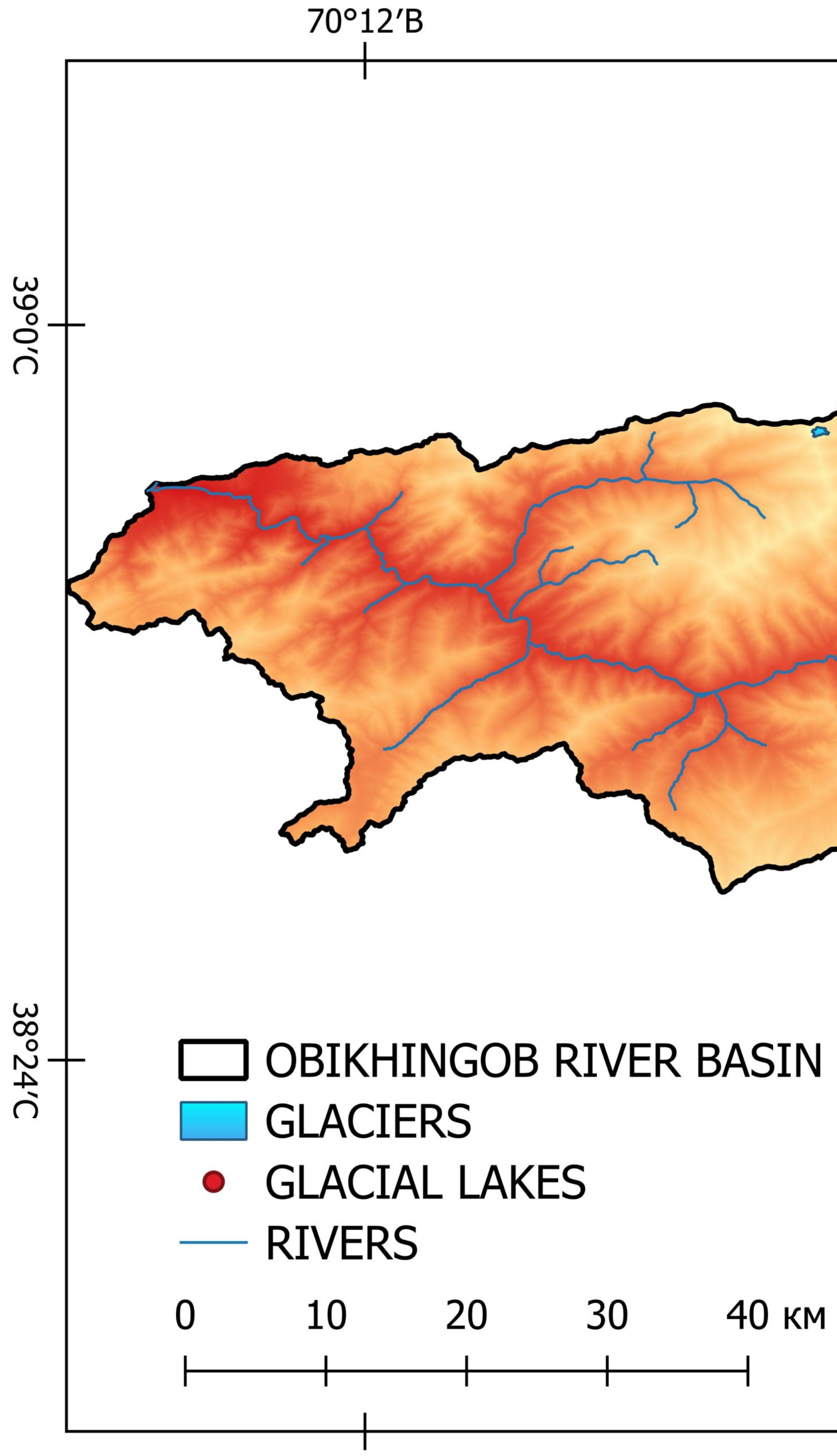
The primary zone of glaciation is located in the upper reaches of the basin, along the Garmo and Kyrghyzob rivers. Here, the largest glaciers of the region are found, including the Garmo Glacier, with an area of 114.6 km², and the Gando Glacier, which covers the northern slope of the Garmo River. All of these glaciers play a crucial role in providing water resources for the rivers in the basin.

The climatic conditions of the Obihingob River basin are characterized by significant temperature fluctuations. In the lowlands, winter temperatures can drop to -29°C, while summer temperatures in the valley can reach 25.8°C. In the high-altitude areas, the summer temperature is much lower than in the valleys due to the presence of snow and ice. Snowfall and rainfall are particularly intense during the winter and spring, and the total precipitation increases with altitude. At elevations above 4200 meters, nearly all precipitation falls as snow.

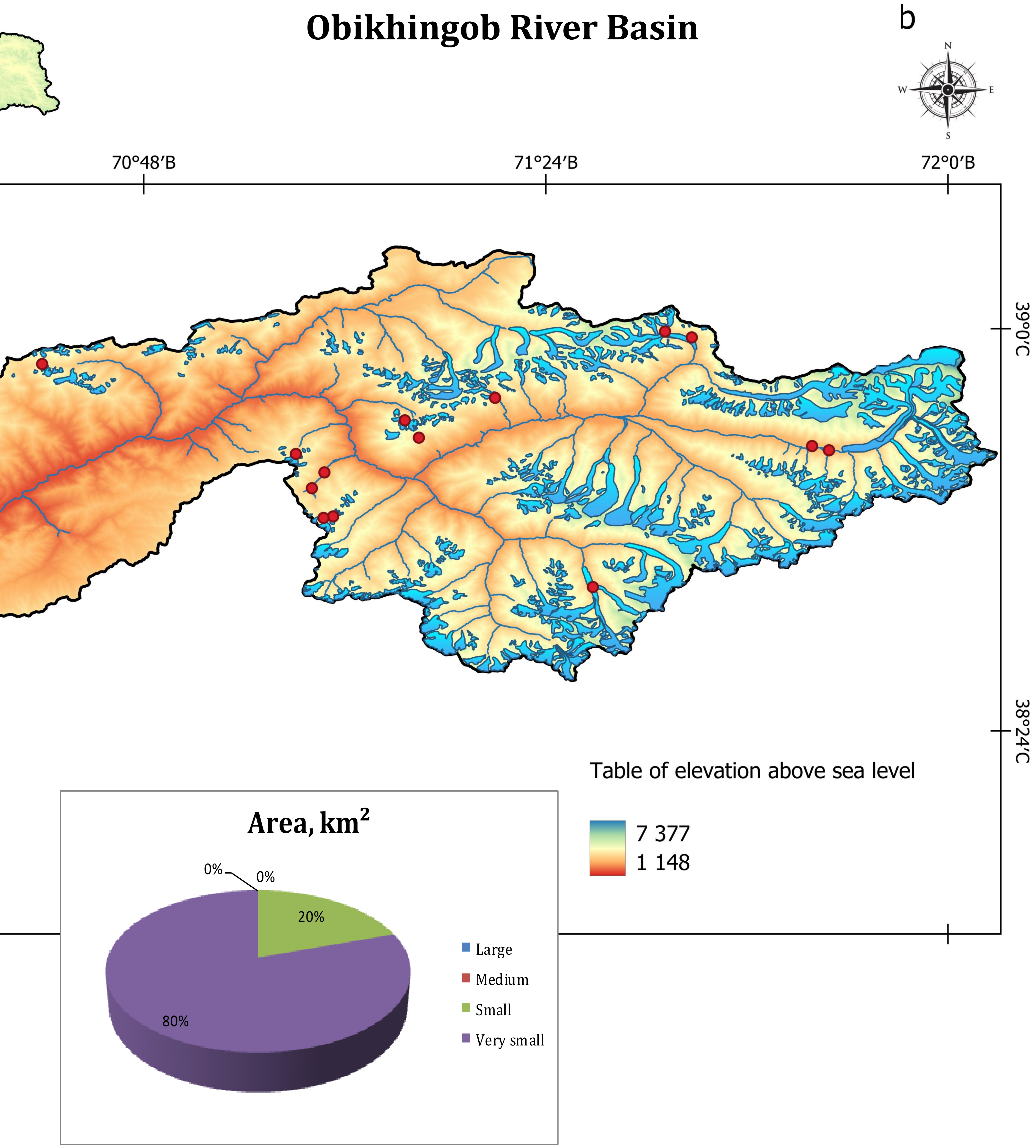
Despite the complex mountainous terrain, the glaciers of the Obihingob River basin are impacted by climatic factors and are in a state of degradation.

Observational results have shown that there are 8 glacial lakes in the Obihingob River basin, all of which are classified as very small in size (less than 0.05 km²).





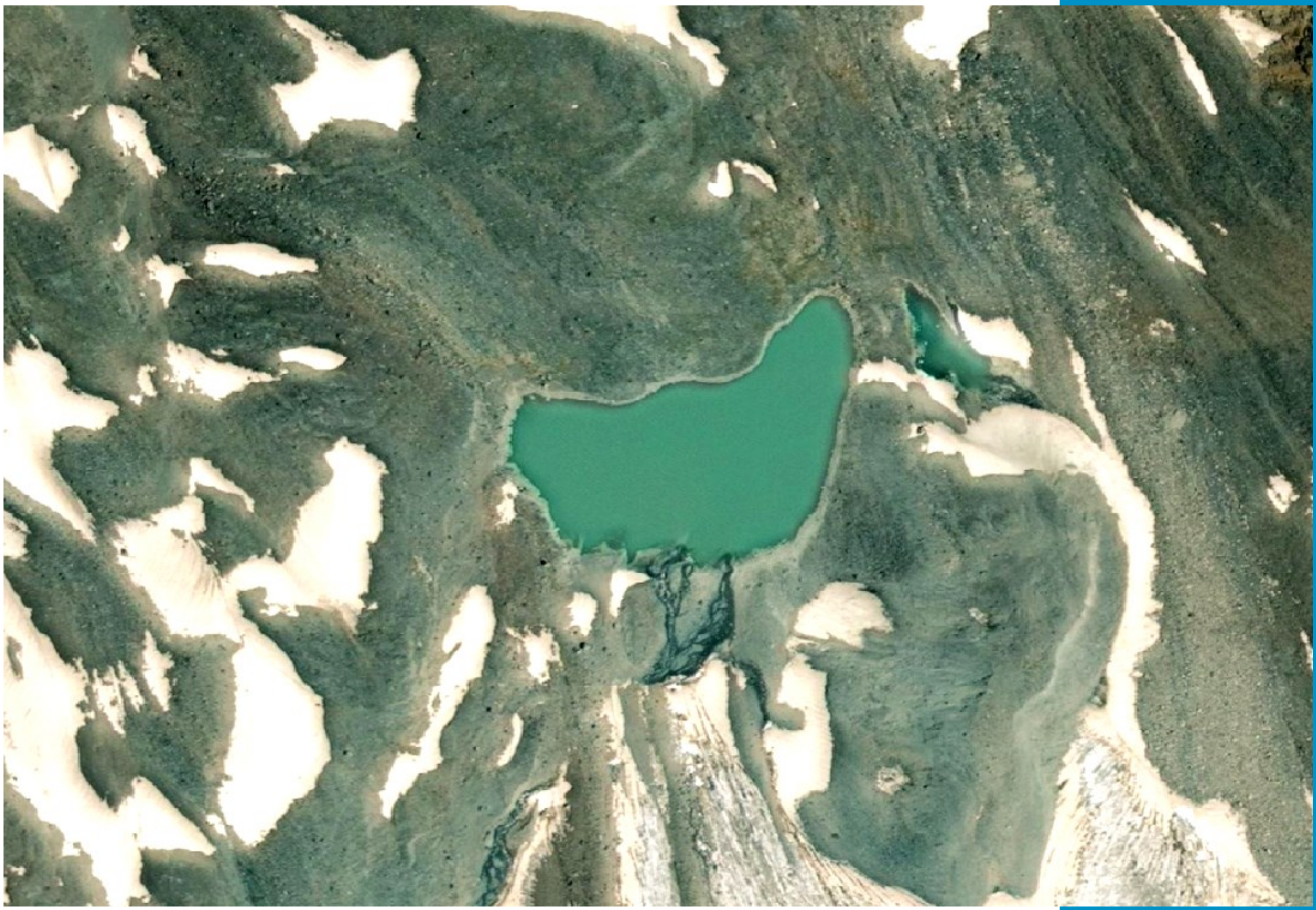
Map of the location of glacial lakes in the Obikhingob River Basin



Pisoda Moraine Lake, 2023

Glacial Lakes of the Obikhingob River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Obikhingob	32	38, 56' 50	70, 38' 54	Farkikush	3960	Glacial	0.01
2	Obikhingob	Baralmos	39, 05' 53	71, 23' 08	Karashura	3626	Glacial	0.02
3	Obikhingob	127	38, 51' 47	71, 11' 22	Sangoba	3796	Glacial	0.01
4	Obikhingob	131	38, 50' 14	71, 12' 38	Obikhingob	3711	Moraine	0.01
5	Obikhingob	141	38, 53' 49	71, 19' 28	Obikhingob	3491	Glacial	0.02
6	Obikhingob	Devlokhan	38, 59' 13	71, 37' 03	Devlokhan	3447	Moraine	0.01
7	Obikhingob	Devlokhan	38, 59' 45	71, 34' 41	Devlokhan	3694	Glacial	0.02
8	Obikhingob	Darvoz	38, 36' 50	71, 28' 13	Obimazor	3388	Glacial	0.01
9	Obikhingob	Garmo	38, 49' 08	71, 49' 17	Garmo	3133	Glacial	0.14
10	Obikhingob	Belyaeba	38, 49' 30	71, 47' 49	Garmo	3084	Moraine	0.02
11	Obikhingob	533	38, 43' 11	71, 04' 56	Pisoda	4065	Glacial	0.02
12	Obikhingob	Pisoda	38, 47' 07	71, 04' 10	Pisoda	3973	Moraine	0.28
13	Obikhingob	534	38, 45' 42	71, 03' 04	Pisoda	3286	Moraine	0.18
14	Obikhingob	534	38, 43' 03	71, 04' 06	Pisoda	3949	Glacial	0.02
15	Obikhingob	547	38, 48' 47	71, 01' 38	Laur	3728	Moraine	0.01



Glacial Lake on Glacier No. 124 of the Obikhingob River Basin, 2023

Identification of Glacial Lakes in the upper Obikhingob River Basin

Vanj and Yazghulom River Basins

The Vanj and Yazghulom river basins, located in the western part of the Pamirs, are among the most geographically and geologically complex regions of the Republic of Tajikistan. These basins are situated between three major mountain ranges—Darvoz, Vanj, and Yazghulom—that stretch from the northeast to the southwest. These ranges separate the Vanj and Yazghulom river basins from each other. The Vanj and Yazghulom rivers are the main tributaries of the Panj River, which in turn is part of the Amu Darya system.

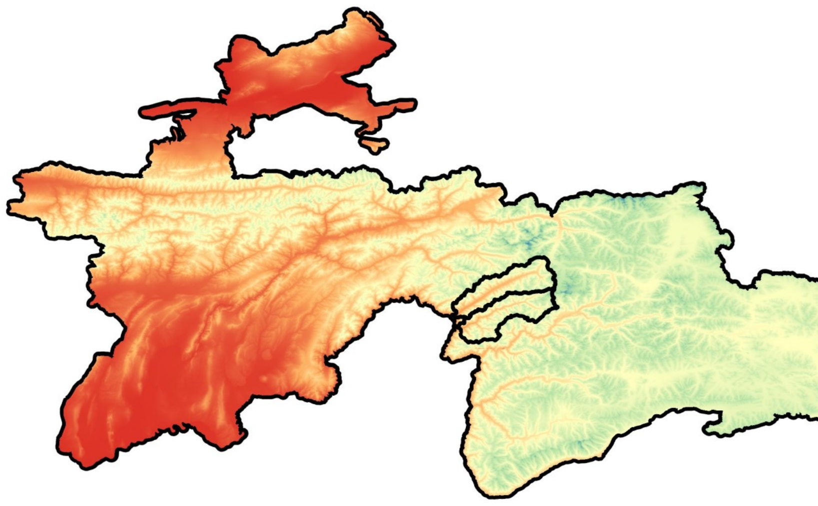
This region consists of deep and difficult-to-access valleys located between high mountain ranges, which form the borders of the river basins. These ranges and valleys have been affected by erosion and tectonic movements, leading to the formation of diverse and sharp relief features. The highest point in the region is Garmo Peak (6595 m), located in the Academy of Sciences Range.

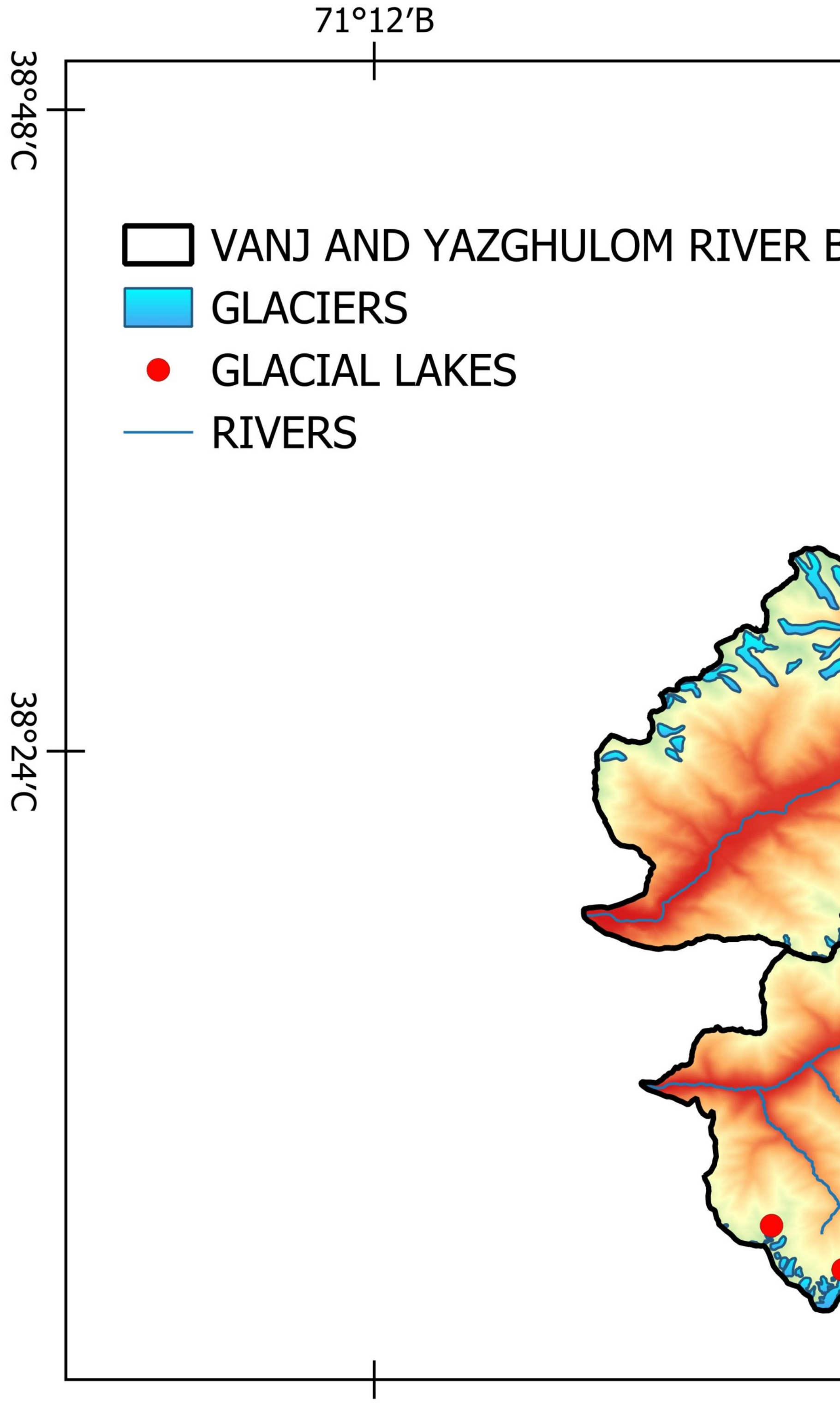
The relief of this region was mainly shaped during the Neogene period and the glacial epochs, which led to the formation of modern glacial features. The glaciers in these areas are part of a large glacial system that continues to develop.

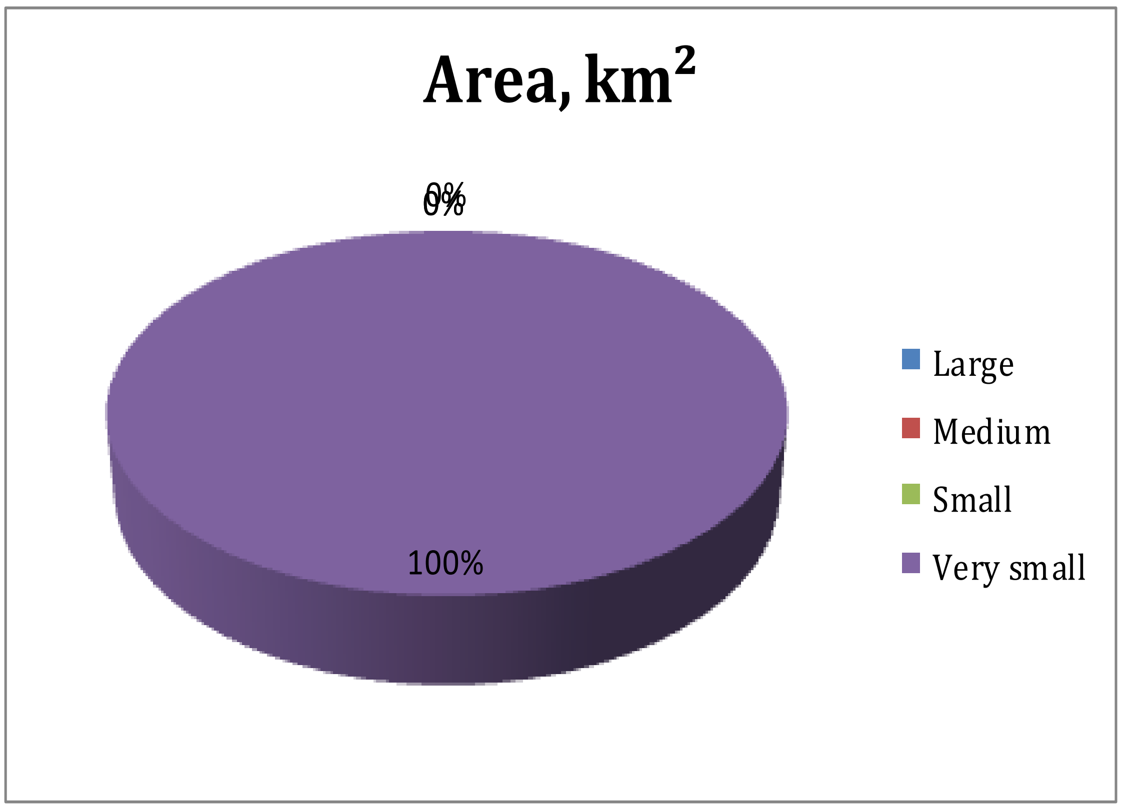
The climate of the Vanj and Yazghulom river basins is continental, typical of high-altitude regions. The area is influenced by cold air masses from the northwest, which lead to low temperatures, especially in winter. Summer temperatures are moderate but fluctuate sharply between day and night.

One of the distinctive features of the Vanj and Yazghulom river basins is the high level of glaciation. The region is known for its large, mobile glaciers, such as the Geographical Society Glacier, Khirson Glacier, and Yazghulom Glacier, which are among the most active glaciers in Central Asia. Due to the climate's impact, the glaciers in these basins are continuously shrinking.

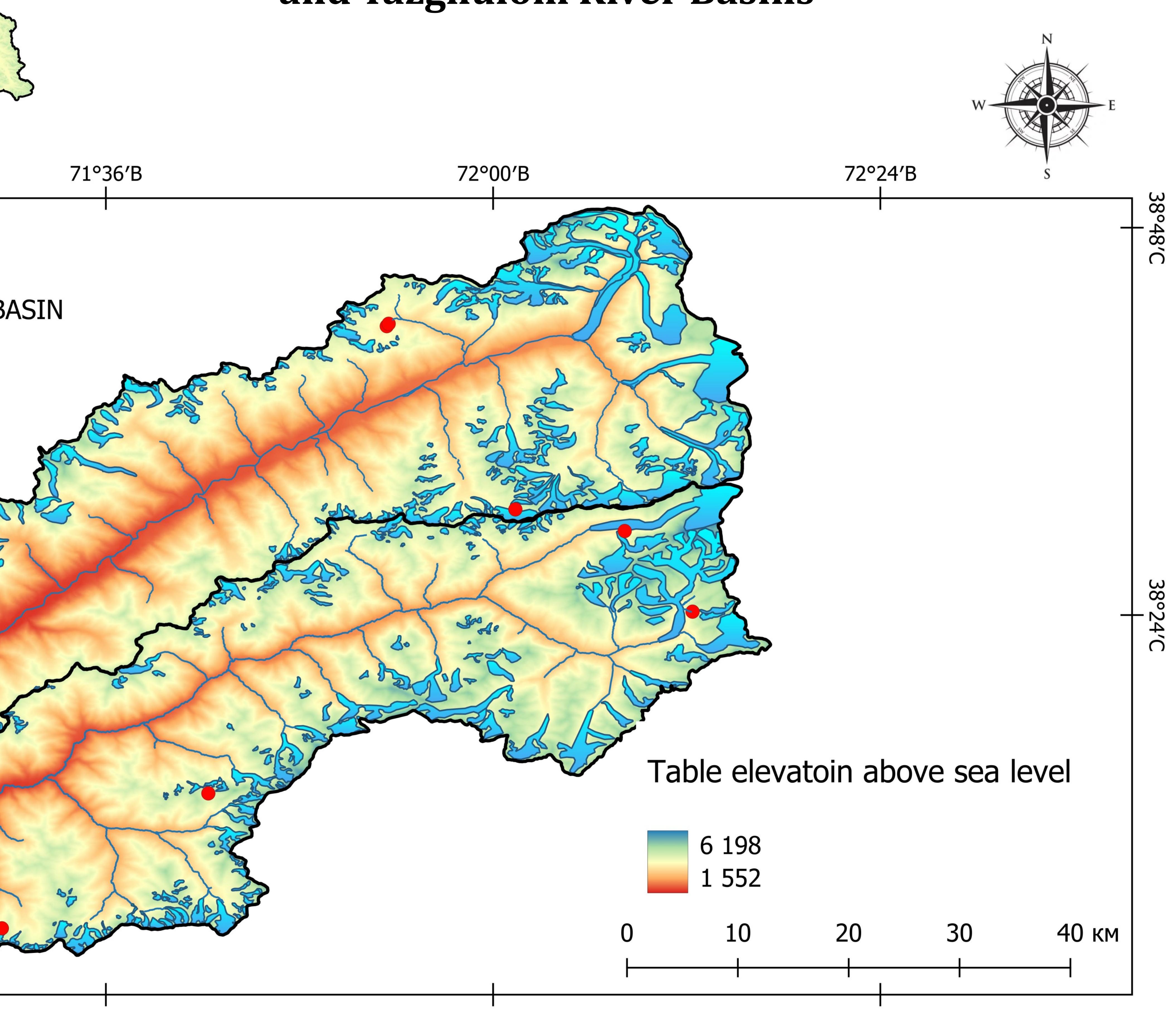
According to photographic data, there are 8 glacial lakes within the Vanj and Yazghulom river basins, with areas categorized as very small (less than 0.05 km^2).

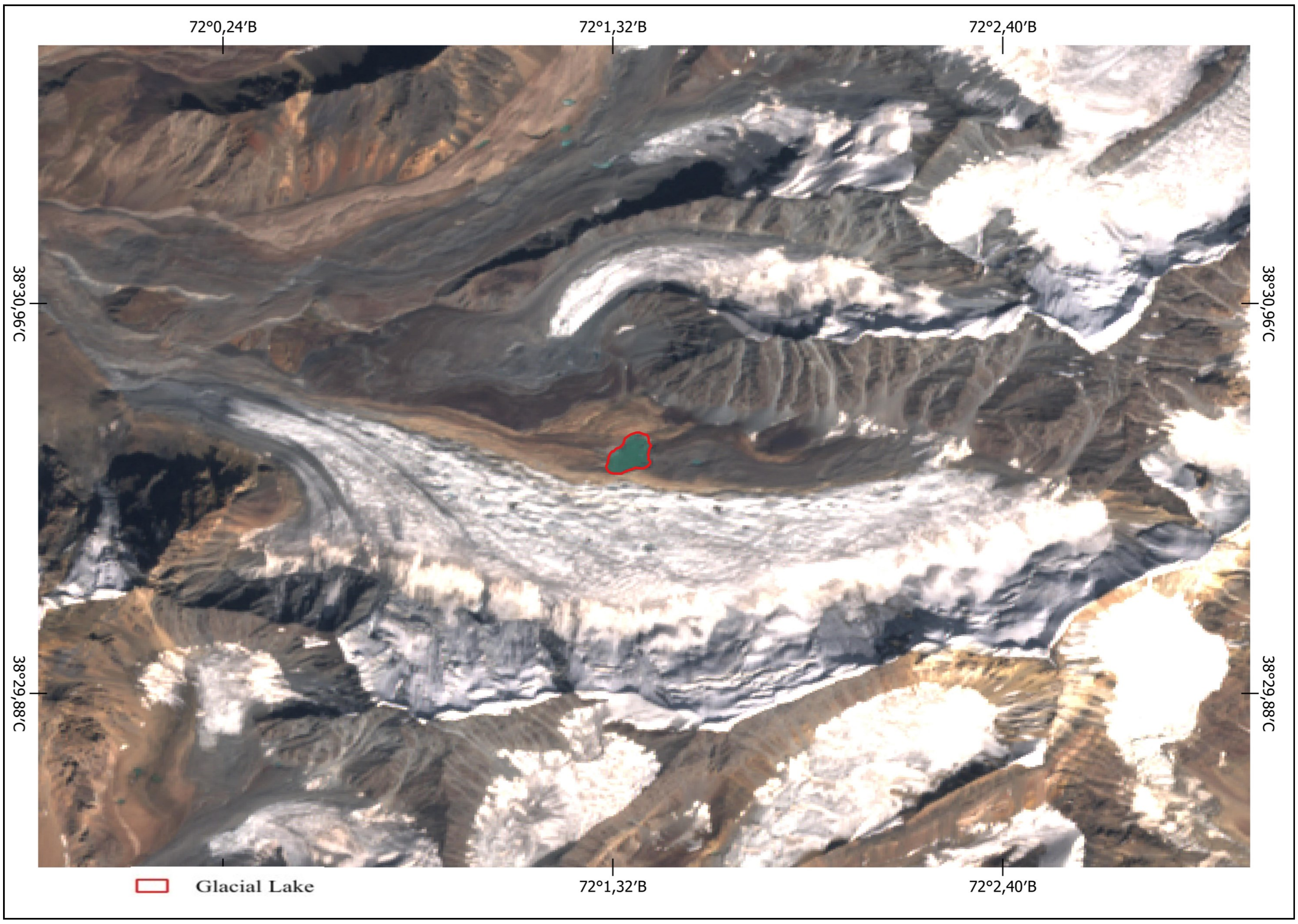






Map of the location of Glacial Lakes in the Vanj and Yazghulom River Basins

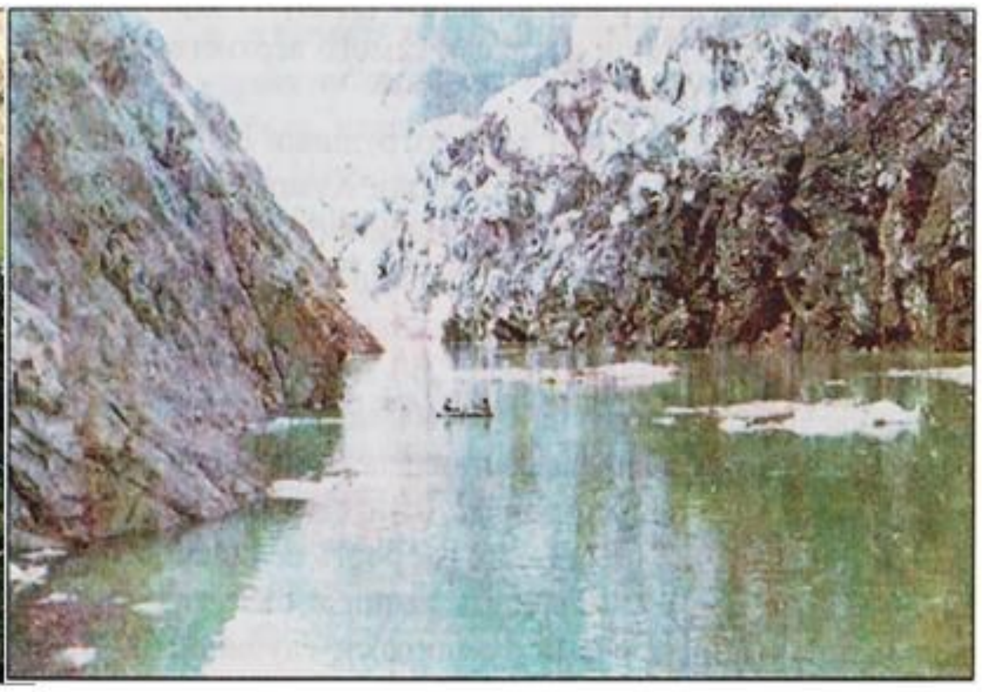




Identification of Glacial Lakes in the Upper Vanj River Basin

The Khirson Glacier, located in the Vanj River basin, is among the rare surge-type glaciers. It is characterized by alternating long periods of stability and sudden rapid advances during which the glacier can move hundreds of meters in a short time. Similar events were observed in 1963, 1973, 1989, 2001, and 2011. As a result of one of these rapid advances, the glacier blocked the Abduqahor River valley, leading to the formation of a glacial lake. The rising water level in this lake caused a sudden breach, which ultimately resulted in destructive downstream floods. Such events clearly demonstrate that the surge behavior and instability of glaciers are directly linked to the formation of temporary lakes and the increasing risk of glacial lake outburst floods (GLOFs).

Movement of the Khirson Glacier, 1973



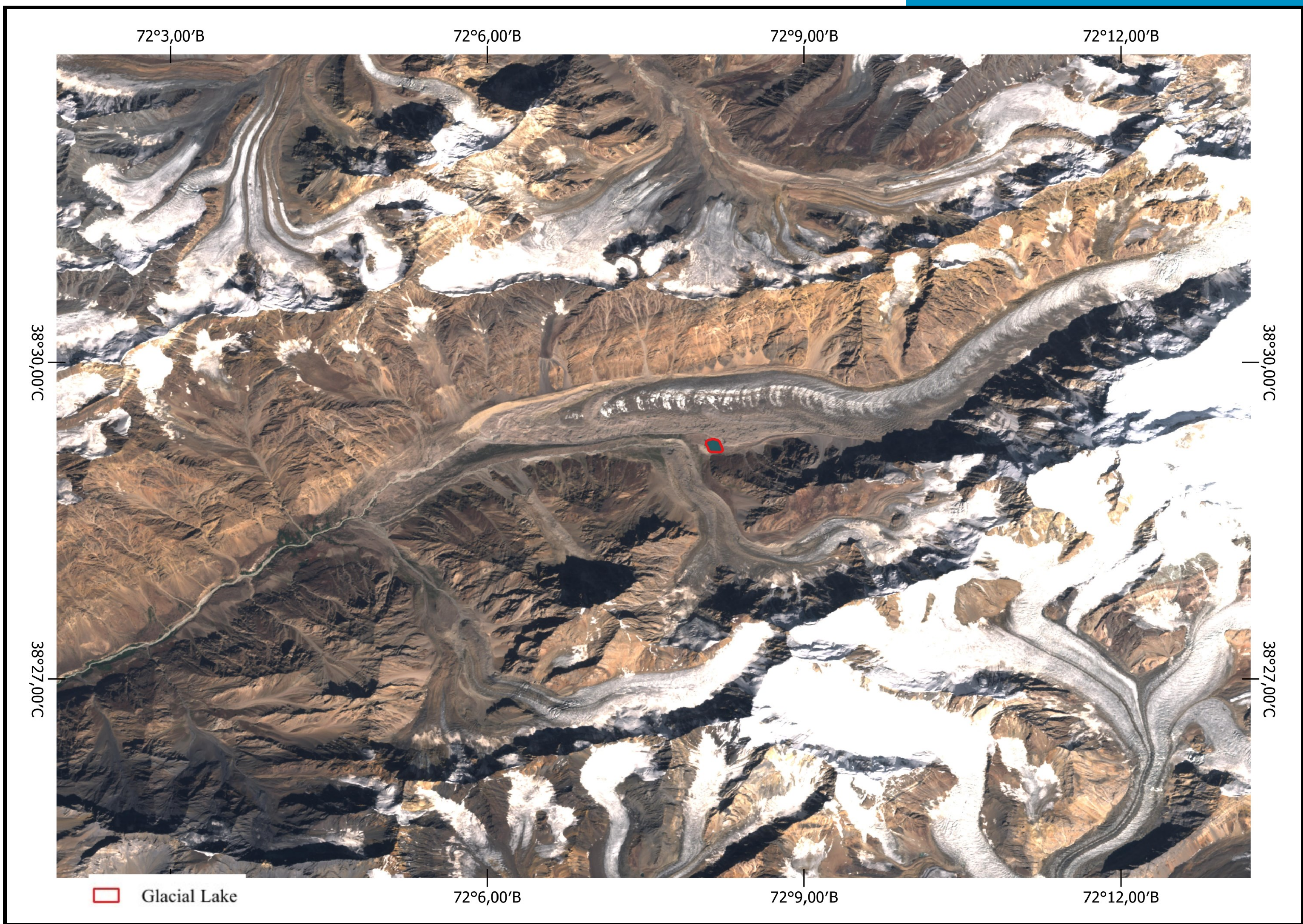
Formation of a Glacial Lake on the Abduqahor River, 1973

Glacial Lakes of the Vanj River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Vanj	75	38, 41' 54	71, 53' 24	Darai Mazor	3631	Moraine	0.05
2	Vanj	75	38, 42' 02	71, 53' 32	Darai Mazor	3631	Moraine	0.01
3	Vanj	185	38, 30' 32	72. 01' 22	Suntagdara	4419	Glacial	0.02

Glacial Lakes of the Yazghulom River Basin

№	Basin	Glacier name	Latitude	Longi-tude	River	Elevation	Type	Area, km^2
1	Yazghulom	-	38, 12' 57	71, 42' 20	Khuzdodara	4460	Moraine	0.01
2	Yazghulom	Yazghulom	38, 29' 12	72, 08' 08	Mazordara	3685	Glacial	0.04
3	Yazghulom	Komsomolet	38, 24' 12	72, 12' 23	Raghob	4180	Glacial	0.02
4	Yazghulom	232	38, 04' 35	71, 29' 33	Daraimotravn	4064	Glacial	0.05
5	Yazghulom	241	38, 06' 16	71, 36' 52	Daratrak	4119	Moraine	0.02



Identification of Glacial Lakes in the Upper Yazghulom River Basin

Bartang River Basin

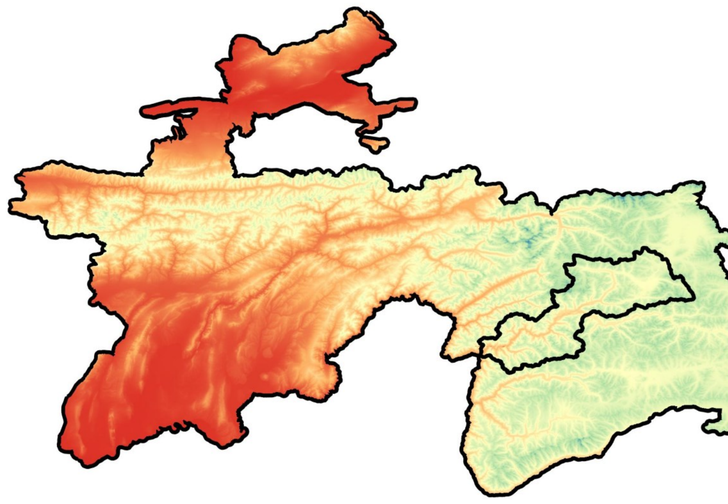
The region described in this section includes the right bank of the Bartang River—specifically the Kudara River—and also encompasses the Tanimas and Kukuybel rivers, as well as the Bartang River valley from the confluence of the Kudara and Murghob rivers to its confluence with the Panj River. To the north, the boundary follows the axial line of the Yazghulom Range, the southern group of the Vang and Devori Baland Ranges. To the east and southeast, the region borders the basin of Lake Qarokul. The total area of this region is approximately 8,000 km^2, with a length of about 180 km from southwest to northeast.

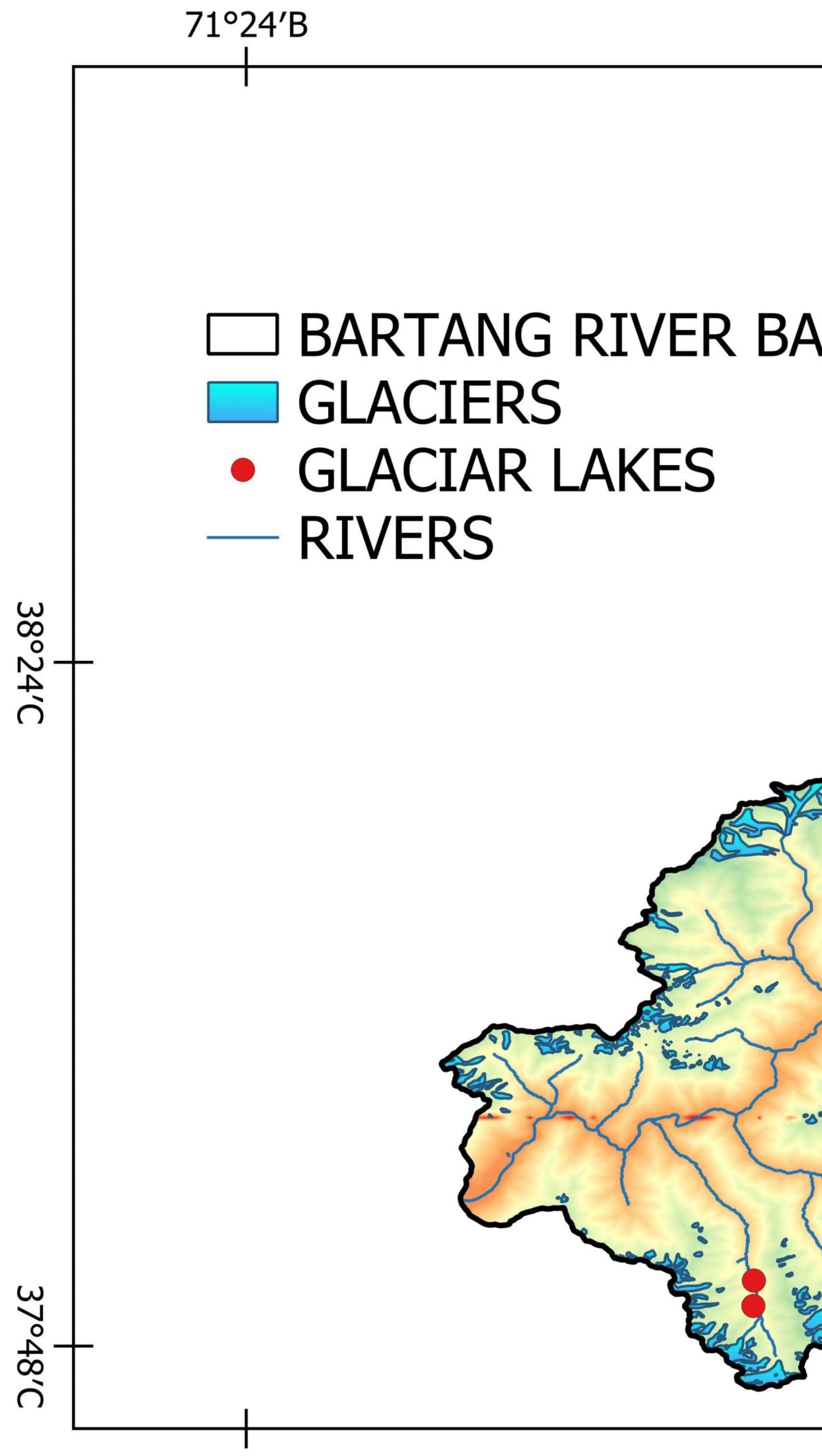
The Bartang River Basin consists of two main geomorphological regions: Eastern Pamir and Western Pamir, which have distinct geomorphological characteristics. The dividing line between these two regions runs from the foot of the Vanjyakh Glacier to the western shore of Lake Sarez. In the western part, the relief of Western Pamir is characterized by a young alpine-type mountain system, while in the eastern part, the Eastern Pamir has older mountains with moderate heights. The formation of the relief in both regions occurred under the influence of glaciers, river erosion, and frost weathering.

The climate of the Bartang River Basin is extremely continental, cold, and dry. The influence of western and southwestern winds is limited by the Yazghulom Range and the Vanjyakh Range, resulting in a low amount of precipitation in the region. The annual precipitation in the lower course of the Bartang River does not exceed 300 mm, and at the foot of the Kukuybel River, it ranges from 50 to 160 mm. The air temperature remains negative for most of the year, particularly at elevations over 4,000 meters—during winter, the temperature can drop to -25°C. The summer season is short, lasting from the end of June to mid-September. Most of the precipitation falls as snow.

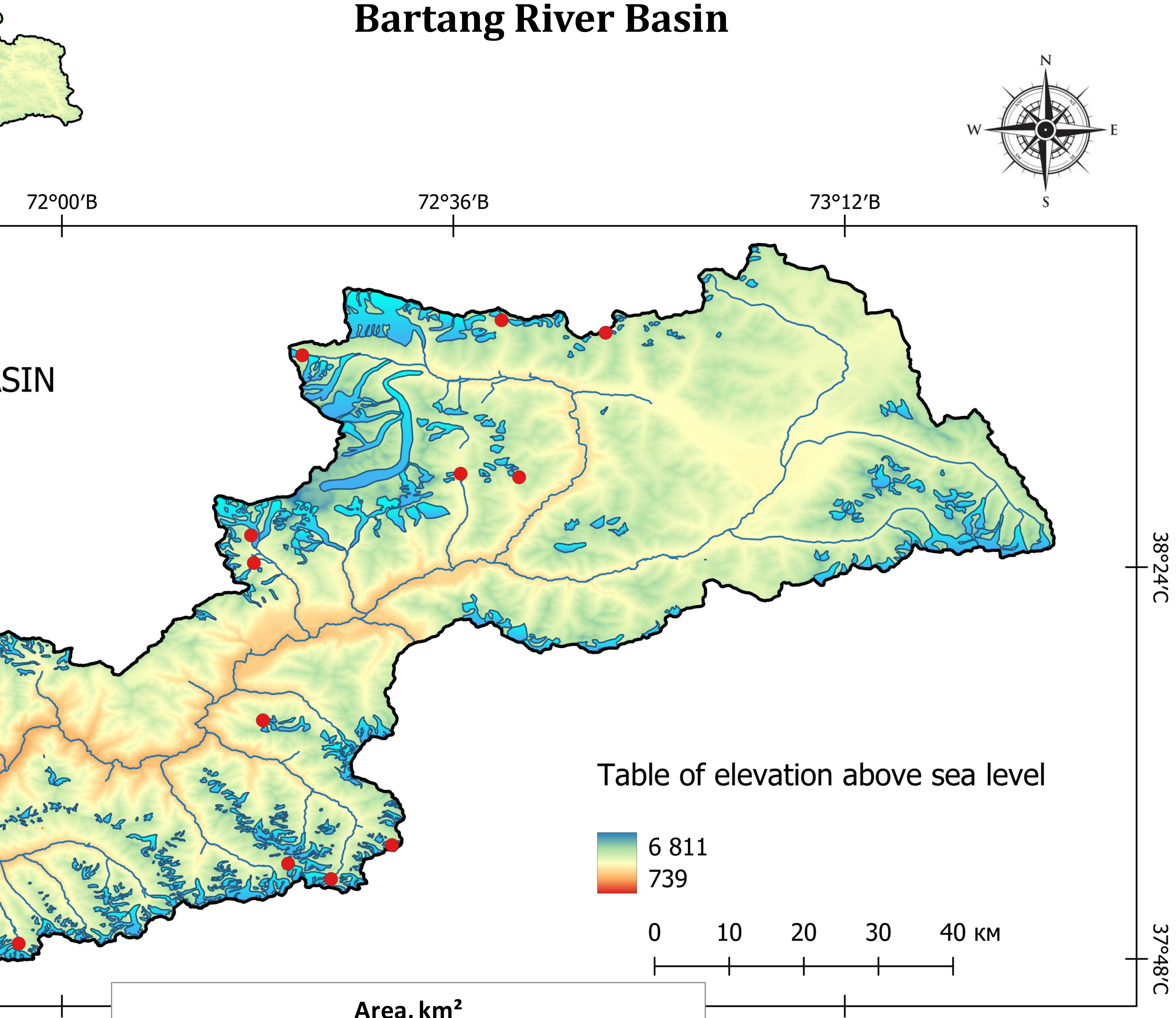
There are 969 glaciers recorded in the basin, covering a total area of 1,082.9 km^2. The majority of the glaciers are located on the southern slopes of the Yazghulom and Northern Tanimas Ranges, as well as on the northern slopes of the Rushon and Muzkol Ranges. The distribution of glaciation in this basin is uneven, with a predominance of hanging and cirque glaciers. Most of the glaciers are smaller than 2 km^2, making up 87.7% by number and 35.7% by area of all glaciers in the region. The Grumm-Grijmailo Glacier is one of the largest in the region, with a large accumulation area.

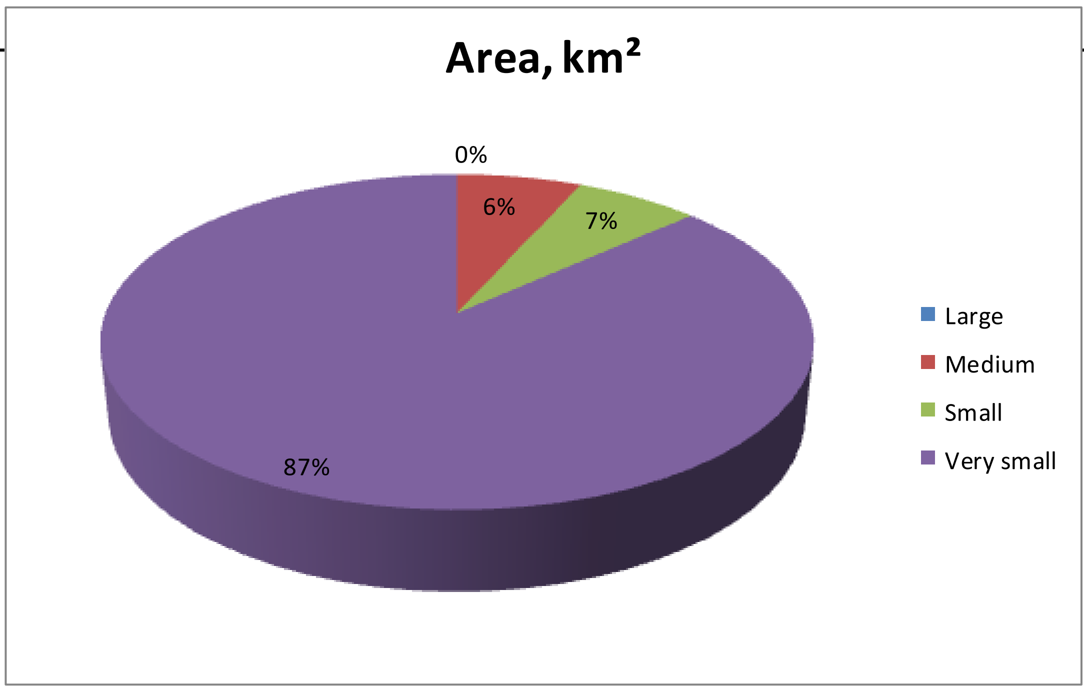
In the Bartang River Basin, one glacial lake has been recorded, which is classified as very small in size (less than 0.05 km^2).





Map of the location of Glacial Lakes in the Bartang River Basin

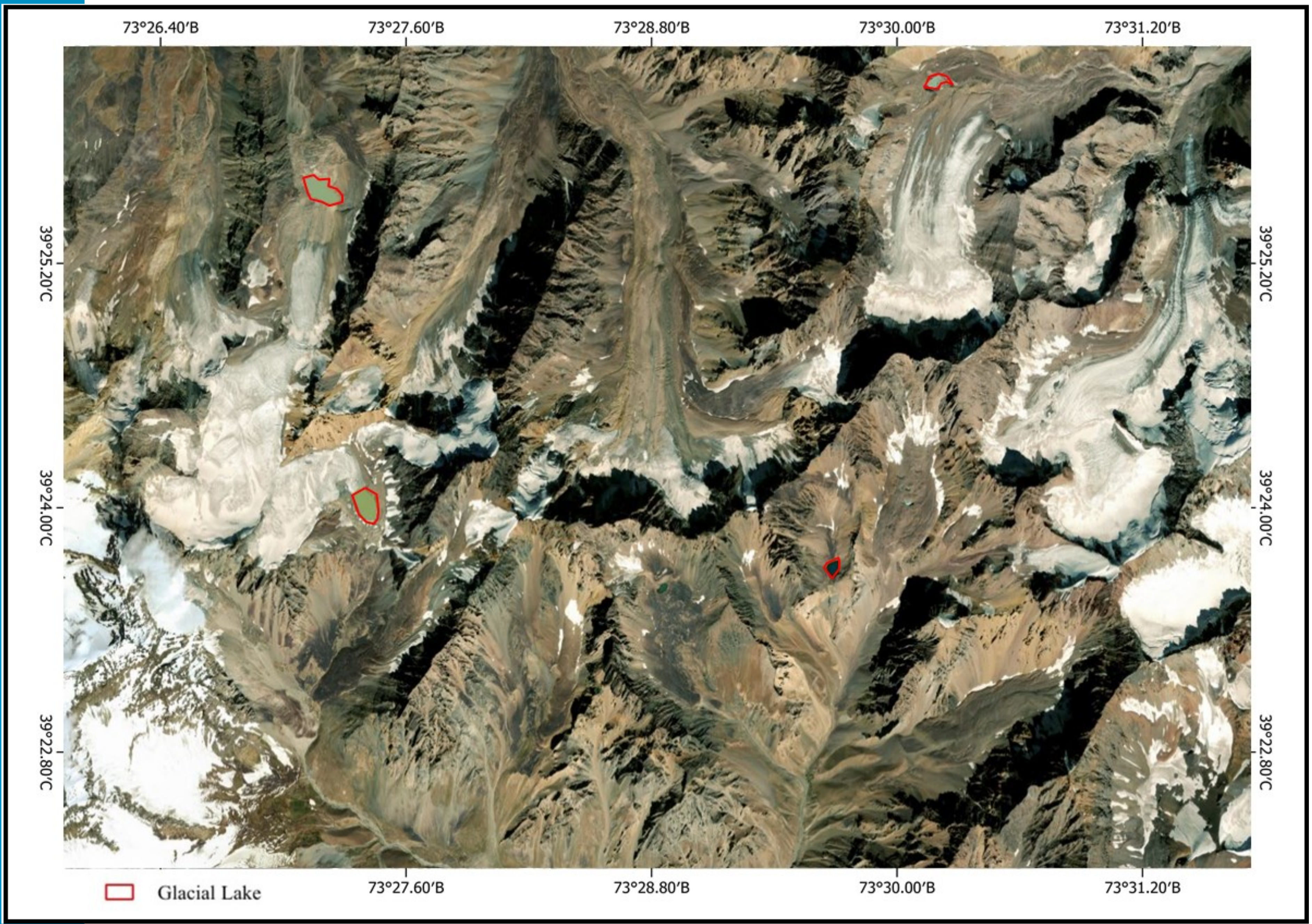




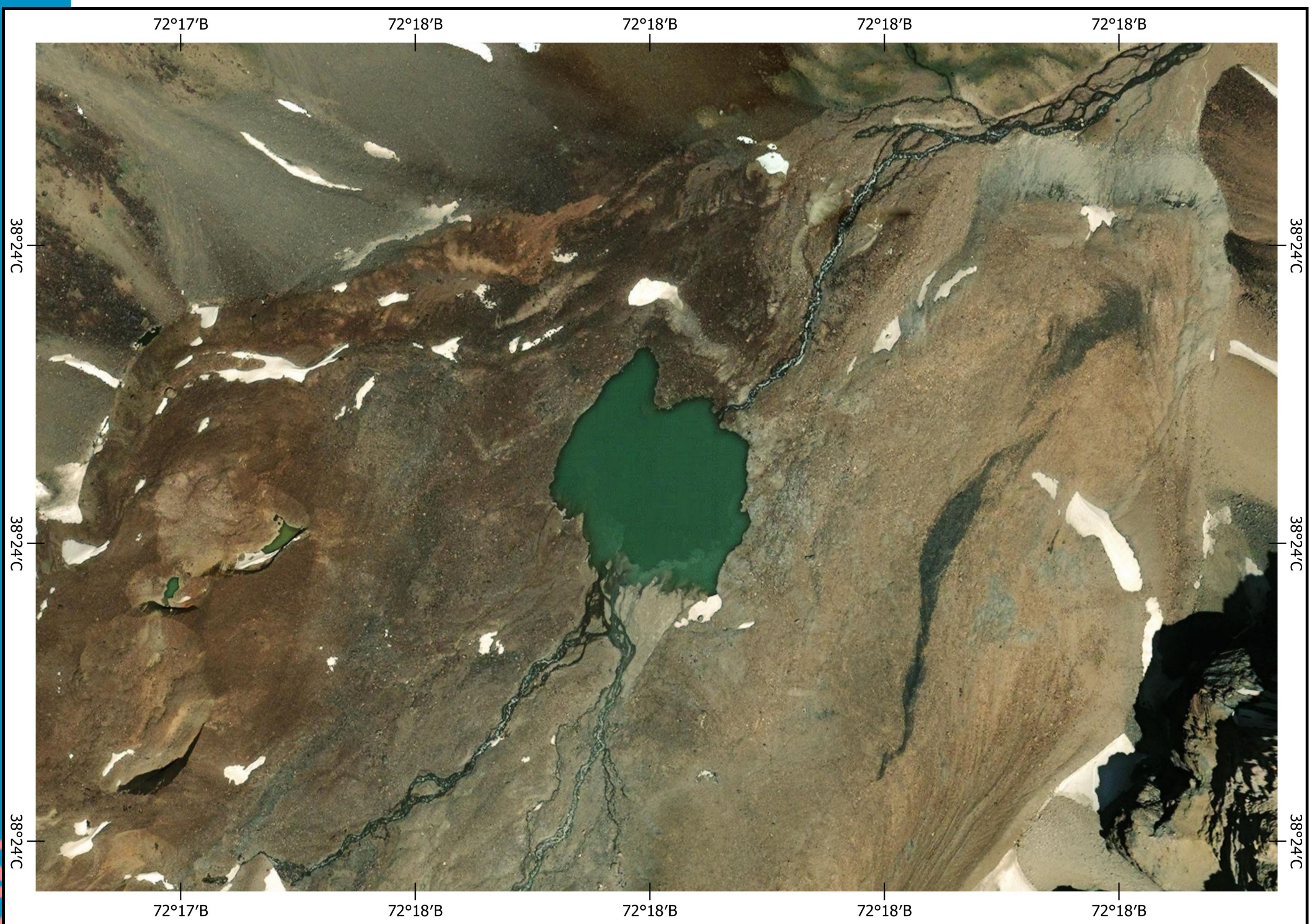
Glacial Lakes of the Bartang River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Eleva-tion	Type	Area, km²
1	Bartang	107	38, 24' 22	72, 17' 38	Yazghulomdara	4021	Glacial	0.02
2	Bartang	Yazghulomdara	38, 26' 54	72, 17' 23	Yazghulomdara	4236	Glacial	0.03
3	Bartang	190	38, 32' 34	72, 36' 39	Khavrozdara	3893	Moraine	0.22
4	Bartang	199	38, 32' 15	72, 42' 03	Khobarang	4460	Moraine	0.02
5	Bartang	Tanimas	38, 41' 05	72, 20' 57	Tanimas	4707	Glacial	0.01
6	Bartang	Tanimas	38, 43' 27	72, 22' 05	Tanimas	4501	Glacial	1.13
7	Bartang	-	38, 45' 33	72, 50' 00	Yangidavo	4676	Moraine	0.02
8	Bartang	331	38, 46' 39	72, 40' 27	Yamanjilga	4696	Moraine	0.08
9	Bartang	596	38, 09' 55	72, 18' 28	Bartang	4460	Glacial	0.02
10	Bartang	647	37, 58' 27	72, 30' 21	Mana	4771	Glacial	0.01
11	Bartang	662	37, 55' 21	72, 24' 42	Bordara	4622	Glacial	0.02
12	Bartang	717	37, 56' 45	72, 20' 46	Devlokh	4676	Glacial	0.03
13	Bartang	783	37, 51' 26	71' 50' 42	Jizevdara	3375	Moraine	0.08
14	Bartang	850	37, 49' 24	71, 56' 02	Shuvdara	4121	Moraine	0.02
15	Bartang	869	37, 50' 06	71, 50' 41	Jizevdara	3625	Moraine	0.05

Identification of Glacial Lakes in the Upper Bartang River Basin



Identification of Glacial Lakes in the upper Bartang River Basin



Glacial Lakes in the upper Bartang River Basin

Ghund and Shohdara River Basins

The Ghund and Shohdara river basins are among the largest in the Gorno-Badakhshan Autonomous Region. They represent one of the main sources of water resources for the region and are the largest left-bank tributaries of the Panj River. These basins cover significant areas within the Shughnon, Rushon, and Ishkoshim districts.

The source of the Ghund River is located on the southwest slope of the Shohdara Range, near the Ghund Glacier, and flows westward through narrow mountain valleys. The Shokhdara River originates at the foothills of the Shughnon and Shohdara Ranges, being the largest tributary of the Ghund River, and merges with the Ghund River 6.5 km before it flows into the Panj River.

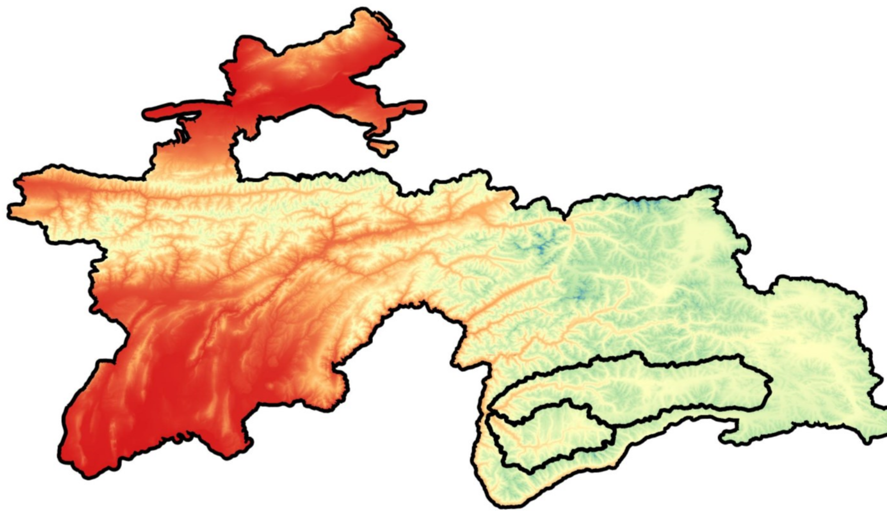
The river basins feature complex mountainous terrain, with elevations ranging from 2,000 to 6,700 meters above sea level. The high Shughnon, Shohdara, and Rushon ranges are covered by permanent snow and glaciers. These glaciers are the main source of water for the rivers, ensuring a steady flow throughout the year.

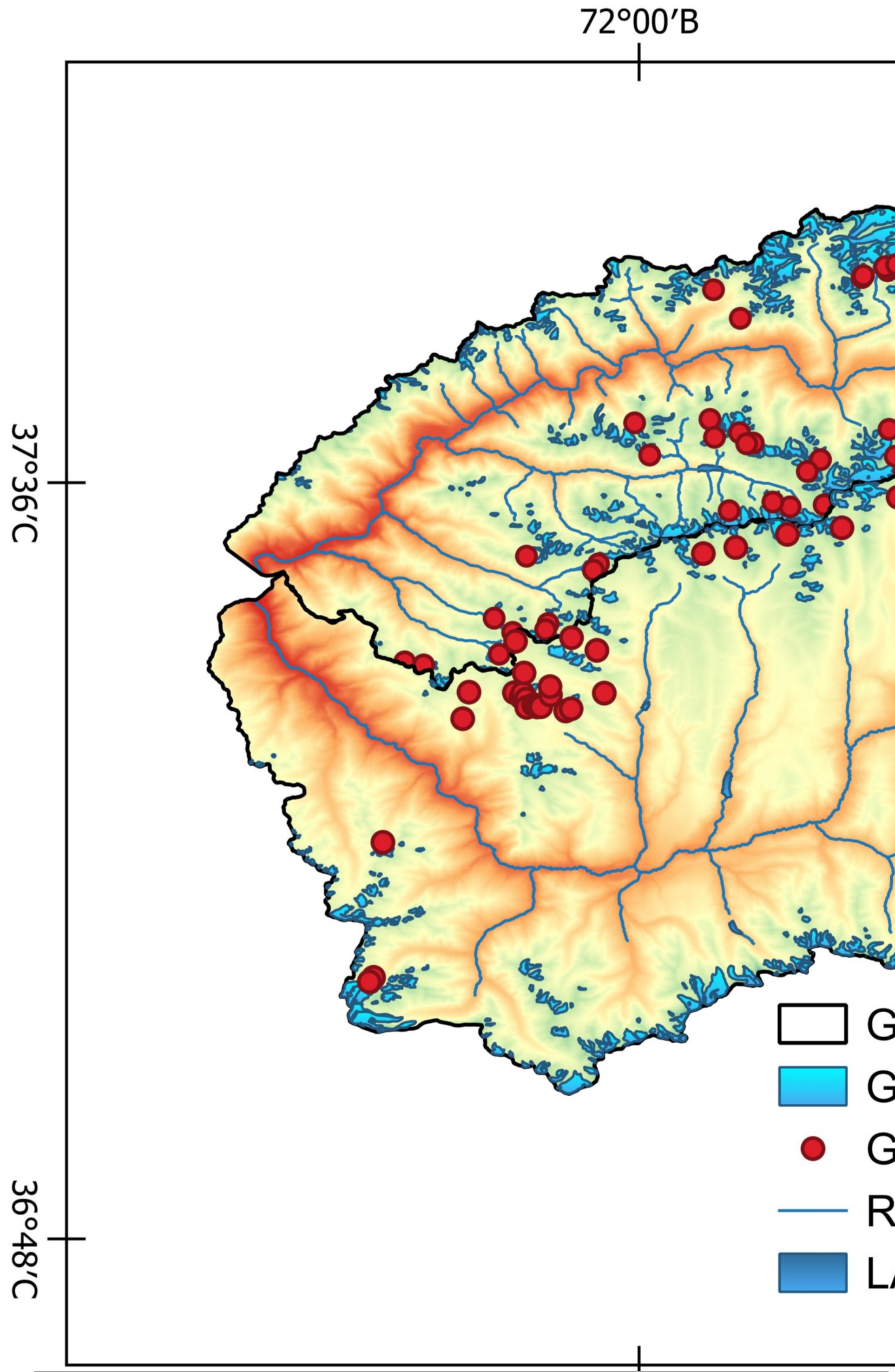
The climate of the Ghund and Shohdara river basins is sharply continental, with cold winters and moderately warm summers. The average temperature in January ranges from -10°C to -25°C, and in high mountain areas, it can drop to -40°C. Summer temperatures in the valleys reach up to +25°C, while in the mountains, it remains cool.

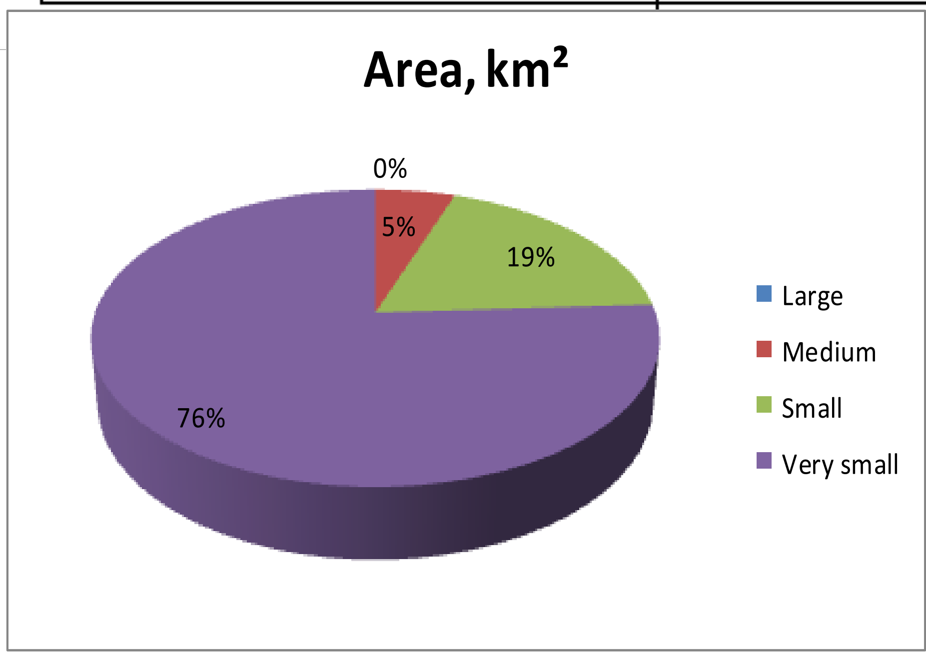
The annual precipitation is relatively low, varying depending on the altitude, ranging from 100 to 400 mm. Most of the precipitation falls in winter and spring as snow and rain. The glaciers and snow resources of the mountains provide a constant supply of water to the rivers, even during dry periods.

The Ghund and Shohdara rivers are fed by a mix of sources, including glaciers, snow, and rain. The river flow regime is characterized by a high flow during the summer when the glaciers and snow are actively melting. The lowest water levels are observed in winter when the precipitation freezes.

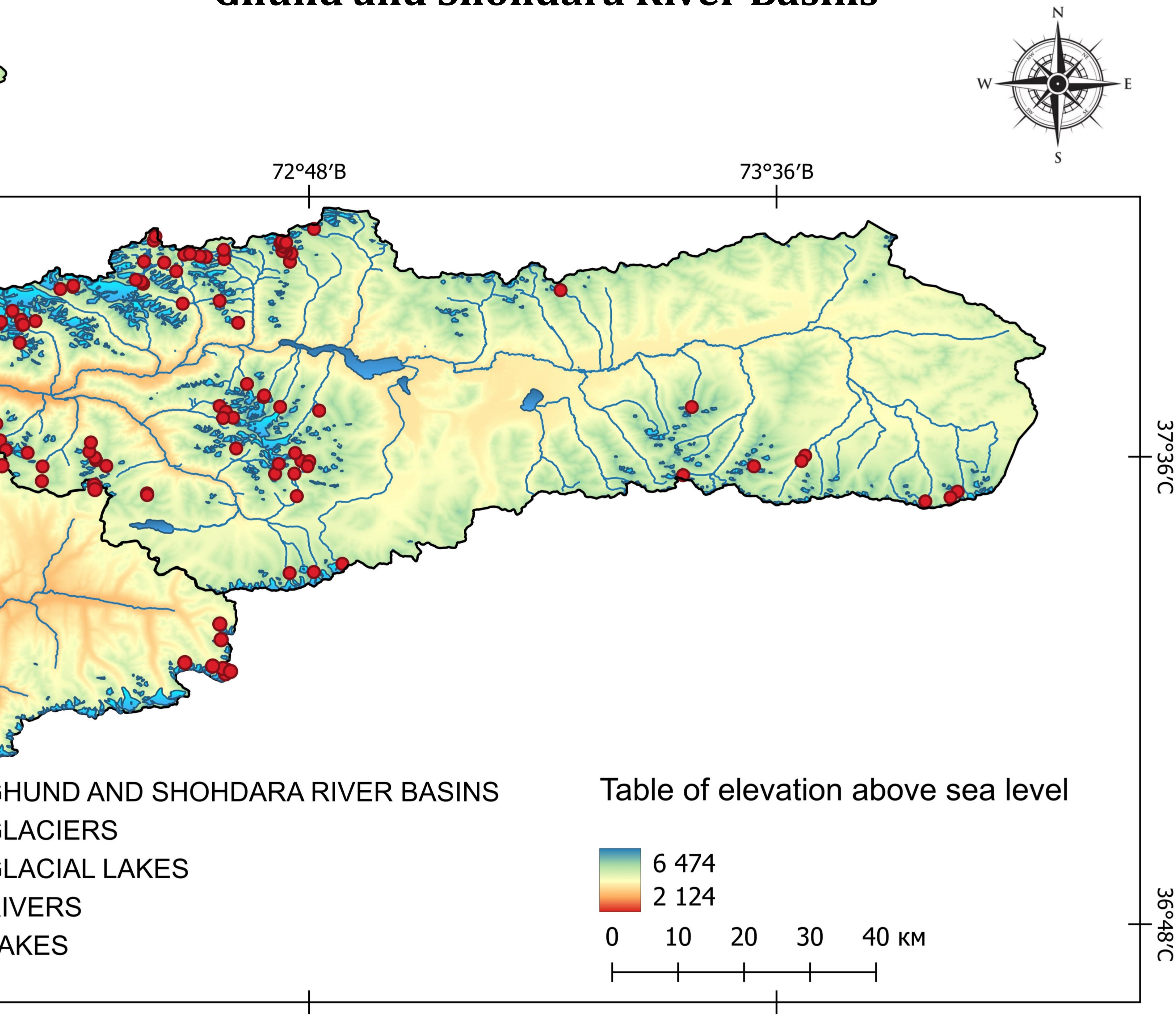
There are 917 glaciers registered in the Ghund and Shohdara river basin, with an area greater than 0.1 km^2, totaling 609 km^2. On the right bank of the Ghund River, 35% of the glaciers are located, 38% on the left bank, and 27% in the Shohdara River basin, making up the total number of glaciers in the region. These glaciers are located at various elevations and are shrinking in size due to climatic processes, leading to the formation of glacial lakes within the basin. The majority of the glacial lakes are classified as very small in terms of area.







Map of the location of Glacial Lakes in the Ghund and Shohdara River Basins



Shazud Glacial Lake, 2024

Glacial Lakes of the Ghund River Basin

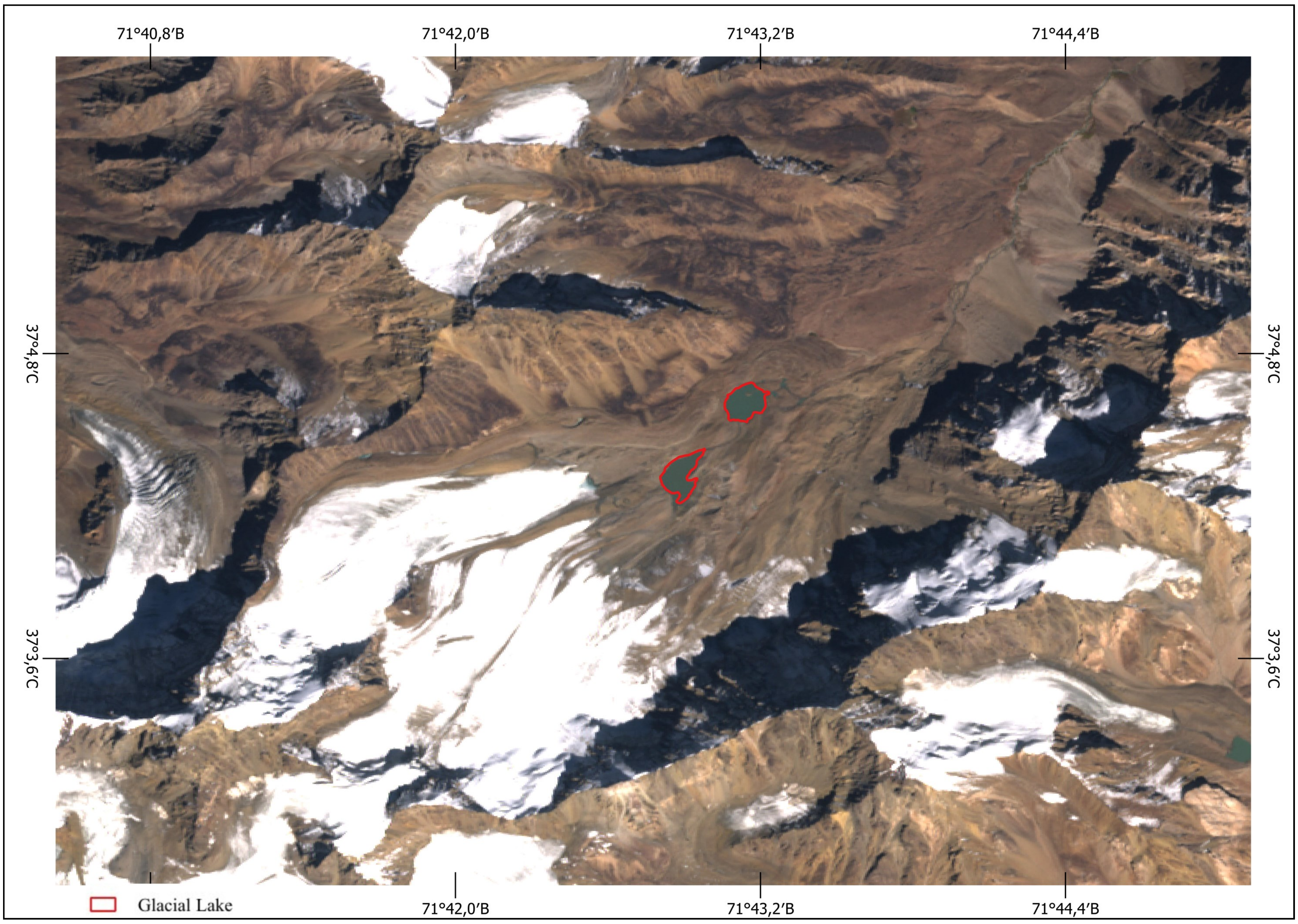
№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
1	Ghund	43	37, 48' 14	72, 04' 43	Zuvordara	4210	Glacial	0.01
2	Ghund	54	37, 46' 25	72, 06' 25	Ghund	4549	Glacial	0.01
3	Ghund	82	37, 49' 00	72, 14' 09	Chapdara	4669	Glacial	0.02
4	Ghund	82	37, 49' 08	72, 14' 14	Chapdara	4667	Glacial	0.01
5	Ghund	84	37, 49' 26	72, 15' 46	Chapdara	4628	Glacial	0.05
6	Ghund	84	37, 49' 37	72, 16' 08	Chapdara	4745	Glacial	0.01
7	Ghund	84	37, 49' 41	72, 15' 36	Chapdara	4708	Glacial	0.02
8	Ghund	84	37, 49' 51	72, 16' 20	Chapdara	4809	Glacial	0.02
9	Ghund	88	37, 47' 41	72, 18' 17	Chapdara	4463	Glacial	0.03
10	Ghund	104	37, 50' 58	72, 17' 32	Shazuddara	4904	Glacial	0.01
11	Ghund	104	37, 50' 02	72, 18' 24	Shazuddara	4646	Glacial	0.05
12	Ghund	105	37, 49' 33	72, 18' 39	Shazuddara	4593	Glacial	0.06
13	Ghund	106	37, 49' 31	72, 18' 31	Shazuddara	4600	Glacial	0.02
14	Ghund	107	37, 49' 55	72, 19' 53	Shazuddara	4529	Glacial	0.01
15	Ghund	136	37, 53' 13	72, 22' 25	Safedob	4599	Glacial	0.02
16	Ghund	138	37, 53' 24	72, 23' 44	Safedob	4688	Glacial	0.02
17	Ghund	138	37, 53' 32	72, 23' 45	Safedob	4691	Glacial	0.01
18	Ghund	151	37, 51' 42	72, 34' 59	Uar	3921	Moraine	0.03
19	Ghund	Uar	37, 53' 44	72, 30' 58	Uar	4565	Glacial	0.03
20	Ghund	Uar	37, 53' 57	72, 30' 45	Uar	4561	Glacial	0.49

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
21	Ghund	164	37, 54' 09	72, 30' 11	Bartangi	4630	Glacial	0.07
22	Ghund	167	37°56'02	72°31'12	Bartangi	4514	Moraine	5.44
23	Ghund	171	37, 58' 08	72, 32' 02	Bartangi	4533	Moraine	0.10
24	Ghund	171	37, 58' 34	72, 32' 09	Bartangi	4528	Moraine	0.09
25	Ghund	174	37, 55' 54	72, 33' 10	Bartangi	4476	Moraine	0.04
26	Ghund	176	37, 56' 45	72, 35' 12	Bartangi	4606	Moraine	0.02
27	Ghund	177	37,54' 56	72, 34' 28	Bartangi	4290	Glacial	0.33
28	Ghund	184	37, 52' 00	72, 38' 48	Kayk	4817	Glacial	0.03
29	Ghund	186	37, 49' 45	72, 41' 40	Langar	4590	Glacial	0.02
30	Ghund	199	37, 56' 16	72, 39' 17	Chapdara	4551	Moraine	0.07
31	Ghund	199	37, 57' 14	72, 38' 59	Chapdara	4527	Moraine	3.00
32	Ghund	200	37, 56' 31	72, 37' 25	Langar	4626	Moraine	0.02
33	Ghund	200	37, 56' 35	72, 36' 48	Bartangi	4644	Glacial	0.03
34	Ghund	201	37, 56' 50	72, 35' 46	Chapdara	4690	Glacial	0.03
35	Ghund	214	37, 56' 01	72, 46' 03	Qaradara	4548	Moraine	0.03
36	Ghund	215	37, 56' 50	72, 46' 14	Qaradara	4472	Moraine	0.06
37	Ghund	215	37, 57' 01	72, 45' 37	Qaradara	4533	Moraine	0.05
38	Ghund	216	37, 57' 06	75, 45' 14	M.Marjonov	4597	Moraine	0.07
39	Ghund	216	37, 57' 28	72, 45' 32	M.Marjonov	4589	Moraine	0.02
40	Ghund	217	37, 57' 34	72, 45' 27	M.Marjonov	4596	Moraine	0.01
41	Ghund	217	37, 57' 37	72, 45' 14	M.Marjonov	4621	Moraine	0.01
42	Ghund	217	37, 57' 58	72, 45' 03	M.Marjonov	4695	Moraine	0.02
43	Ghund	217	37, 58' 09	72, 45' 13	M.Marjonov	4751	Moraine	0.01
44	Ghund	218	37, 57' 58	72, 45' 37	M.Marjonov	4753	Moraine	0.01
45	Ghund	223	37, 59' 23	72, 48' 28	Kokbelas	4889	Moraine	0.02
46	Ghund	253	37, 53' 06	73, 13' 48	Kulakesta	4802	Moraine	0.01
47	Ghund	258	37,35' 30	73, 59' 11	Irisu	4521	Moraine	0.02
48	Ghund	264	37, 25' 00	72, 51' 23	Gurumdi	4909	Glacial	0.26
49	Ghund	267	37, 32' 24	73, 54' 35	Gurumdi	5008	Glacial	0.01
50	Ghund	271	37, 31' 49	73, 53' 53	Kanjiber	4803	Moraine	0.04
51	Ghund	280	37, 24' 05	72, 45' 56	Kanjiber	4589	Moraine	0.21
52	Ghund	293	37, 36' 03	73, 38' 55	Koluchol	4179	Moraine	1.28
53	Ghund	293	37, 35' 33	73, 38' 33	Koluchol	4179	Moraine	0.04
54	Ghund	307	37, 35' 00	73, 33' 40	Koluchol	4879	Moraine	0.01
55	Ghund	322	37, 34' 06	73, 26' 24	Bashgumbez	4803	Moraine	0.01
56	Ghund	337	37, 41' 06	73, 27' 17	Kulkorumdi	4621	Moraine	0.09
57	Ghund	367	37, 40' 42	72, 49' 01	Bakchigir	4368	Moraine	0.21
58	Ghund	380	37, 42' 08	72, 43' 19	Urta-Bakchigir	4565	Glacial	0.02
59	Ghund	380	37, 42' 16	72, 43' 23	Urta-Bakchigir	4551	Glacial	0.02
60	Ghund	385	37, 43' 27	72, 41' 35	Oqtayloq	4507	Glacial	0.01
61	Ghund	Urta-Soghchigir	37, 41' 07	72, 45' 00	Urta-Soghchigir	4427	Glacial	0.31

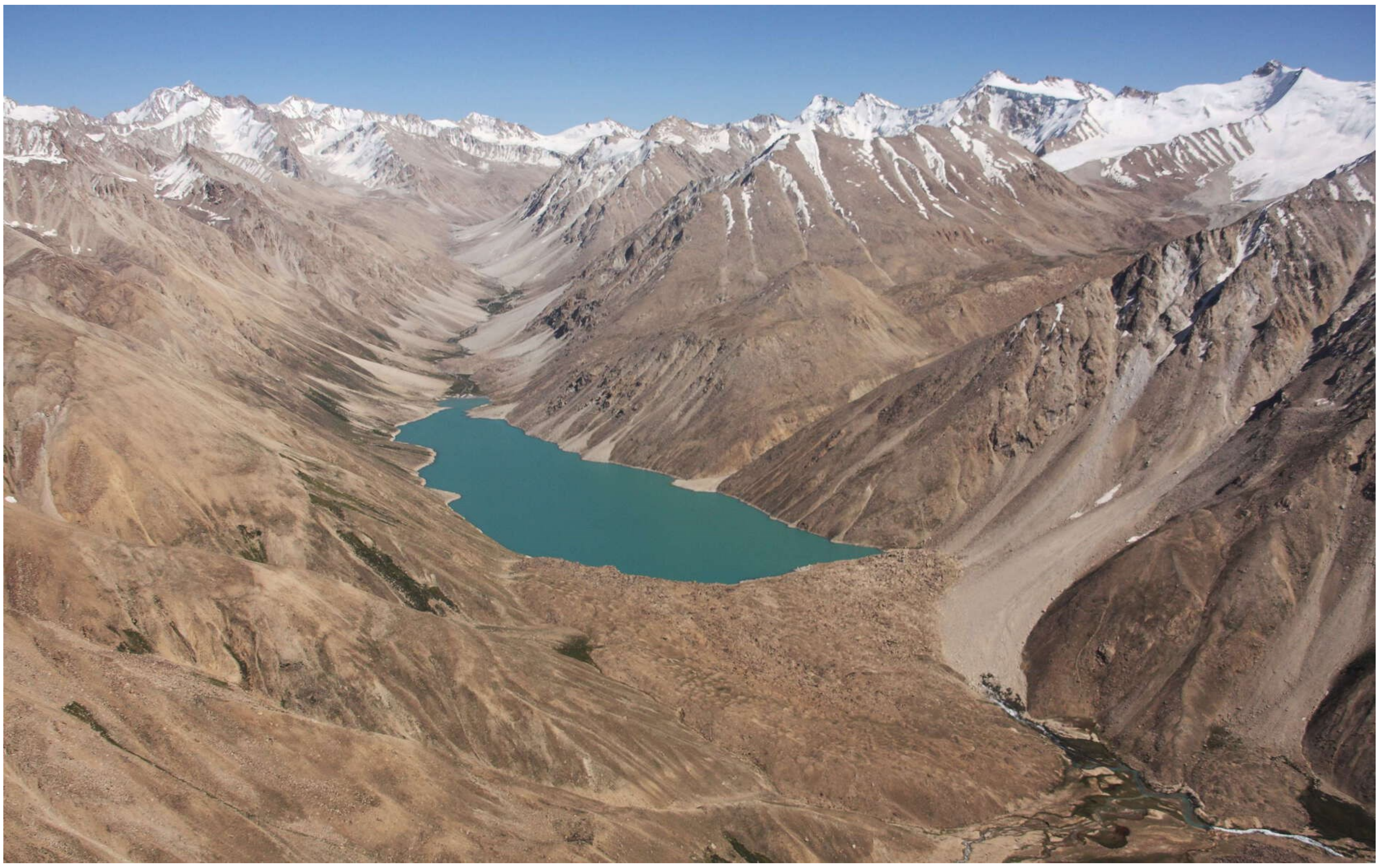
№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
62	Ghund	401	37, 41' 11	72, 38' 48	Oqtayloq (south)	4466	Moraine	0.02
63	Ghund	403	37, 40' 38	72, 39' 25	Oqtayloq (south)	4666	Moraine	0.08
64	Ghund	405	37, 40' 00	72, 40' 09	Oqtayloq (south)	4674	Moraine	0.03
65	Ghund	406	37, 39' 58	72, 39' 08	Oqtayloq (south)	4591	Moraine	0.04
66	Ghund	425	37, 36' 51	72, 40' 30	Tuzuqbuloq	4683	Moraine	0.03
67	Ghund	440	37, 34' 13	72, 44' 29	Gurumdi	4674	Moraine	0.05
68	Ghund	441	37, 35' 15	72, 44' 53	Upalsoy	4844	Moraine	0.01
69	Ghund	444	37, 35' 39	72, 47' 09	Upalsoy	4418	Moraine	0.62
70	Ghund	444	37, 34' 16	72, 46' 28	Upalsoy	4327	Moraine	0.11
71	Ghund	445	37, 36' 21	72, 46' 31	Upalsoy	4511	Glacial	0.11
72	Ghund	448	37, 35' 31	72, 48' 01	Upalsoy	4435	Moraine	0.03
73	Ghund	453	37, 35' 02	72, 47' 49	Upalsoy	4435	Moraine	0.12
74	Ghund	455	37, 31' 58	72, 46' 44	Upalsoy	4219	Moraine	0.79
75	Ghund	459	37, 36' 24	72, 19' 04	Ayransu	4750	Glacial	0.02
76	Ghund	459	37, 24' 12	72, 48' 24	Gurumdi	4688	Glacial	0.05
77	Ghund	479	37, 35' 02	72, 27' 10	Tuzuqbuloq	4458	Moraine	0.11
78	Ghund	482	37, 35' 39	72, 36' 05	Duzakhdara	4547	Glacial	0.03
79	Ghund	482	37, 35' 53	72, 26' 00	Duzakhdara	4529	Moraine	0.01
80	Ghund	483	37, 36' 28	72, 25' 24	Duzakhdara	4443	Moraine	0.09
81	Ghund	483	37, 37' 27	72, 27' 33	Duzakhdara	4298	Moraine	0.09
82	Ghund	488	37, 33' 33	72, 20' 33	Kulindra	4391	Moraine	0.31
83	Ghund	490	37, 35' 10	72, 20' 38	Duzakhdara	4291	Glacial	0.56
84	Ghund	Varshedz	37, 37' 40	72, 16' 14	Varshedz	4517	Glacial	0.17
85	Ghund	501	37, 36' 41	72, 16'	Varshedz	4799	Glacial	0.37
86	Ghund	Rog	37, 39' 21	72, 15' 53	Pishdara	4572	Glacial	0.10
87	Ghund	515	37, 37' 28	72, 11' 29	Akamadara	4807	Glacial	0.02
88	Ghund	522	37, 38' 31	72, 07' 14	Chartimdara	4522	Glacial	0.02
89	Ghund	523	37, 38' 28	72, 06' 50	Chartimdara	4633	Glacial	0.02
90	Ghund	524	37, 39' 10	72, 06' 22	Chartimdara	4744	Glacial	0.01
91	Ghund	532	37, 40' 04	72, 04' 32	Nematsdara	4442	Moraine	0.02
92	Ghund	535	37, 39' 48	71, 59' 43	Vuzhdara	4351	Moraine	0.01
93	Ghund	542	37, 37' 44	72, 00' 43	Vuzhdara	4553	Glacial	0.04
94	Ghund	546	37, 38' 52	72, 04' 48	Vuzhdara	4683	Glacial	0.03
95	Ghund	549	37, 36' 38	72, 10' 40	Rivakdara	4744	Glacial	0.04
96	Ghund	554	37, 34' 35	72, 11' 44	Rivakdara	4960	Glacial	0.01
97	Ghund	555	37, 34' 28	72, 09' 35	Rivakdara	4640	Glacial	0.01
98	Ghund	556	37, 34' 46	72, 08' 29	Rivakdara	4836	Glacial	0.02
99	Ghund	561	37, 34' 13	72, 05' 42	Rivakdara	4520	Glacial	0.11

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
102	Ghund	615	37, 31' 20	71, 52' 50	Kalkhozobod	4394	Glacial	0.03
103	Ghund	621	37, 27' 03	71, 54' 13	Shoripdara	4492	Moraine	0.02
104	Ghund	622	37, 26' 42	71, 54' 07	Shoripdara	4479	Glacial	0.05
105	Ghund	626	37, 27' 23	71, 50' 48	Bagivdara	4257	Moraine	0.10
106	Ghund	632	37, 24' 30	71, 46' 19	Urmochdara	4410	Moraine	0.02
107	Ghund	634	37, 24' 37	71, 45' 07	Urmochdara	4488	Glacial	0.01
108	Ghund	-	37, 25' 55	71, 52' 08	Bagivdara	4515	Moraine	0.07
109	Ghund	-	37, 26' 29	71, 51' 57	Bagivdara	4447	Moraine	0.05
110	Ghund	-	37, 32' 14	72, 31' 21	Toquzbuloq	4258	Moraine	0.02
111	Ghund	-	37, 32' 04	72, 31' 20	Toquzbuloq	4262	Moraine	0.02
112	Ghund	-	37, 25' 07	71, 51' 06	Urmochdara	4396	Moraine	0.01
100	Ghund	612	37, 30' 26	71, 57' 06	Uyben	4473	Glacial	0.03
101	Ghund	612	37, 30' 50	71, 57' 25	Uyben	4556	Moraine	0.01

Varshedz Glacial Lake, 2024



Identification of Glacial Lakes in the upper Shohdara River Basin



Rivakkul Moraine Lake, 2023

Glacial lakes of the Shohdara River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Eleva-tion	Type	Area, km²
1	Shohdara	-	37, 21' 01	71, 48' 48	Zanindara	4412	Moraine	0.01
2	Shohdara	-	37, 22' 34	71, 54' 232	Khitsondara	4554	Moraine	0.04
3	Shohdara	-	37, 23' 03	71, 54' 20	Khtsumetsdara	4426	Moraine	0.04
4	Shohdara	-	37, 22' 41	71, 49' 11	Zanojdara	4411	Moraine	0.03
5	Shohdara	656	37, 21' 48	71, 52' 51	Chandimdara	4454	Moraine	0.04
6	Shohdara	656	37, 21' 49	71, 53' 45	Chandimdara	4450	Moraine	0.02
7	Shohdara	656	37, 21' 58	71, 53' 22	Chandimdara	4452	Moraine	0.08
8	Shohdara	656	37, 22' 22	71, 52' 59	Chandimdara	4505	Moraine	0.14
9	Shohdara	656	37, 22' 37	71, 52' 44	Chandimdara	4583	Moraine	0.01
10	Shohdara	656	37, 22' 23	71, 52' 31	Chandimdara	4531	Moraine	0.02
11	Shohdara	656	37, 22' 39	71, 52' 04	Chandimdara	4572	Moraine	0.11
12	Shohdara	656	37, 21' 45	71, 53' 31	Chandimdara	4453	Moraine	0.02
13	Shohdara	658	37, 22' 41	71, 57' 46	Khitsondara	4005	Moraine	0.15
14	Shohdara	662	37, 23' 55	71, 52'41	Khtsumetsdara	4523	Moraine	0.01
15	Shohdara	665	37, 25' 21	71, 57' 19	Shaviashdara	4359	Moraine	0.25
16	Shohdara	667	37, 26' 08	71, 55' 41	Shaviashdara	4530	Moraine	0.07
17	Shohdara	668	37, 21' 32	71, 55' 20	Chandimdara	4509	Moraine	0.02
18	Shohdara	668	37, 55' 43	71, 55' 40	Chandimdara	4490	Moraine	0.01
19	Shohdara	690	37, 31' 29	72, 04' 04	Drumdara	4687	Moraine	0.03
20	Shohdara	695	37, 31' 53	73, 06' 08	Drumdara	4791	Glacial	0.01
21	Shohdara	703	37, 32, 42	72, 09' 25	Drumdara	4885	Glacial	0.04
22	Shohdara	725	37, 33' 08	72, 12' 52	Nemots	4721	Glacial	0.01
23	Shohdara	736	37, 35' 03	72, 16' 27	Ayransu	4606	Glacial	0.01
24	Shohdara	738	37, 33' 04	72, 25' 56	Duzakhdara	4622	Moraine	0.04
25	Shohdara	738	37, 32' 38	72, 25' 59	Duzakhdara	4528	Moraine	0.02
26	Shohdara	745	37, 23' 29	72, 39' 20	Shalmats	4408	Moraine	0.07
27	Shohdara	747	37, 18' 49	72, 38' 49	Shalmats	4517	Moraine	0.02
28	Shohdara	748	37, 17' 14	72, 38' 57	Javshangoz	4585	Moraine	0.08
29	Shohdara	752	37, 13' 42	72, 39' 24	Javshangoz	4805	Glacial	0.03
30	Shohdara	752	37, 13' 57	72, 39' 54	Javshangoz	4744	Glacial	0.05
31	Shohdara	752	72, 39' 34	37, 14' 05	Javshangoz	4743	Glacial	0.02
32	Shohdara	752	72, 39' 08	37, 14' 18	Javshangoz	4671	Glacial	0.09
33	Shohdara	755	72, 38' 05	37, 14' 32	Javshangoz	4535	Glacial	0.02
34	Shohdara	761	37, 14' 51	72, 35' 14	Javshangoz	4535	Glacial	0.02
35	Shohdara	882	37, 04' 19	71, 42' 51	Darmordavon	4360	Glacial	0.05
36	Shohdara	882	37, 04' 36	71, 43' 08	Darmordavon	4279	Moraine	0.05
37	Shohdara	902	37, 13' 12	71, 43 ' 44	Dasht	4340	Moraine	0.01

Panj River Basin (lower part)

The Panj River basin is located within the Darvoz region in the south of the Republic of Tajikistan, on the right bank of the Panj River, in the area where the Pamir and Hindu Kush mountain ranges converge. The region's terrain is predominantly mountainous, characterized by steep slopes, deep valleys, and significant vertical relief. Elevation in the river basin ranges from 1,000 to over 4,000 meters above sea level.

The climate of the region is continental and mountainous, with distinct vertical zonation. In the lower parts, winters are moderately cold, while in the highlands they are very cold with abundant snowfall. Summers are hot and dry in the valleys and mild in the highlands.

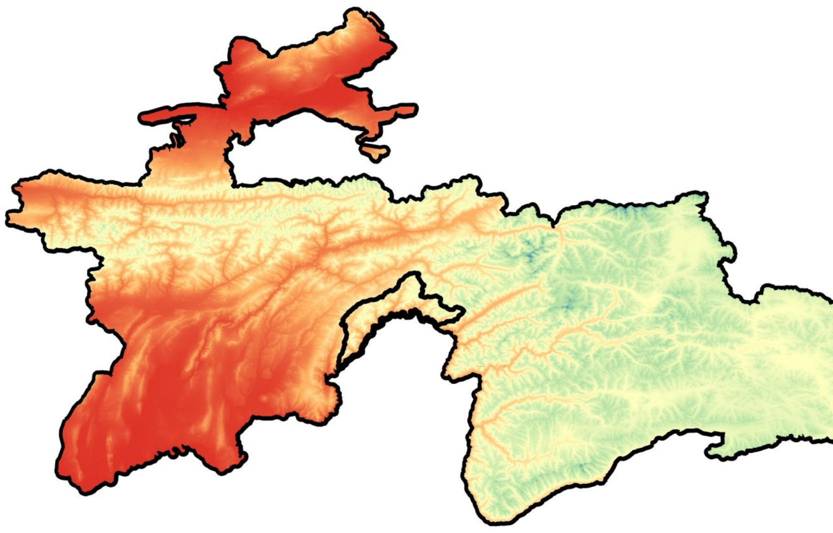
The average annual air temperature ranges from +12 °C in the lowlands to −5 °C at elevations above 3000 m, with minimum winter temperatures potentially dropping to −25 °C.

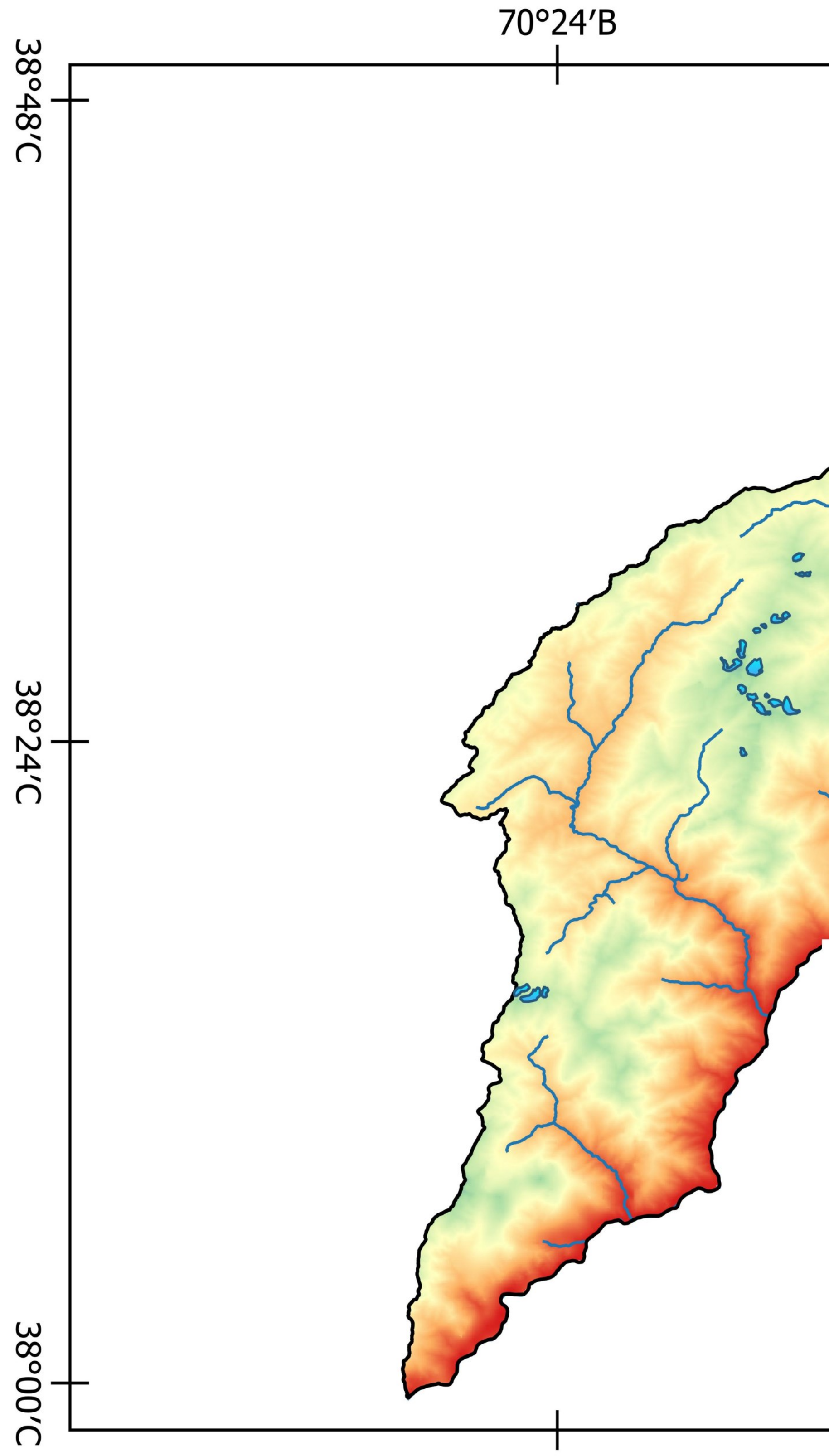
The average annual precipitation ranges from 300 to 800 mm, with the majority falling during spring and early summer. In the mountainous areas, most of the precipitation falls as snow, contributing to the formation of snow cover and sustaining glaciers.

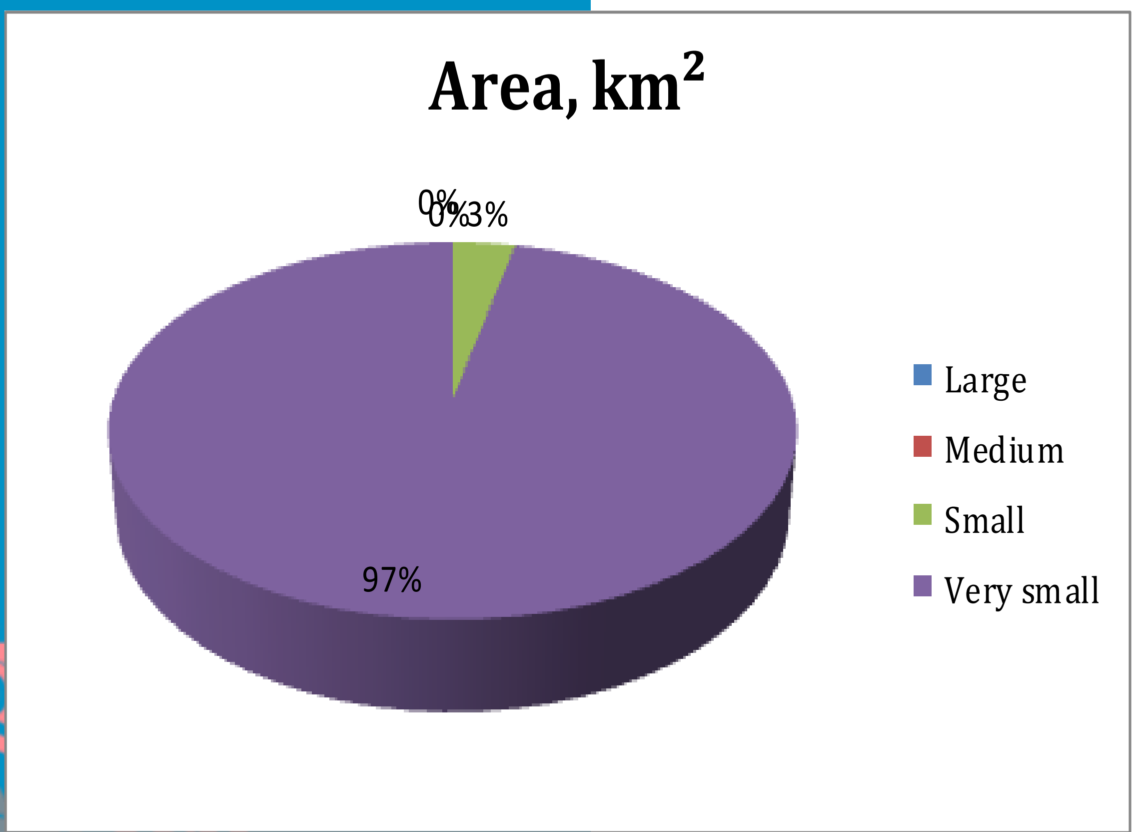
The climatic conditions of the basin play a key role in shaping the hydrological regime of the Panj River and are of great importance for local livelihoods—especially in agriculture and mountain livestock farming.

Glaciers in the region are mainly located at altitudes above 3500 meters and are currently retreating due to climatic influences.

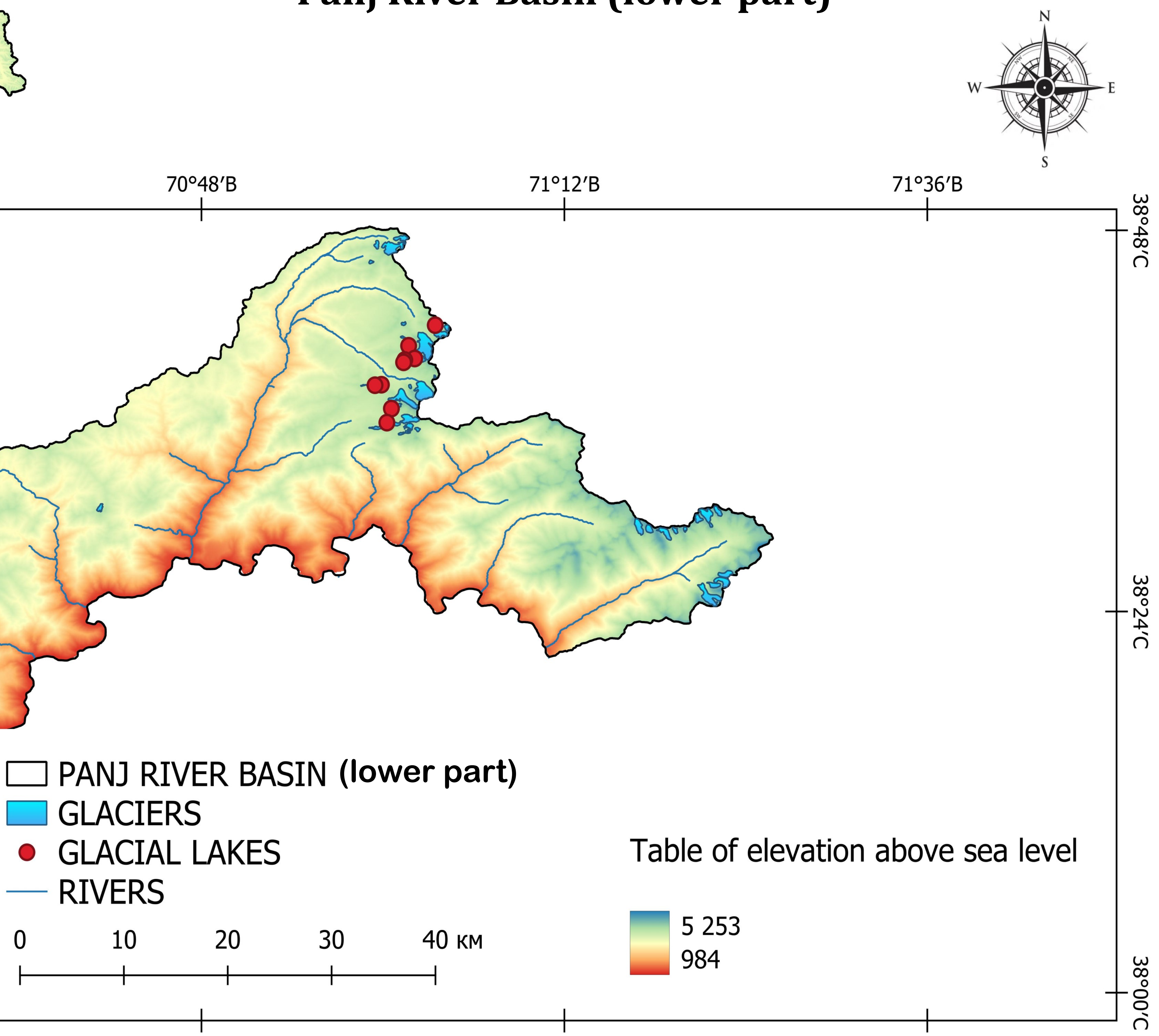
Observations have shown that 8 glacial lakes have been registered within the basin, 73% of which are classified as extremely small in terms of surface area.

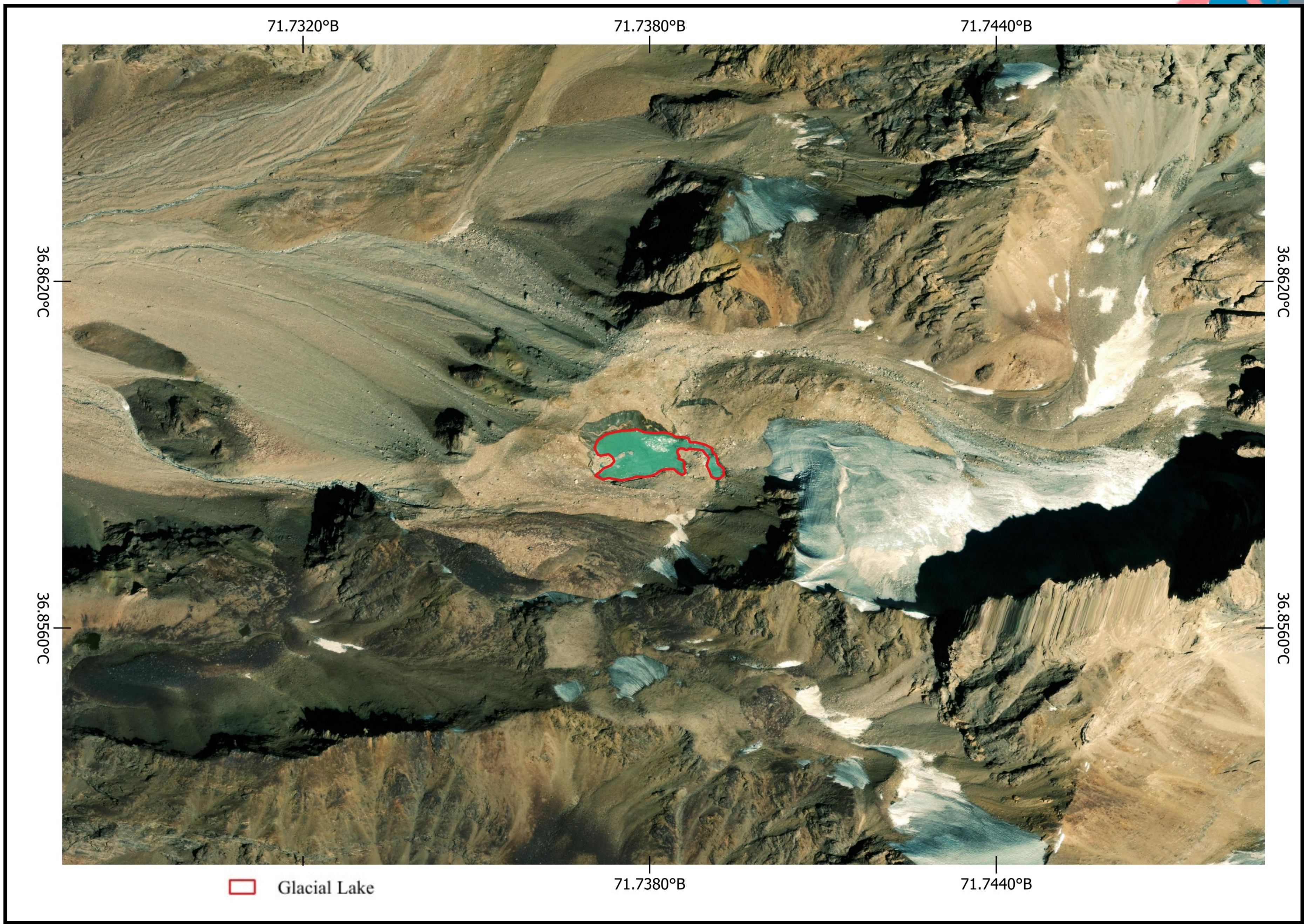




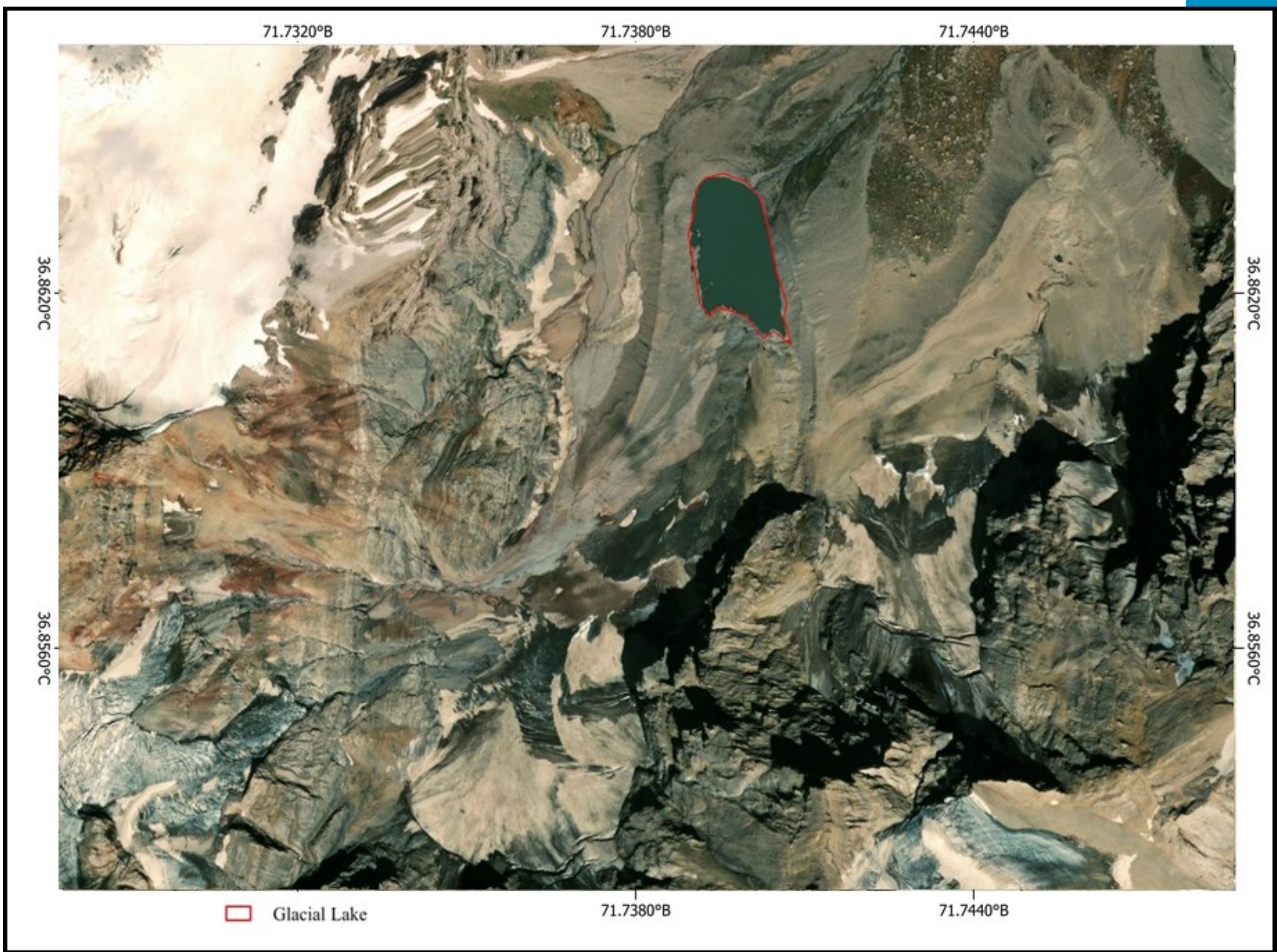


Map of the location of Glacial Lakes in the Panj River Basin (lower part)





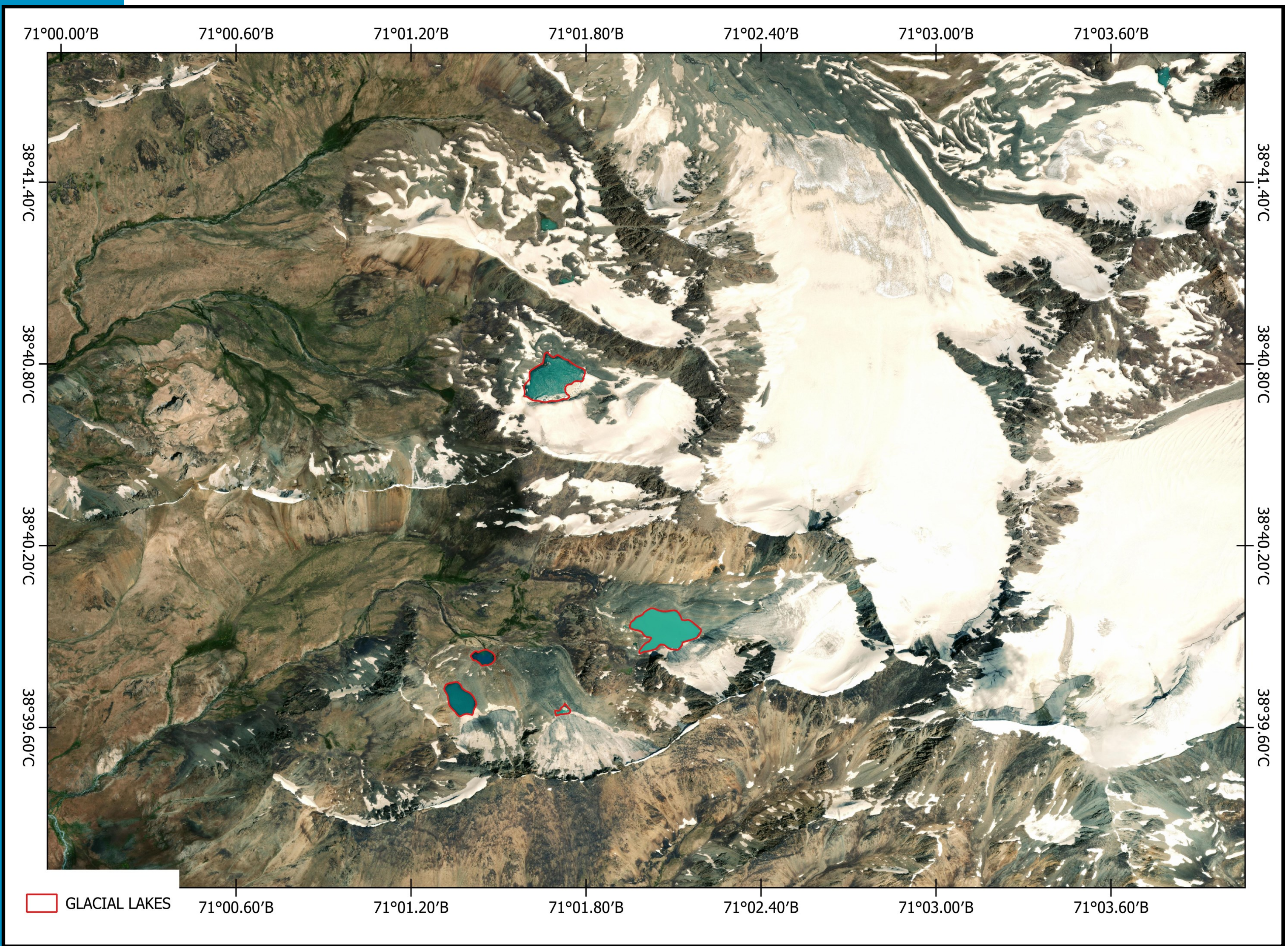
Identification of glacial lakes in the upper reaches of the Lower Panj River basin



Identification of glacial lakes in the upper reaches of the Lower Panj River basin

Glacial Lakes in the Panj River Basin (lower part)

№	Basin	Glacier name	Latitude	Longitude	River	Eleva-tion	Type	Area, km^2
1	Panj	-	38, 35' 53	71, 00' 16	Khostrogh	3905	Glacial	0,02
2	Panj	-	38, 36' 47	71, 00' 33	Khostrogh	4060	Glacial	0,07
3	Panj	-	38, 38' 15	70, 59' 28	Qarsangdara	3854	Glacial	0,04
4	Panj	-	38, 38' 16	70, 59' 54	Karsangdara	3857	Moraine	0,01
5	Panj	-	38, 39' 41	71, 01' 21	Karsangdara	3985	Glacial	0,02
6	Panj	-	38, 39' 49	71, 01' 27	Karsangdara	3962	Moraine	0,01
7	Panj	-	38, 39' 55	71, 02' 05	Karsangdara	4109	Glacial	0,07
8	Panj	-	38, 40' 44	71, 01' 42	Karsangdara	4043	Glacial	0,08
9	Panj	-	38, 42' 02	71, 03' 28	Siyohdara	4195	Moraine	0,01



Identification of glacial lakes in the upper basin of the lower Panj River — the Khumbou River.

The Upper Panj River Basin – The Pamir River

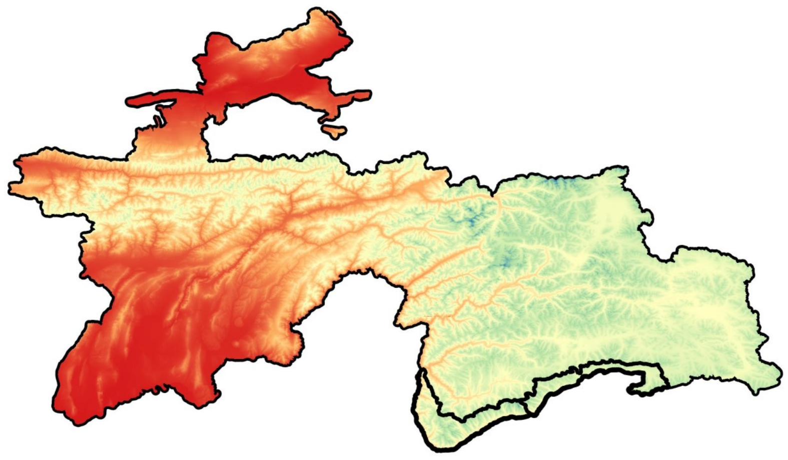
The basin of the river to the lower part of the Panj covers the foothills of the main mountain ranges—Ishkashim, Shokhdara, Southern Alichur, and Vakhon. The heights of these ranges vary from 6,000 meters in the southwestern part of the Pamirs to 5,000 meters in the southeastern part.

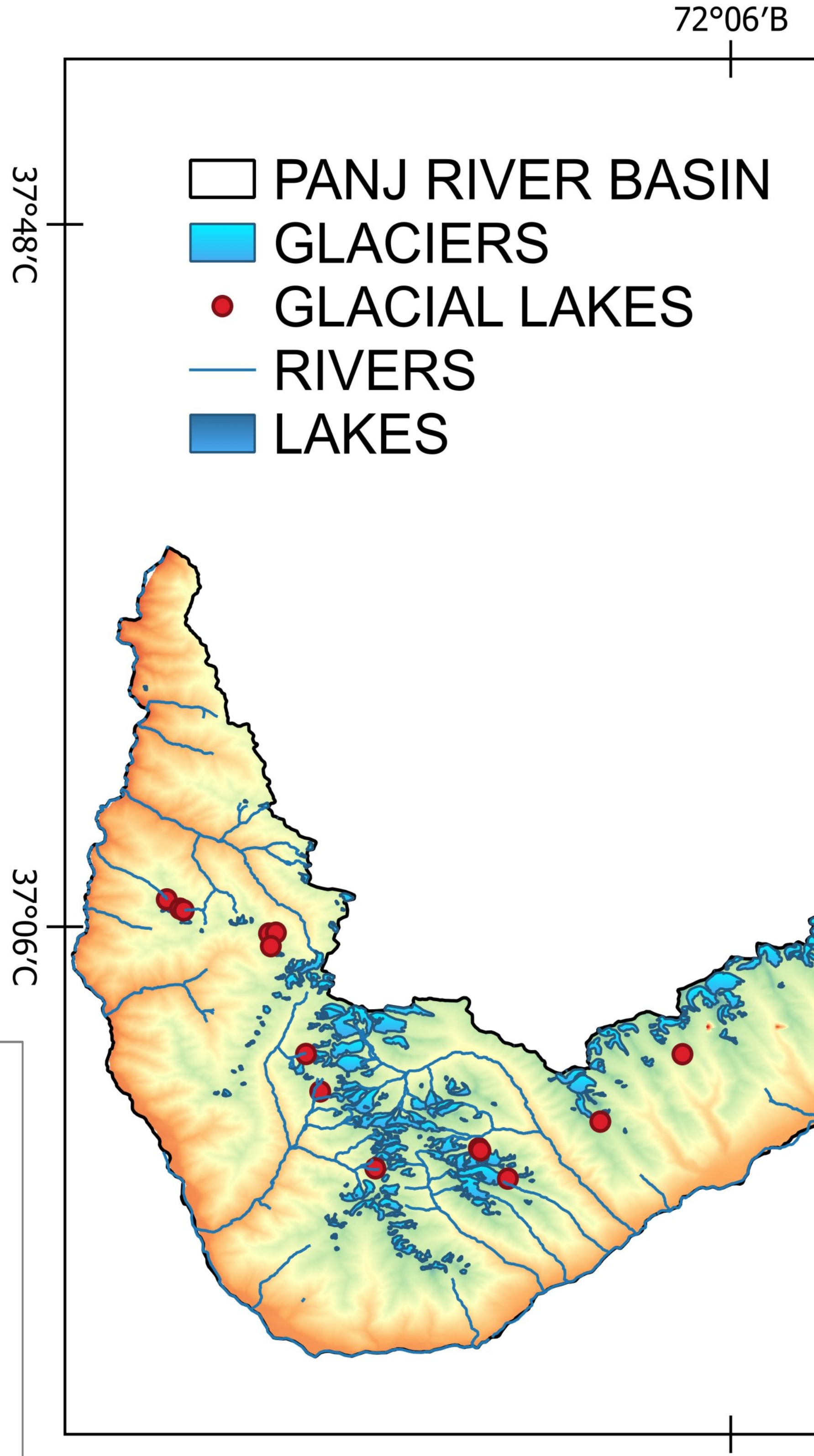
The Panj River originates from the Vakhghir River, and in its lower course, it is known by the name Vakhondaryo. This river is named after its five main tributaries: Vakhondarya, Pamir, Ghund, Bartang, and Vanj.

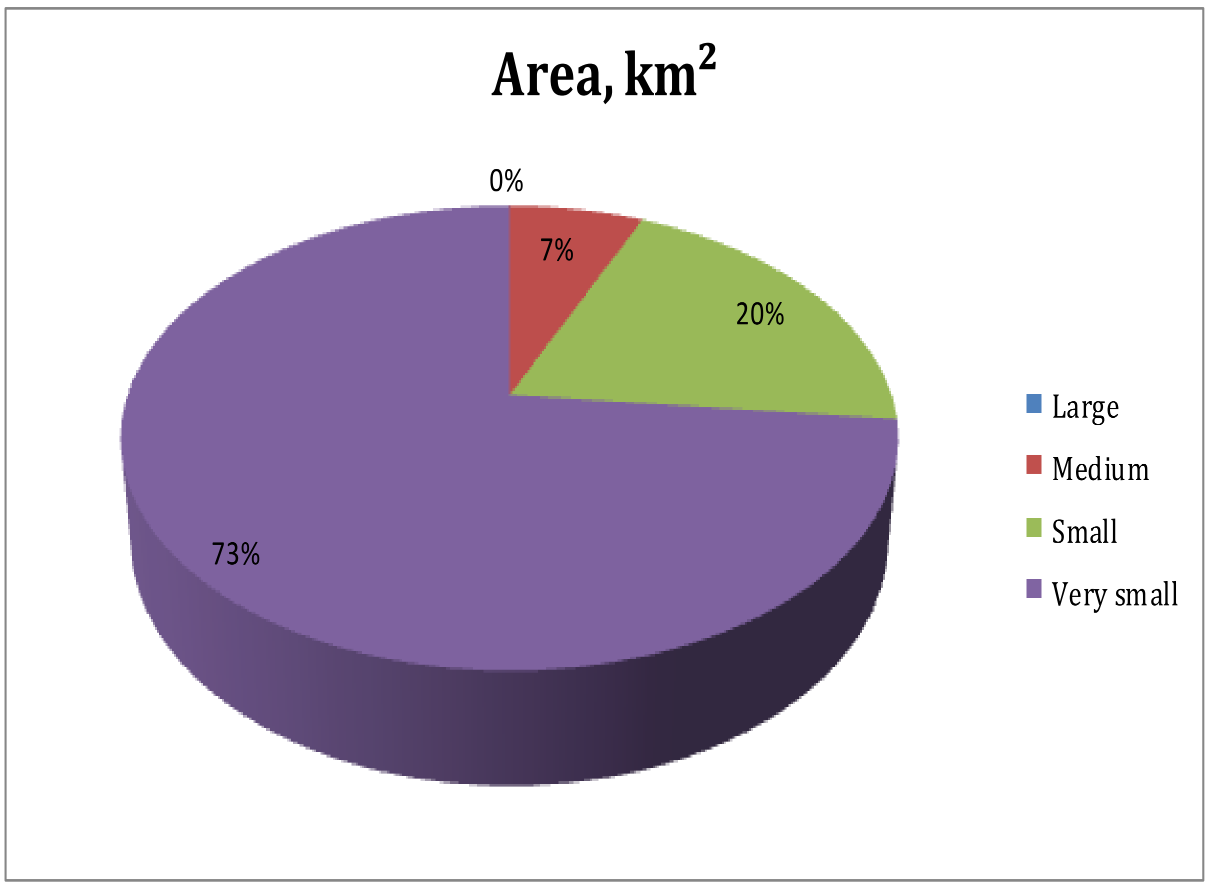
The region is characterized by a dry climate with cold summers in the east and moderately warm summers in the west. It lies in the northern part of the subtropical region. Atmospheric circulations and the geographical location of the area determine its climate. The solar radiation in this area is very intense, related to the high levels of solar activity both in winter and summer.

In the upper reaches of the Panj River basin, 451 glaciers have been registered, covering a total area of 383.4 km^2, most of which are smaller than 0.1 km^2. However, 14 large glaciers make up 27.5% of the total glacier area. The largest glacier, No. 177, is located in the Daraydarshay River basin and has an area of 11.2 km^2. Other large glaciers, such as Kara-Jilga, also have significant sizes.

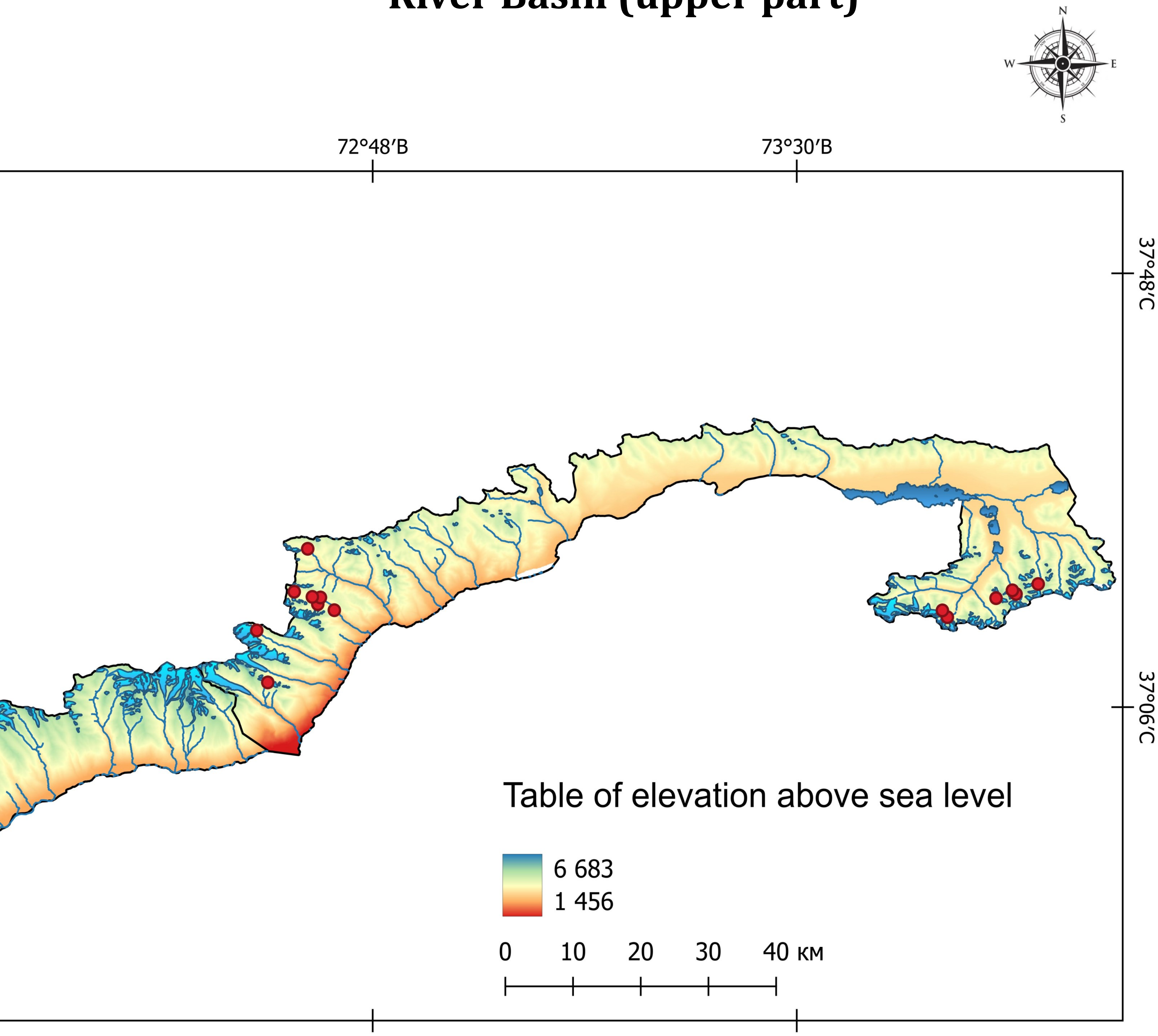
Monitoring results have shown that within the basin of the lower part of the Panj River, as a result of glacial melting, glacial lakes have been registered, most of which are categorized as very small (less than 0.05 km^2 in area).







Map of Glacial Lakes Location in the Panj River Basin (upper part)



Glacial lakes of the upper basin of the Panj River — the river of the Pamirs.

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
1	Panj	Tangjiroy	36, 50' 56	71, 52' 22	Darshay	5016	Moraine	0.01
2	Panj	11	34, 04' 50	71, 37' 57	Bagushdara	4492	Glacial	0.01
3	Panj	19	37, 05' 35	71, 37' 46	Churzh	4453	Moraine	0.01
4	Panj	19	37, 05' 38	71, 38' 11	Churzh	4410	Glacial	0.04
5	Panj	19	38, 03' 15	71, 29' 49	Vomardara	4355	Glacial	0.04
6	Panj	23	37, 06' 58	71, 32' 33	Garmchashma	4456	Moraine	0.02
7	Panj	24	37, 52' 04	71, 43' 27	Barkhufdara	4073	Glacial	0.03
8	Panj	28	37, 07' 03	71, 32' 19	Garmchashma	4475	Moraine	0.03
9	Panj	29	37, 49' 12	71, 46' 33	Kheyrujdara	4567	Moraine	0.01
10	Panj	30	37, 07' 37	71, 31' 31	Darai Sist	4250	Moraine	0.02
11	Panj	38	36, 54' 20	71, 58' 00	Nurkhan	4955	Moraine	0.01
12	Panj	61	36, 58' 22	71, 40' 03	Abkhari	4620	Glacial	0.03
13	Panj	71	36, 56' 08	71, 40' 51	Khudusk	4490	Moraine	0.02
14	Panj	85	36, 51' 32	71, 44' 17	Zend	4879	Glacial	0.01
15	Panj	150	36, 52' 38	71, 50' 40	Darshay	4594	Moraine	0.01
16	Panj	151	36, 52' 45	71, 50' 45	Darshay	4622	Moraine	0.01
17	Panj	192	36, 58' 21	72, 03' 03	Shitsharv	4561	Moraine	0.10
18	Panj	400	37, 21' 50	73, 46' 57	Zaroshkul	4519	Moraine	0.03
19	Panj	505	37, 22' 06	74, 12' 53	Andiminsu	4738	Glacial	0.01
20	Panj	-	38, 02' 58	71, 32' 37	Vomardara	4202	Moraine	0.02
21	Pamir	239	37, 15' 58	72, 42' 32	Rajiv	4502	Moraine	0,03
22	Pamir	273	37, 08' 23	72, 37' 36	Kasvir	4990	Glacial	0,01
23	Pamir	286	37, 13' 24	72, 36' 32	Akba	4837	Glacial	0,02
24	Pamir	293	37, 15' 22	72, 44' 11	Rajiv	4261	Moraine	0,03
25	Pamir	301	37, 16' 39	72, 42' 05	Rajiv	4548	Moraine	0,52
26	Pamir	301	37, 16' 36	72, 42' 49	Rachiv	4550	Moraine	0,02
27	Pamir	302	37, 17' 10	72, 40' 12	Rajiv	4631	Moraine	0,05
28	Pamir	306	37, 21' 19	72, 41' 34	Mots	4549	Moraine	0,02
29	Pamir	362	37, 17' 55	73, 53' 54	Chetchilob	4652	Glacial	0,13
30	Pamir	374	37, 16' 57	73, 51' 40	Karajilgasoy	4582	Moraine	0,27
31	Pamir	374	37, 17' 17	73, 51' 21	Karajilgasoy	4581	Moraine	0,01
32	Pamir	375	37, 16' 31	73, 49' 45	Karajilgasoy	4775	Glacial	0,02
33	Pamir	385	37, 14' 43	73, 44' 55	Karajilgasoy	4619	Glacial	0,01
34	Pamir	387	37, 15' 15	73, 45' 45	Karajilgasoy	4373	Moraine	0,13
35	Pamir	390	37, 15' 22	73, 44' 25	Karajilgasoy	4616	Glacial	0,02

Identification of glacial lakes in the upper basin of the Panj River.

Identification of glacial lakes in the upper basin of the Panj River

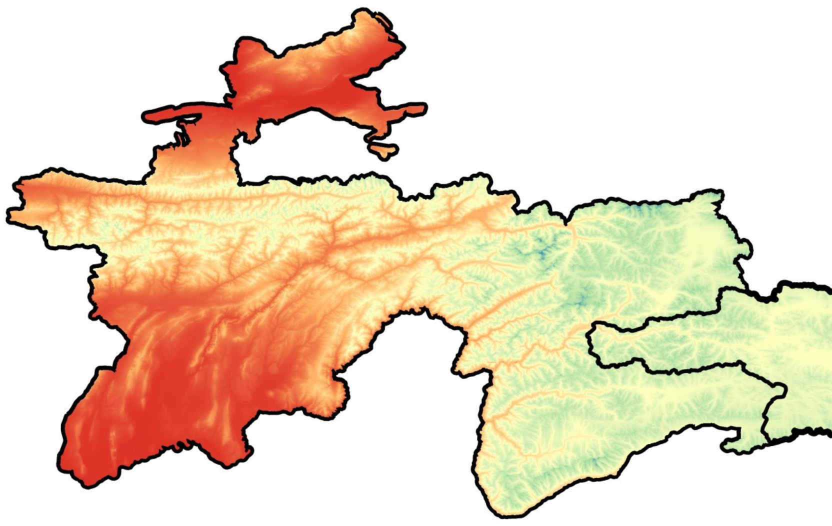
Murghob River Basin

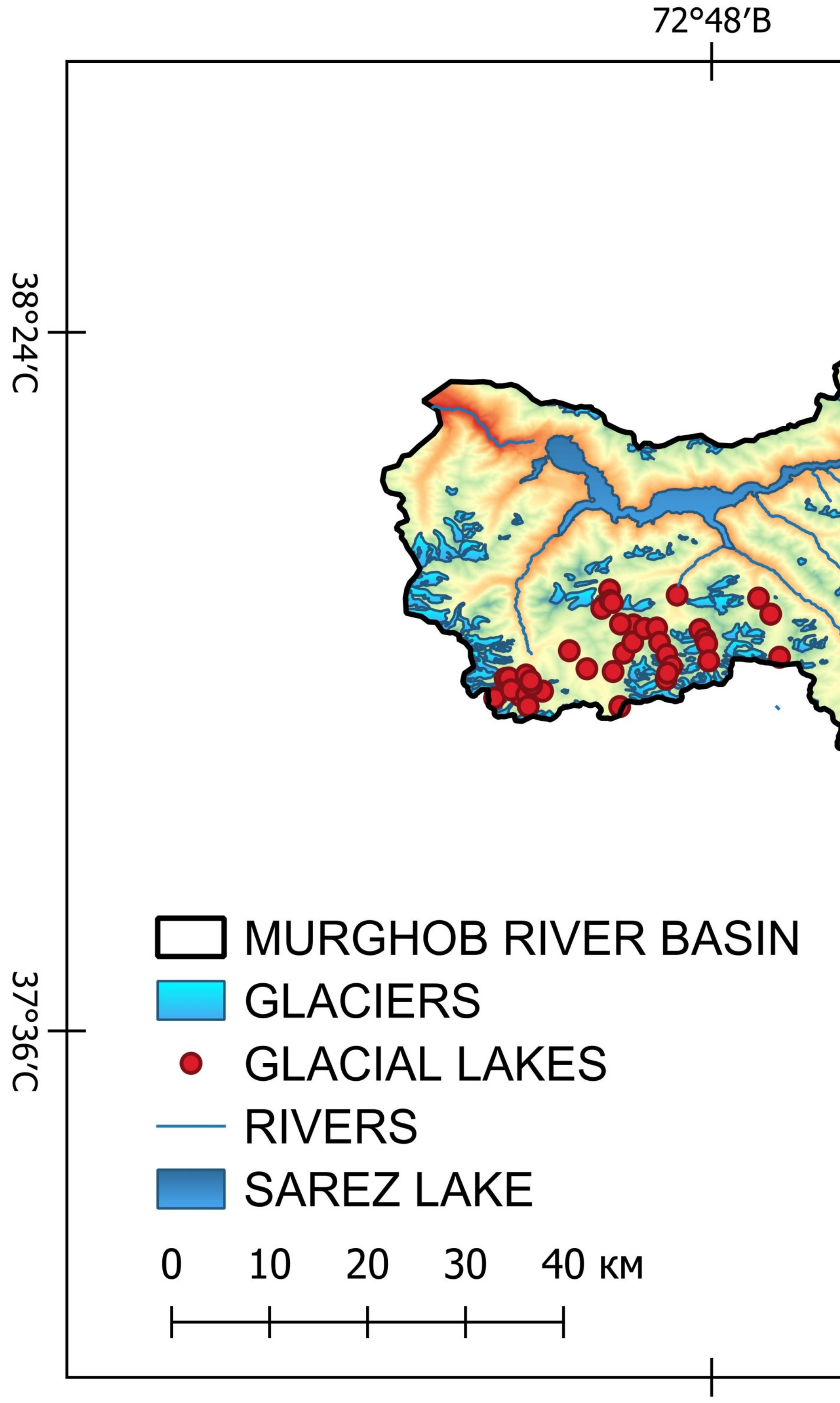
The climate of the Eastern Pamirs is extremely continental and severe, and according to the climatic classification, the Murghob River basin is located in the northern part of the subtropical zone. The zone divides the basin into the Eastern and Western Pamirs, serving as a border between the Trans-Asian region with more precipitation in the cold season and the Central Asian region with less and more precipitation in the warm season. As can be seen, the differences are manifested not only in the degree of humidity, but also in temperature conditions.

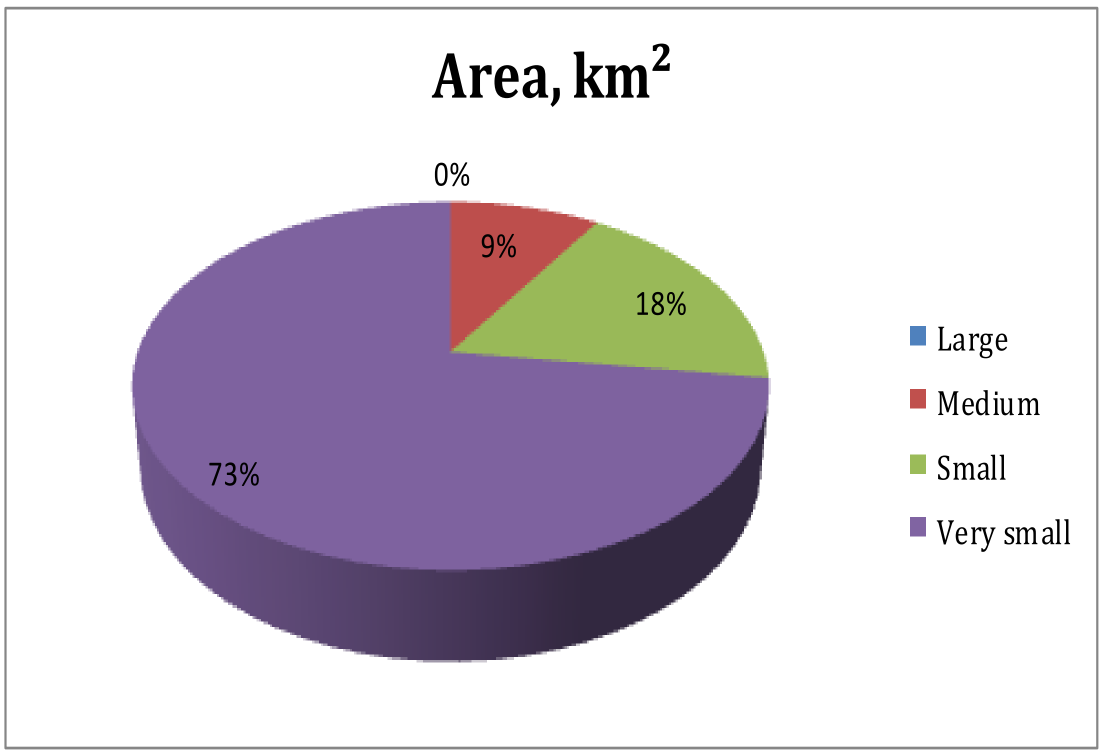
In the glacial zone of the Murghob River basin – both in the eastern and western parts – the absolute minimum temperature reaches below -50°C, and the absolute maximum can exceed 25°C.

The average annual air temperature in the Eastern Pamirs ranges from 5 to 7 degrees Celsius. Strong winds with low temperatures create conditions close to the Arctic climate. Summer is short, and even in the warmest months, the temperature can drop to -5, -10°C. On the other hand, even in the coldest months, when the minimum temperature drops below -40°C, the maximum temperature can rise above zero. For example, at the Murghob meteorological station, the maximum temperature in the winter months is above °C, and in the summer it rises to 30°C.

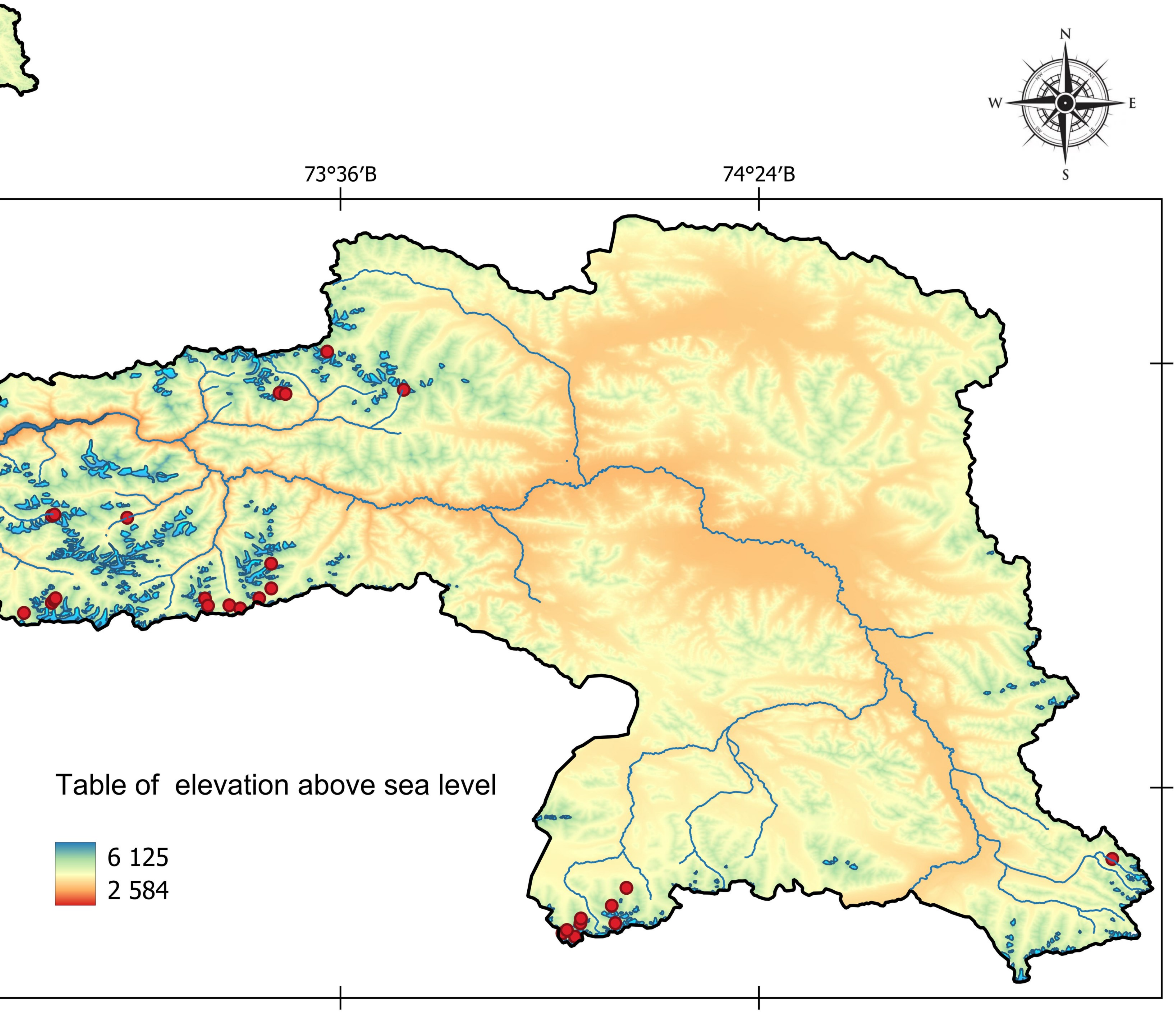
The current glaciation of the Murghob River Basin consists mainly of small glaciers, with 94% of all glaciers not exceeding 2.0 km^2 in area and 82% less than 1.0 km^2. At the same time, among small glaciers, objects with an area of 0.1 and 0.2 km^2 are most common, accounting for 15.8% and 17% of the total number of glaciers, respectively. Despite the harsh Arctic climate, glaciers in the Murghob River Basin are retreating, and as a result, a large number of glacial lakes have appeared in the basin. According to the monitoring results, 66% of glacial lakes have been identified throughout the Murghob River Basin, of which 73% by area belong to extremely small groups.







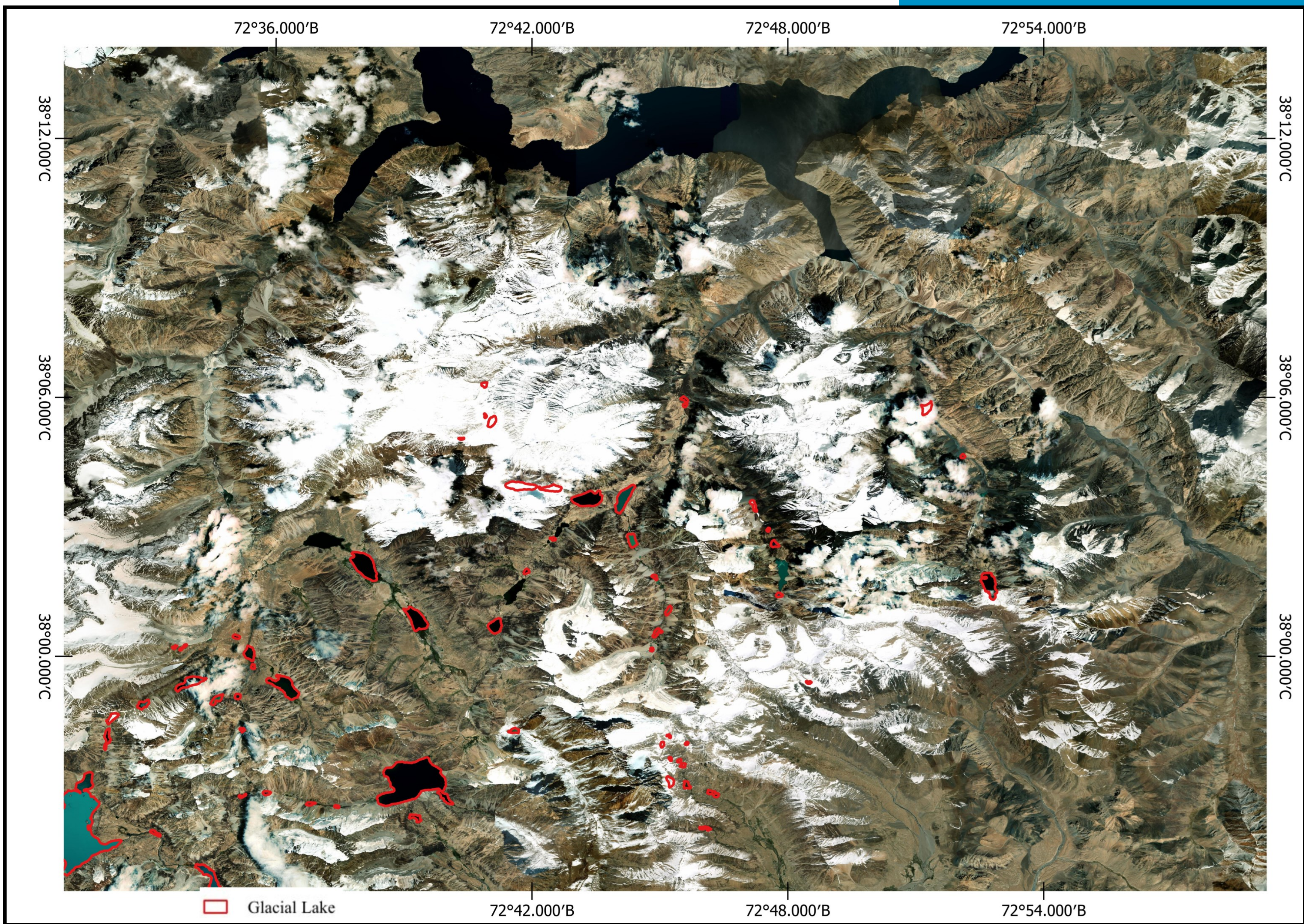
Map of the location of glacial lakes in the Murghob River Basin



Glacial lakes of the Murghob River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Murghob	37	38, 00' 12	72, 33' 36	Langar	4535	Glacial	0.01
2	Murghob	47	38, 00' 13	72, 33' 50	Langar	4507	Moraine	0.02
3	Murghob	47	38, 00' 27	72, 35' 04	Langar	4357	Moraine	0.03
4	Murghob	48	37, 58' 52	72, 32' 52	Langar	4460	Moraine	0.09
5	Murghob	52	37, 59' 00	72, 34' 35	Langar	4449	Moraine	0.08
6	Murghob	52	37, 59' 25	72, 33' 59	Langar	4415	Moraine	0.27
7	Murghob	53	37, 59' 04	72, 35' 06	Langar	4399	Moraine	0.04
8	Murghob	53	37, 58' 17	72, 35' 12	Langar	4506	Glacial	0.02
9	Murghob	54	37, 59' 19	72, 36' 11	Langar	4434	Moraine	0.53
10	Murghob	58	38, 00' 41	72, 41' 07	Langar	4440	Moraine	0.21
11	Murghob	59	37, 59' 45	72, 35' 27	Langar	4346	Moraine	0.02
12	Murghob	59	38, 00' 04	72, 35' 21	Langar	4346	Moraine	0.16
13	Murghob	60	38, 02' 07	72, 38' 02	Langar	4261	Moraine	0.68
14	Murghob	61	37, 58' 17	72, 41' 35	Langar	4571	Glacial	0.05
15	Murghob	61	38, 00' 51	72, 39' 19	Langar	4272	Moraine	0.43
16	Murghob	83	38, 06' 17	72, 40' 53	Ramayf	4477	Moraine	0.03
17	Murghob	85	38, 05' 02	72, 40' 21	Ramayf	4673	Glacial	0.01
18	Murghob	85	38, 05' 34	72, 40' 54	Ramayf	4571	Moraine	0.01
19	Murghob	86	38, 05' 26	72, 41' 03	Ramayf	4606	Moraine	0.09
20	Murghob	91	38, 03' 53	72, 42' 28	Ramayf	4432	Moraine	0.14
21	Murghob	91	38, 03' 56	72, 41' 41	Ramayf	4432	Glacial	0.28
22	Murghob	92	38, 01' 58	72, 41' 52	Ramayf	4486	Moraine	0.03
23	Murghob	93	38' 02' 43	72, 42' 30	Ramayf	4441	Moraine	0.02
24	Murghob	93	38, 03' 39	72, 43' 19	Ramayf	4379	Moraine	0.49
25	Murghob	95	38, 03' 43	72, 44' 10	Ramayf	4295	Moraine	0.37
26	Murghob	97	38, 02' 42	72, 44' 20	Ramayf	4369	Moraine	0.13
27	Murghob	98	38, 01' 51	72, 44' 50	Ramayf	4449	Moraine	0.03
28	Murghob	99	38, 01' 03	72, 45' 12	Ramayf	4520	Moraine	0.05
29	Murghob	100	38, 00' 09	72, 44' 49	Ramayf	4616	Glacial	0.01
30	Murghob	100	38, 00' 33	72, 44' 54	Ramayf	4584	Moraine	0.05
31	Murghob	110	38, 03' 29	72, 47' 12	Ramayf	4400	Moraine	0.05
32	Murghob	111	38, 02' 55	72, 47' 32	Ramayf	4457	Moraine	0.01
33	Murghob	113	38, 02' 35	72, 47' 40	Ramayf	4497	Moraine	0.05
34	Murghob	114	38, 01' 25	72, 47' 47	Ramayf	4555	Moraine	0.03
35	Murghob	124	38, 05' 55	72, 45' 36	Ramayf	4078	Moraine	0.05
36	Murghob	130	38, 05' 46	72, 51' 16	Katta Marjonay	4170	Moraine	0.12
37	Murghob	131	38, 04' 34	72, 52' 06	Katta Marjonay	4322	Moraine	0.02
38	Murghob	137	38, 01' 39	72, 52' 42	Katta Marjonay	4609	Moraine	0.38
39	Murghob	151	37, 55' 47	72, 59' 40	Marjonay	4530	Moraine	0.10
40	Murghob	159	37, 56' 55	73, 02' 51	Qaradara	4620	Glacial	0.29
41	Murghob	159	37, 57' 14	73, 03' 08	Qaradara	4624	Moraine	0.07
42	Murghob	159	37, 57' 24	73, 03' 17	Qaradara	4623	Moraine	0.02
43	Murghob	206	38, 06' 45	73, 02 '49	Vatasayf	4647	Glacial	0.06
44	Murghob	207	38, 06' 54	73, 03' 06	Vatasayf	4681	Glacial	0.03
45	Murghob	320	38, 06' 31	73, 11' 30	Oqjilga	3953	Moraine	0.03
46	Murghob	373	37, 19' 06	74, 02' 55	Zor Sarigurum	4911	Moraine	0.02

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km²
47	Murghob	389	37, 57' 23	73, 20' 27	Bozorariq	4796	Moraine	0.02
48	Murghob	392	37, 56' 35	73, 20' 49	Bozorariq	4699	Moraine	0.02
49	Murghob	394	37, 56' 37	73, 23' 15	Bozorariq	4502	Moraine	0.02
50	Murghob	395	37, 56' 16	73, 24' 28	Bozorariq	4560	Moraine	0.02
51	Murghob	431	38, 01' 21	73, 28' 05	Elisu	4617	Moraine	0.06
52	Murghob	437	37, 58' 31	73, 28' 04	Elisu	4698	Moraine	0.06
53	Murghob	440	37, 57' 24	73, 26' 41	Elisu	4854	Glacial	0.01
54	Murghob	469	37, 19' 29	74, 01' 28	Sarigurum	4911	Glacial	0.02
55	Murghob	469	37, 19' 51	74, 01' 59	Istiq	4600	Moraine	0.02
56	Murghob	475	37, 21' 10	74, 03' 31	Shver Aylikjigla	4617	Moraine	0.04
57	Murghob	475	37, 21' 11	74, 03' 36	Zor Sarigurum	4616	Moraine	0.02
58	Murghob	484	37, 20' 39	74, 07' 32	Zor Sarigurum	4808	Moraine	0.10
59	Murghob	490	37, 22' 38	74, 07' 07	Shver Aylikjigla	4641	Moraine	0.01
60	Murghob	497	37, 24' 38	74, 08' 48	Karanajilga	4461	Moraine	0.02
61	Murghob	498	37, 21' 13	74, 09' 22	Andiminsu	4918	Glacial	0.01
62	Murghob	562	37, 27' 54	75, 04' 33	Shver Kapchal	4496	Moraine	0.03
63	Murghob	610	38, 25' 20	73, 34' 28	Sisiqsu	4791	Glacial	0.02
64	Murghob	687	38, 21' 02	73, 43' 16	Maljuran	4734	Moraine	0.02
65	Murghob	724	38, 20' 38	73, 28' 59	Sasiq	4540	Moraine	0.01
66	Murghob	726	38, 20' 32	73, 29' 41	Sasiq	4468	Moraine	0.01



Муайянкунии кӯлҳои Glacial дар ҳавзаи дарёи Murghob

Basin of Lake Qarokul and the Markansu River

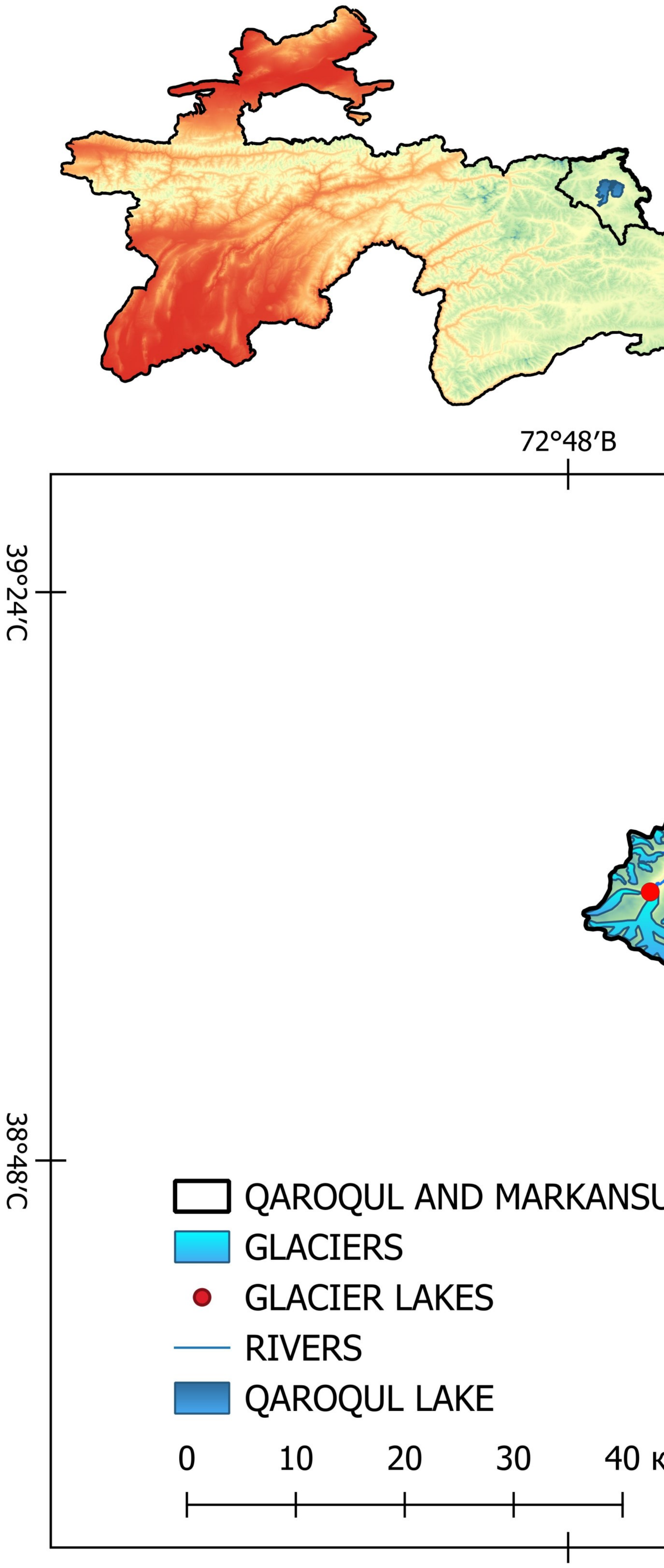
The basin of the Markansu Rivers and Qarokul Lake is located in the northern part of Eastern Pamir. Qarikul Lake is one of the highest lakes in the world, situated at an altitude of 3,914 meters above sea level. The region is characterized by a harsh continental climate, dry high-altitude valleys, and sparse vegetation.

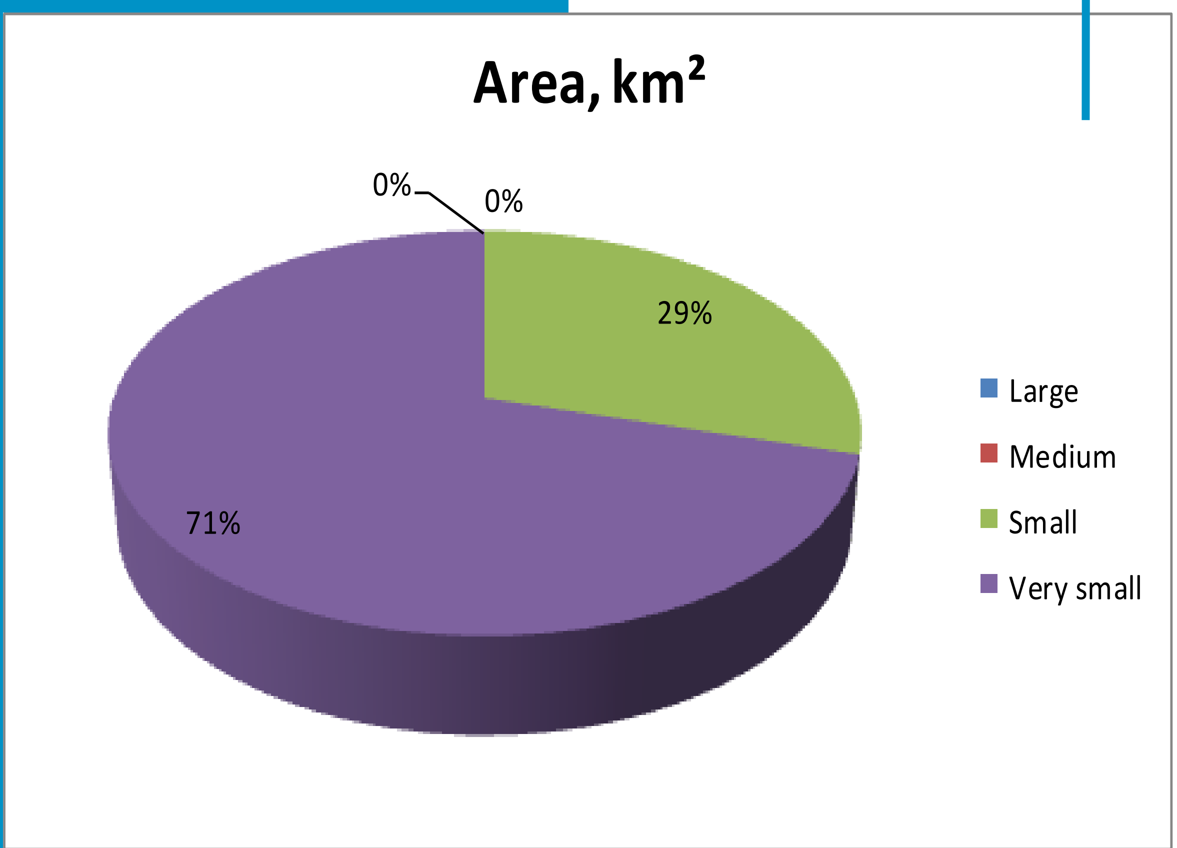
The main rivers of the basin—Siyokhrud (Karajilga), Oqjilga, and Karaart—are fed by the meltwater of snow and glaciers. The only settlement in the area is the village of Qarokul, where a meteorological station is located. This station holds unique scientific significance for observing the climate and the condition of the glaciers.

The largest glacier in the region is the Oqbaytal Glacier, located at the foot of the Oqbaytal range, covering an area of 5.5 km². In the southern part of the basin, there are large glaciers on the Zortashkul range, which are covered with moraine deposits (gravel and stones carried by glaciers).

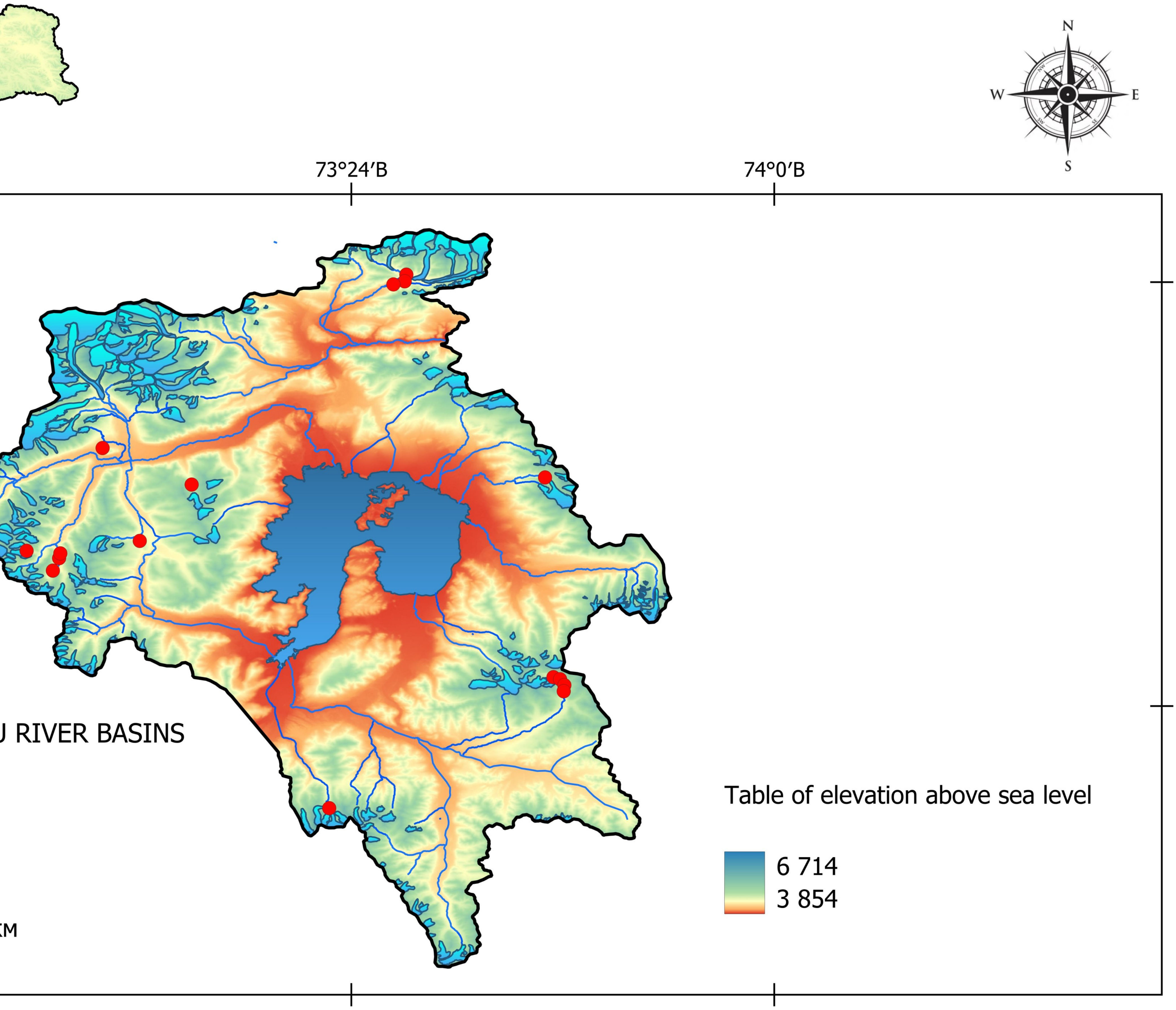
The region's terrain consists of high mountain ranges, deep valleys, and vast glacial plains, making it an important area for studying contemporary glaciology.

Monitoring results have shown that within the Qarokul and Markansu basin, as a result of glacial melting, glacial lakes have been registered, most of which are classified as very small in size (less than 0.05 km²).



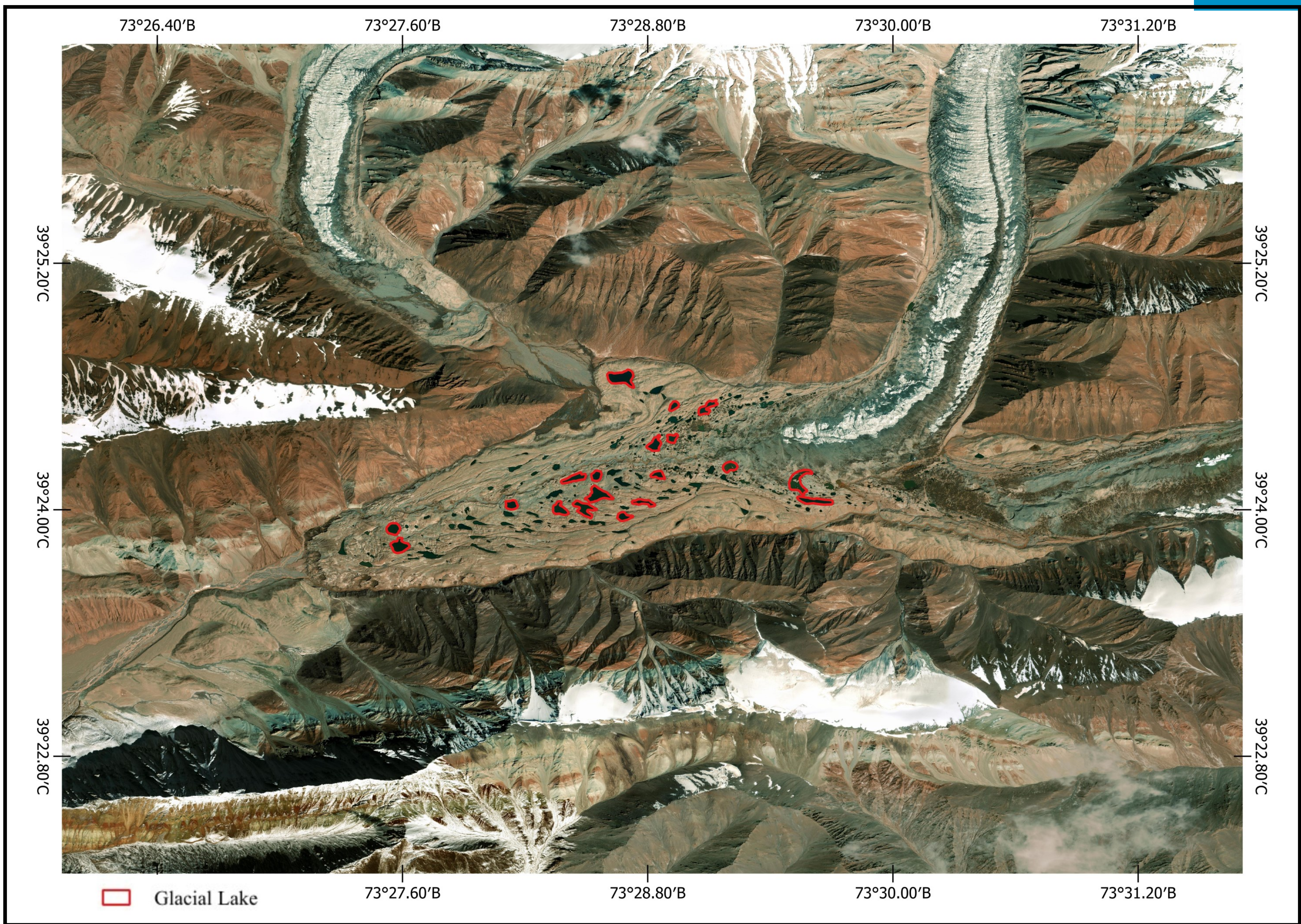


Map of the location of glacial lakes in the basin of Lake Qarokul and the Markansu River

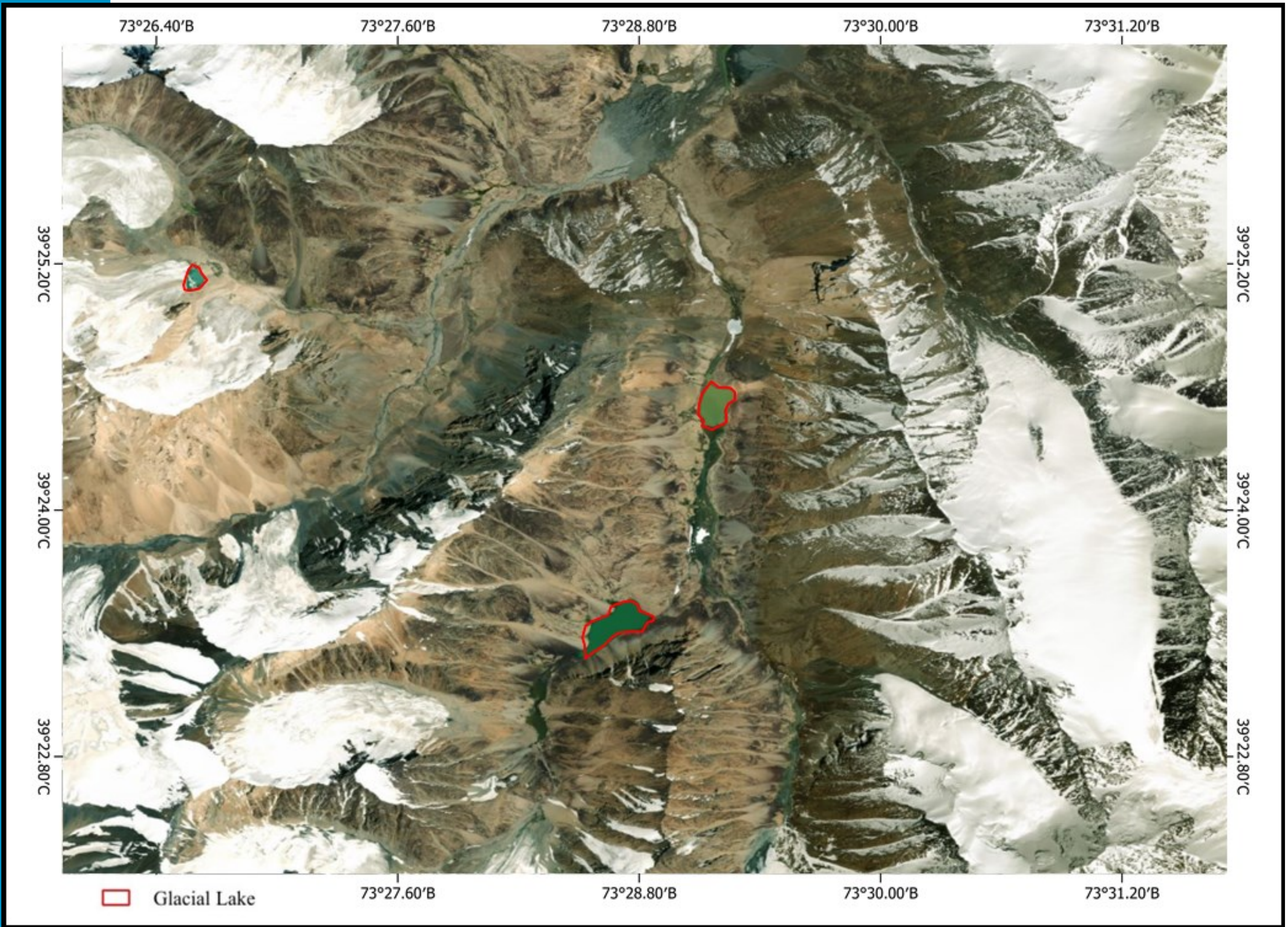


Glacial lakes of the Lake Qarokul Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Qarokul	10	39, 07' 25	73, 40' 27	Qumbuloq	4798	Glacial	0.01
2	Qarokul	68	38, 50' 16	73, 41' 46	Saar	4637	Moraine	0.15
3	Qarokul	70	38, 50' 27	73, 41' 12	Saar	4668	Moraine	0.01
4	Qarokul	74	38, 49' 14	72, 43' 02	Saar	4621	Moraine	0.14
5	Qarokul	75	38, 49' 46	73, 42' 08	Saar	4633	Moraine	0.09
6	Qarokul	122	38, 39' 20	73, 20' 07	Muqsu	4783	Glacial	0.01
7	Qarokul	178	39, 06' 48	73, 10' 24	Qarajilga	4595	Moraine	0.01
8	Qarokul	185	39, 02' 01	73, 05' 59	Qarajim	4632	Moraine	0.04
9	Qarokul	200	39, 00' 35	72, 59' 09	Qarajilga	4399	Moraine	0.07
10	Qarokul	200	39, 00' 57	72, 59' 13	Qarajilga	4396	Moraine	0.02
11	Qarokul	206	38, 59' 30	72, 58' 35	Qarajilga	4554	Moraine	0.12
12	Qarokul	216	39, 01' 10	72, 56' 22	Qarajilga	4737	Glacial	0.04
13	Qarokul	254	39, 05' 00	72, 53' 13	Baygashka	4473	Glacial	0.03
14	Qarokul	270	39, 09' 55	73, 02' 49	Qoqghudur	4267	Moraine	0.10



Identification of glacial lakes in the upper basin of the Markansu River



Identification of glacial lakes in the basin of the Karakul River

Glacial lakes of the Markansu River Basin

№	Basin	Glacier name	Latitude	Longitude	River	Elevation	Type	Area, km^2
1	Markansu	2	39° 23' 49	73° 27' 37	Qurumdi	4330	Moraine	0.01
2	Markansu	93	73, 24' 04	73, 28' 35	Qurumdi	4413	Glacial	0.01
3	Markansu	93	39, 24' 38	73, 28' 41	Qurumdi	4405	Moraine	0.02

Conclusion

The Atlas of Glacial Lakes of the Republic of Tajikistan has been prepared based on the analysis of high-quality satellite data and field studies. During the work, a large number of glacial lakes were identified and registered, including very small ones that had not been previously documented in detail.

The analysis showed that the number of small glacial lakes has significantly increased in the main river catchment basins, indicating the impact of active glacial melt against the backdrop of climate change. According to the results, most of the glacial lakes are located in the basins of the Zarafshon, Ghund, and Shohdara rivers. These regions stand out for their high concentration of glaciers and active melting, leading to the constant formation of new lakes and the expansion of existing ones.

The use of software tools and satellite images allowed for the precise identification of glacial lakes, as well as the clarification of their physical characteristics, such as area and current condition. Aerial and field studies conducted in glacial areas of the country confirmed the results of remote analysis and provided additional information on the condition of the lakes.

This atlas is an important tool for studying the state of glacial lakes, assessing natural disaster risks, and monitoring and planning water resources in the context of climate change. Its use is particularly important for research institutions, environmental organizations, and emergency management authorities.

Recommendations

I. **Strengthening the monitoring of glacial lakes**. Given the increasing number of glacial lakes, it is recommended to organize regular monitoring of lakes using Sentinel satellite images and other remote data sources. This will allow for the timely detection of changes in volume and the risk of lake destruction.

II. **Conducting regular field studies.** To validate the results of satellite analyses and assess the real state of hazardous lakes, regular field studies should be conducted in the field, involving specialists in the area.

III. **Developing an early warning system.** Considering the risk of glacial lake destruction, it is crucial to create an early warning system for populations in vulnerable areas and develop evacuation plans.

IV. **Ensuring data coordination and collaboration.** It is recommended to establish a national coordinated network for the collection, updating, and exchange of information on glacial lakes between scientific institutions, environmental organizations, and emergency management bodies.

V. **Using the atlas for water resource planning.** This atlas should be used as a basis for developing sustainable water resource management strategies, especially in the context of climate change.

VI. **Expanding research to other vulnerable regions.** To gain a comprehensive understanding of hydrological and glacial changes, similar studies should be conducted in other mountainous areas of the country.

References

1. Ресурсы поверхностных вод СССР: Гидрологическая изученность, 1967.
2. Каталог ледников СССР. Средняя Азия, Амударья – часть 6 - Ленинград -1971г.
3. Каталог ледников СССР, т. 14. Средняя Азия. вып. 3, ч. 11,12. Л., ГИМИЗ, 1978,
4. Таджикистан – природа и природные ресурсы – изд. «Дониш» - Душанбе 1982;
5. Отчеты о наблюдениях за колебанием ледников Таджикистана в 1968-92 и 1996-2001 годах. Главтаджикгидромет, Душанбе, 2001.
6. Отчет о гляциологической экспедиции «Памир 2005». Агентство по гидрометеорологии, Душанбе, 2005.
7. Каталог ледников СССР , Том 14, части 1-18
8. Ищук Н. Саидов А. Опасные природные явления в Таджикистане Душанбе, Таджикистан. -Душанбе, 2018. -33с.
9. Каюмов А.К., Шомахмадов А.М., Сафаров М.Т. Анализ погодных условий и их связь с возникновением стихийных бедствий в Таджикистане в 2021 году. // Криосфера - 2021– № 1 (1). -С.124-140
10. Mergili, M., & Schneider, J. F. (2011). Regional-scale analysis of lake outburst hazards in the southwestern Pamir, Tajikistan, based on remote sensing and GIS. Natural Hazards and Earth System Science, 11(5), 1447–1462. https://doi.org/10.5194/nhess-11-1447-2011
11. Pirmamadov, U. R., Bobov, R. A., Raimbekov, Y. K., Maroda, F. O., Savernyuk, E. A., Kidyaeva, V. M., Krylenko, I. V., Krylenko, I. N., Viskhadzhievaseinov, K. S., Zikillobekov, I. I., & Chernomorets, S. S. (2020). Risk and consequences of high-mountain lake outbursts in Tajikistan. In S. S. Chernomorets & K. S. Viskhadzhieva (Eds.), Debris Flows: Disasters, Risk, Forecast, Protection. Proceedings of the 6th conference (Vol. 1, pp. 1–24).
12. Shugar, D. H., Burr, A., Haritashya, U. K., Kargel, J. S., Watson, C. S., Kennedy, M. C., Bevington, A. R., Betts, R. A., Harrison, S., & Strattman, K. (2020). Rapid worldwide growth of glacial lakes since 1990. Nature Climate Change, 10(10), 939–945. https://doi.org/10.1038/s41558-020-0855-4
13. Zhang, G., Yao, T., Xie, H., Wang, W., & Yang, W. (2015). An inventory of glacial lakes in the Third Pole region and their changes in response to global warming. Global and Planetary Change, 131, 148–157. https://doi.org/10.1016/j.gloplacha.2015.05.013