



NATIONAL VULNERABLE GLACIERS & GLACIAL LAKES ATLAS

Assessment • Monitoring • Understanding • Sustainability

KNOWLEDGE
FOR A SAFER
AND RESILIENT
PAKISTAN



GLACIER
INVENTORY



GLACIAL LAKES
DATABASE



CRYOSPHERE
MONITORING



WATER RESOURCES &
HYDROLOGY



HAZARD & RISK
ASSESSMENT



SATELLITE DATA &
TECHNOLOGY

2026

MESSAGE

Pakistan contributes less than one percent of global greenhouse gas emissions, yet it is among the countries most vulnerable to the impacts of climate change. This inequity is especially evident in the Hindu Kush–Karakoram–Himalaya (HKH) region, the "Third Pole". Its glaciers, snowfields, permafrost and glacier-fed lakes are central to Pakistan's natural heritage and water security, feeding the Indus River Basin that sustains agriculture, hydropower, ecosystems and millions of people downstream. As temperature, precipitation, snow cover and glacier dynamics shift, the risks of Glacial Lake Outburst Floods (GLOFs), flash floods, landslides, avalanches and cascading mountain hazards are growing, with consequences that reach far beyond the mountain valleys.

For the National Disaster Management Authority (NDMA), building a science-based understanding of these risks is a national priority. Each year, NDMA issues GLOF and flood alerts for the northern valleys, and our experience shows how much depends on timely, reliable information. Effective disaster management increasingly relies on integrating Earth observation, glacier and hydrological monitoring, modelling and early warning systems into a risk-informed framework. This Atlas of the Cryosphere and Glacial Environment of Pakistan is a step towards strengthening that knowledge base. It brings together information on the country's glaciers, glacial lakes, snow and high-mountain environments as a consolidated scientific and geospatial reference for researchers, policymakers, planners and disaster management authorities. It is intended to support evidence-based decision-making, risk assessment, climate adaptation and the continued development of early warning and anticipatory action.

The HKH is a shared mountain system whose changes transcend national boundaries, and its cryosphere, water resources and hazards call for sustained regional cooperation, scientific collaboration and knowledge exchange. Pakistan remains committed to working with national institutions and regional and international partners to build resilience against the growing impacts of climate change. Our mountains are both an early indicator of environmental change and a reminder of how closely water, ecosystems, communities and national development are linked. Protecting them is not only an environmental responsibility but an essential part of Pakistan's water security, disaster resilience and sustainable future.

Lieutenant General Inam Haider Malik, HI (M)

Chairman

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**Lieutenant General
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About the Atlas

These changes can also create hazards.

A growing glacial lake, an unstable moraine, a sudden release of meltwater or a destabilized mountain slope can transform a remote high-altitude landscape into a downstream threat. Glacial Lake Outburst Floods (GLOFs), avalanches, landslides, debris flows and flash floods are therefore an integral part of the mountain-risk landscape.

This Atlas seeks to make these complex systems visible, understandable and usable.

A Journey Through Pakistan's High Mountains

The Atlas begins deep in geological time, tracing the remarkable journey from the ancient Tethys Ocean to the Third Pole. The collision of the Indian and Eurasian plates built the great mountain systems of the HKH; climate, snow and ice then sculpted them into the landscapes we see today.

From this foundation, the Atlas moves from mountains to glaciers, glaciers to lakes, and lakes to hazards.

Seeing Change from Space

By combining Earth Observation, GIS, digital elevation models, hydro-meteorological data and other geospatial datasets, this Atlas provides a spatial picture of where glaciers and glacial lakes are located, how they are changing and where their changes may matter most.

Where possible, glacier and lake information is presented using consistent geographic references and established inventory approaches, while recognizing that cryospheric features are dynamic and continuously evolving.

From ancient mountains to modern satellites, this Atlas connects the past, present and future of Pakistan's cryosphere.

Mapping the Frozen Water Towers of Pakistan

Pakistan's mountains are more than towering peaks of rock and ice. They are living landscapes—shaped by ancient geology, fed by snow and glaciers, and connected to the rivers, communities and ecosystems far downstream.

This Atlas of Glaciers and Glacial Lakes of Pakistan brings this remarkable world together in one place. It tells the story of Pakistan's high mountains—from the Hindu Kush, Karakoram and Himalaya to the glaciers and glacial lakes scattered across their valleys.

From mountains to rivers. From ice to life.

Pakistan's northern mountains hold some of the most extensive glacier systems outside the polar regions. Their snow and ice feed the Upper Indus Basin, helping sustain water supplies, agriculture, hydropower, ecosystems and millions of lives downstream. But these frozen reservoirs are not static. Glaciers advance and retreat, lakes expand and drain, snow accumulates and melts, and mountain slopes continuously evolve.



● Afghanistan

● Bangladesh

● Bhutan

● China

● India

● Myanmar

● Nepal

● Pakistan

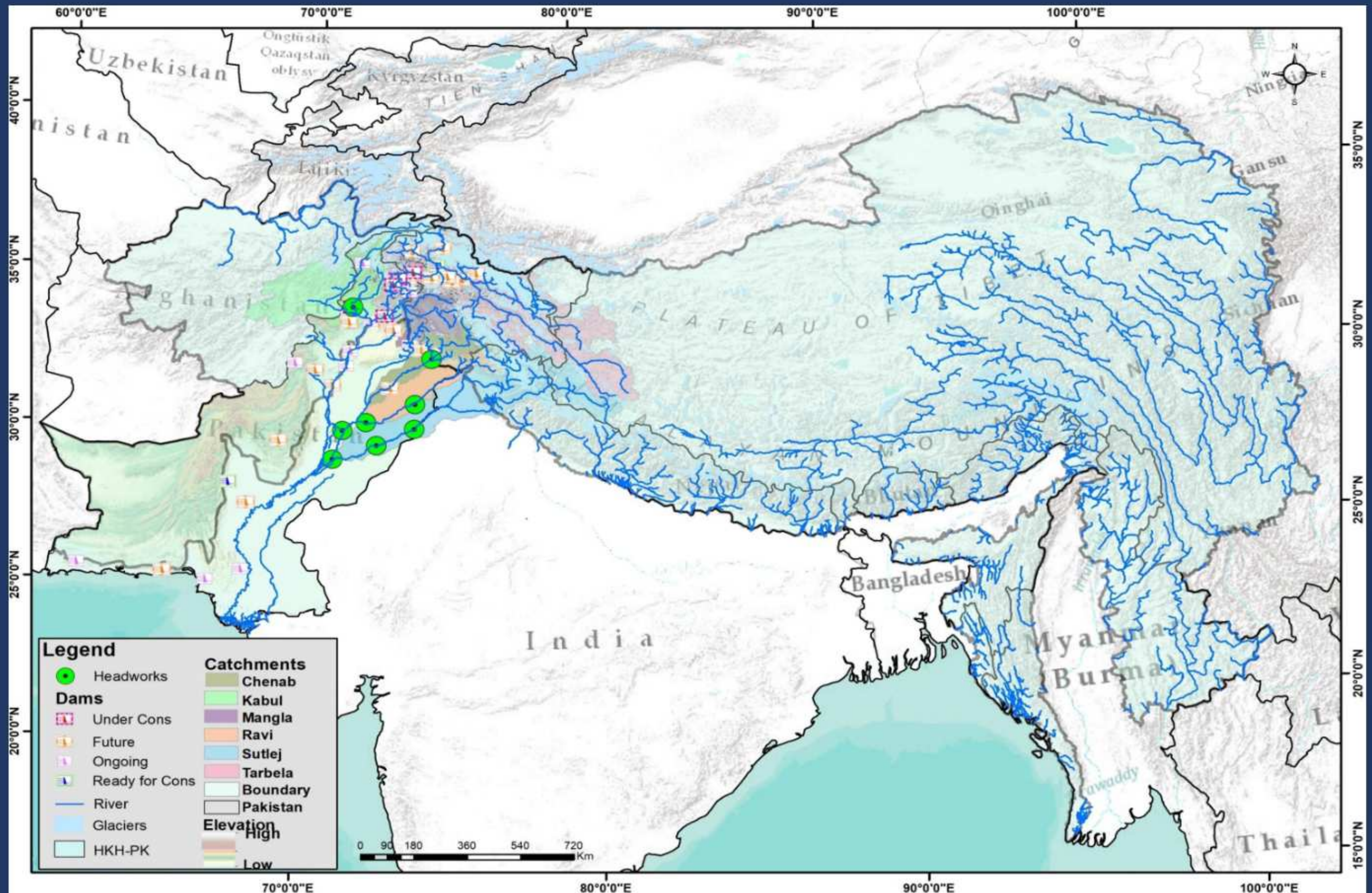
From the Tethys Ocean to the Third Pole

Geological formation and evolution of the Hindu Kush–Karakoram–Himalaya

The Hindu Kush–Karakoram–Himalaya (HKH) is one of the most dynamic mountain systems on Earth. It stretches across the highlands of Central, South and East Asia and is the product of hundreds of millions of years of plate movement, ocean closure, terrane accretion, continental collision, uplift and erosion. The glaciers, snowfields, rivers and lakes of today's "Third Pole" sit on top of this long geological foundation, and that foundation shapes where glaciers and glacial lakes occur and the hazards they pose.



Hydrological Setting of the HKH Region



From the HKH Water Towers to Pakistan's Lifelines

The regional hydro-glaciological and hydrological connectivity of the Hindu Kush–Karakoram–Himalaya (HKH) region is illustrated, showing how glaciers, rivers, catchments and water infrastructure form an interconnected system extending across national boundaries. The map highlights the extensive glacierised terrain and dense river networks that form the headwaters of major Asian river systems.

Within Pakistan, it particularly shows the concentration of glaciers and high-altitude rivers across Gilgit-Baltistan, Khyber Pakhtunkhwa and the Himalayan–Karakoram ranges, emphasizing their role as critical sources of snow- and glacier-fed runoff.

Pakistan's major catchments including Chenab, Kabul, Mangla, Ravi, Sutlej and Tarbela, illustrating the spatial connectivity between mountain headwaters and downstream drainage systems are delineated. Major rivers, headworks and dams are mapped.

Together, these features illustrate the glacier–river–catchment–reservoir continuum from water stored as snow and ice in the HKH, through river systems, to reservoirs that support irrigation, hydropower, water storage and national water & food security.

Major Basins and River Network of the HKH Region

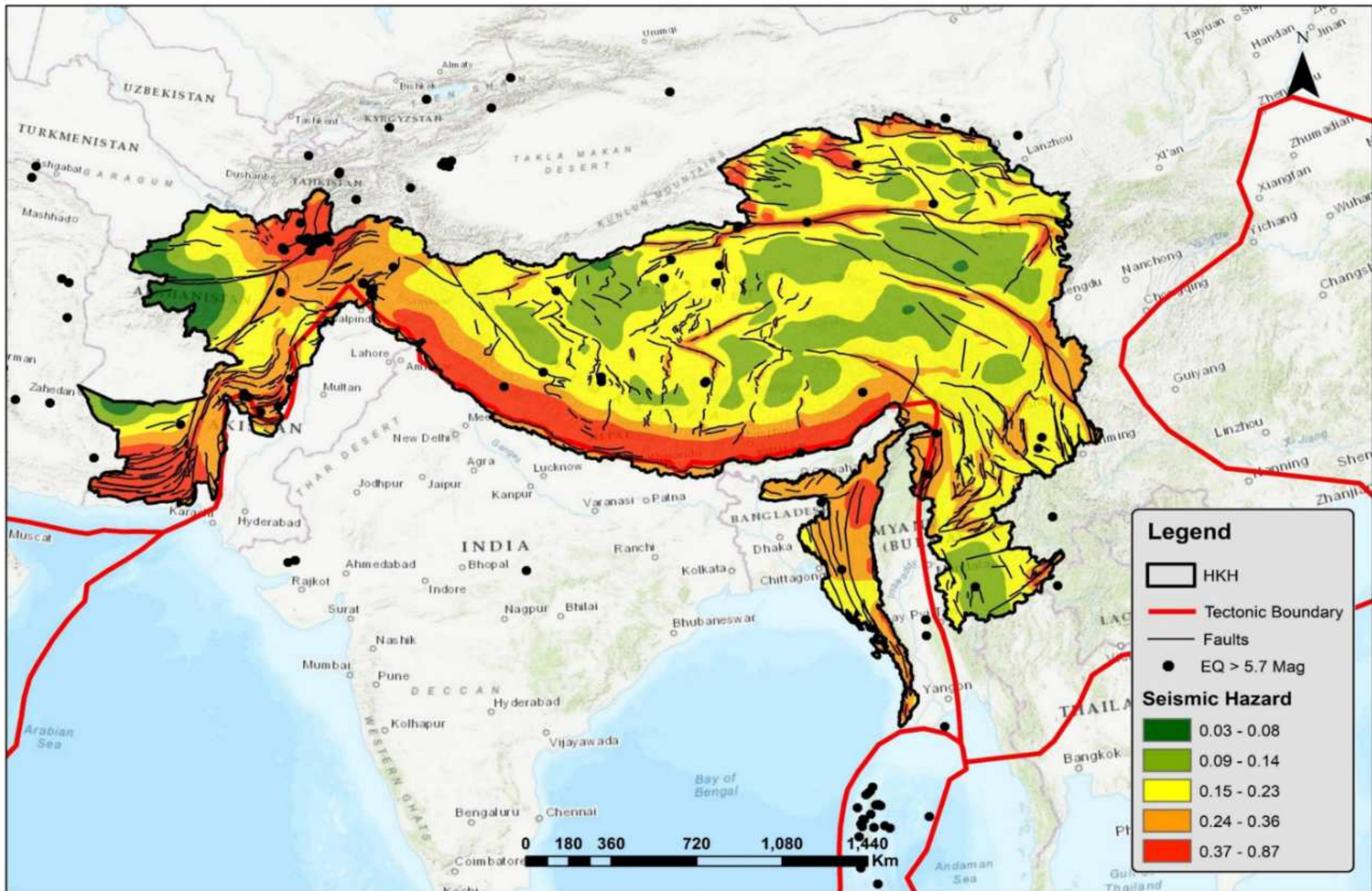


The map illustrates the Hindu Kush–Himalayan (HKH) region and its extensive downstream river network, which forms one of Asia’s most important freshwater systems. The HKH headwaters feed major transboundary rivers, including the Indus, Ganges, Brahmaputra, Amu Darya, Tarim, Yellow, Yangtze, Irrawaddy, Salween and Mekong.

The Indus River network is particularly significant for Pakistan, linking the glacier- and snow-fed headwaters of the western HKH with the downstream plains and irrigation systems of the Indus Basin. The interconnected river networks shown on the map demonstrate how high-mountain precipitation, snow and glacier melt are transferred through tributaries into major downstream basins.

The map highlights the HKH as a strategic mountain–river system, where changes in cryospheric conditions can influence river discharge, seasonal water availability and downstream water security. It provides the broader regional context for understanding Pakistan’s glacier–river–basin connectivity and the importance of its northern cryosphere to the national water system.

Seismic Setting of the HKH Region



The Hindu Kush–Karakoram–Himalaya (HKH) is an active tectonic zone formed by the ongoing convergence of the Indian and Eurasian plates. The map shows seismic hazard (PGA), major faults, tectonic boundaries and earthquakes >5.7 magnitude, with PGA values ranging from 0.03 to 0.87 g.

Higher seismic hazard is concentrated along the Himalayan frontal belt, western Himalaya, northern Pakistan and Hindu Kush, broadly coinciding with active faults and major tectonic structures. Northern Pakistan, in particular, exhibits elevated hazard associated with the Main Mantle Thrust, Main Karakoram Thrust, Main Boundary Thrust and associated fault systems.

The distribution of earthquake epicentres further highlights the region's active seismicity. The spatial overlap of glacierised terrain, active faults and high seismic hazard underscores the importance of considering seismic processes in glacier stability, glacial-lake development, GLOF risk and mountain hazard assessment.

Spatial Distribution of HKH Snow Cover - 2000



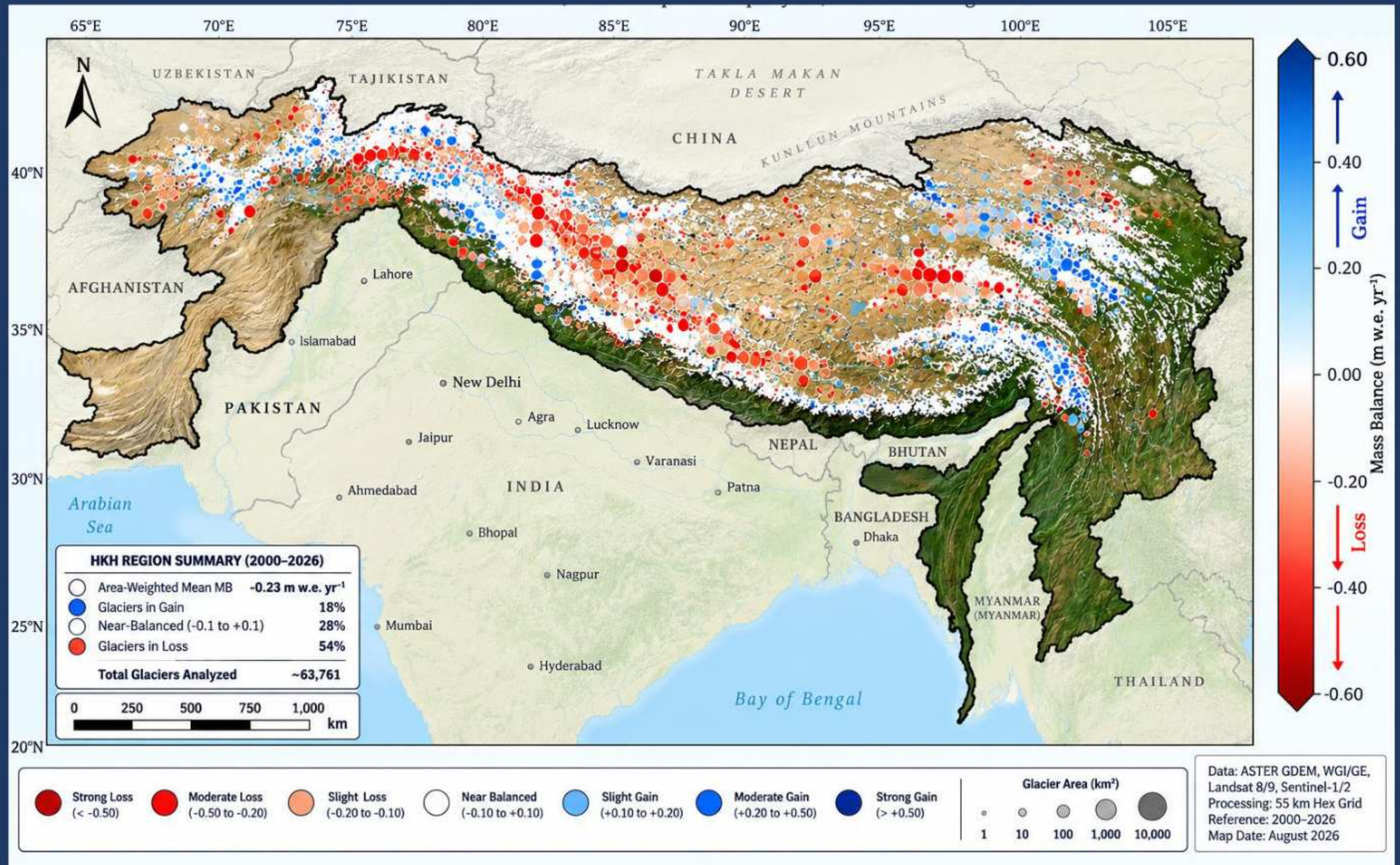
The comparison of the 2000 and 2026 snow-cover distributions illustrates an important transition in the regional cryosphere. The 2000 pattern shows broader and more continuous seasonal snow coverage across the major high mountain systems, with extensive snowfields extending across the Hindu Kush–Karakoram–Himalayan arc. By 2026, snow cover appears more fragmented and increasingly concentrated over the highest elevations, while relatively lower and intermediate elevation zones show greater exposure of the underlying terrain.

Spatial Distribution of HKH Snow Cover - 2026



This spatial shift is consistent with the broader evidence of declining snow-covered area, earlier snowmelt and increasing temperature sensitivity across much of the HKH. Recent regional assessments report significant reductions in annual and seasonal snow cover, while observations indicate increasing warming at middle and high elevations.

Glacier Mass Balance in the HKH in 2015 - 2026



The Third Pole: Cryosphere Crisis & Regional Action

The Fragile “Third Pole” Under Increasing Stress

Regional Response & Pakistan's Leadership



Supporting 2.3 Billion People

The HKH cryosphere sustains 12 major river basins across eight countries, providing freshwater, food, energy and livelihoods for ~2.3 billion people.



Accelerated Glacier Retreat

Glaciers in the HKH lost 65% more mass in the 2010s compared to the previous decade, with rising temperatures and changing precipitation patterns.



2050: The “Peak Water” Threshold

Sharp water declines after 2050 will threaten food security, hydropower and livelihoods across Asia.



Pakistan: At the Frontline

Home to 13,000+ glaciers and the 4th most vulnerable country to climate change, with ~3,000 potential GLOF sites.



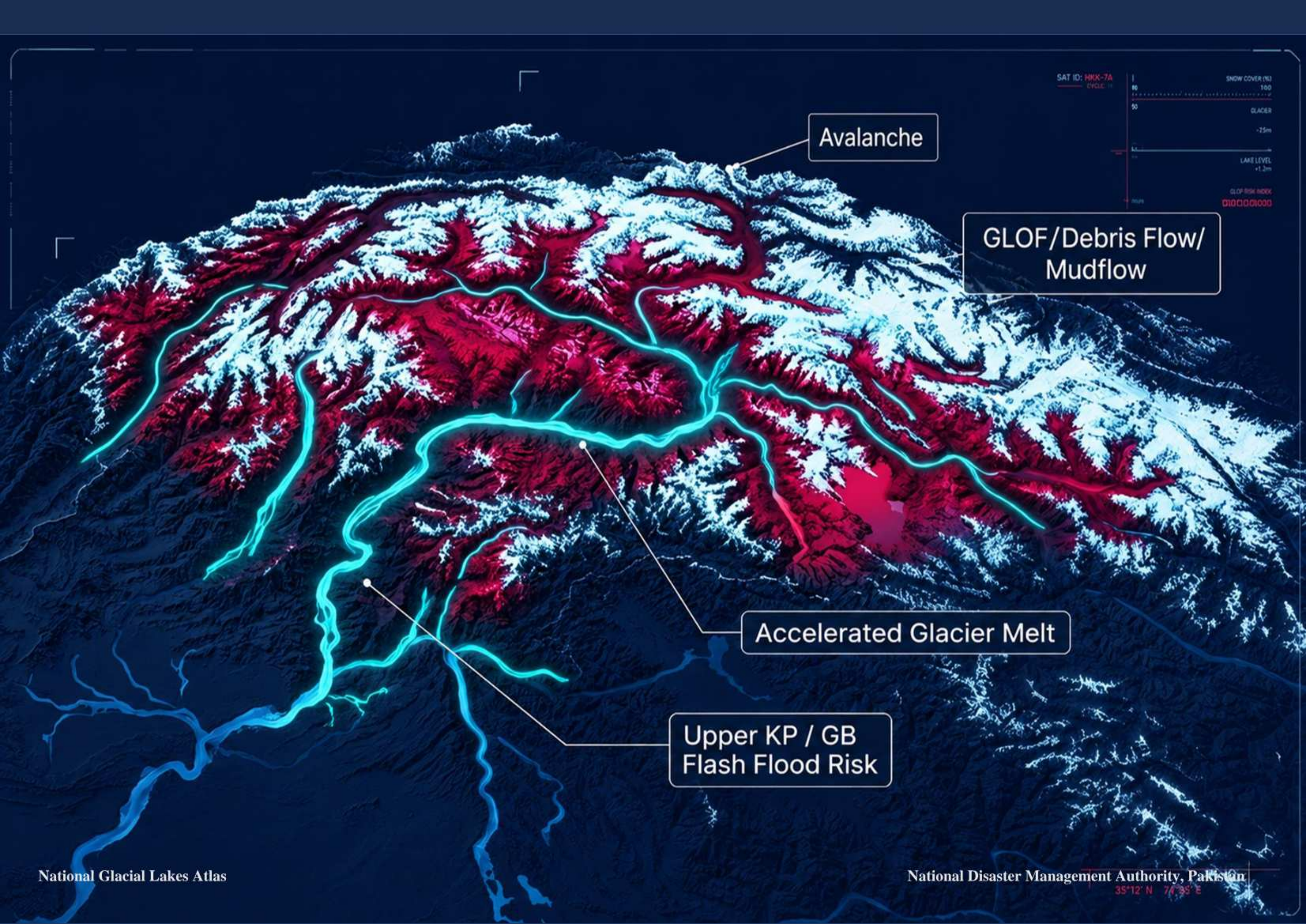
Multi-Hazard Early Warning and Risk Reduction

Integrated monitoring and forecasting for GLOFs, flash floods, landslides, avalanches, droughts and heat/cold waves to save lives and reduce disaster risk.

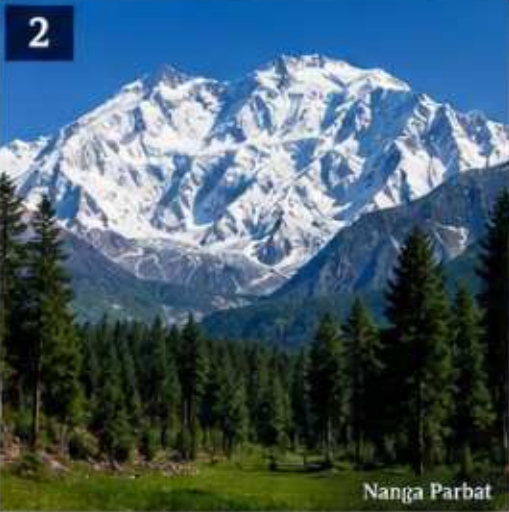


Vulnerability, Adaptation and Resilient Development

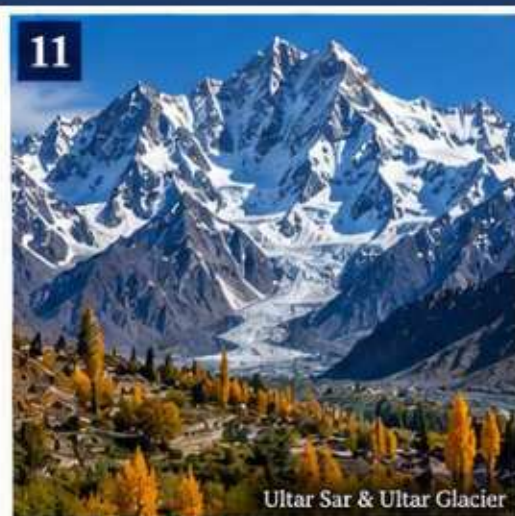
Sustainable management of glacier and snowmelt resources through regional and national collaboration, ecosystem-based adaptation and climate-resilient infrastructure for water, food and energy security.



Major Peaks of Pakistan

1  K2 (Chhogori) Peak 📍 Baltoro–Concordia, Central Karakoram 🏠 Shigar, GB 🏔️ 8,611 m ★ World's 2nd-highest mountain and highest peak of Pakistan; iconic mountaineering destination.	2  Nanga Parbat Peak 📍 Diamer–Raikot / Fairy Meadows 🏠 Diamer, GB 🏔️ 8,125 m ★ World's 9th-highest peak; famous as the "Killer Mountain" and for its enormous Rupal Face.	3  Broad Peak Peak 📍 Concordia, Baltoro region 🏠 Shigar, GB 🏔️ 8,051 m ★ World's 12th-highest mountain; part of the famous K2–Concordia mountain group.	4  Gasherbrum I (Hidden Peak) Peak 📍 Baltoro / Upper Baltoro 🏠 Shigar, GB 🏔️ 8,080 m ★ World's 11th-highest mountain; one of Pakistan's five 8,000-m peaks.	5  Gasherbrum II Peak 📍 Baltoro / Concordia region 🏠 Shigar, GB 🏔️ 8,035 m ★ World's 13th-highest mountain and one of the most prominent peaks visible from Concordia.
6  Rakaposhi Peak 📍 Nagar–Bagrote region 🏠 Nagar / Gilgit, GB 🏔️ 7,788 m ★ Famous for its enormous vertical rise and spectacular views from the Karakoram Highway.	7  Masherbrum (K1) Peak 📍 Hushe Valley 🏠 Ghanche, GB 🏔️ 7,821 m ★ One of the great Karakoram peaks; historically designated K1 during British surveys.	8  Tirich Mir Peak 📍 Tirich Valley, Hindu Kush 🏠 Upper Chitral, KP 🏔️ 7,708 m ★ Highest peak of the Hindu Kush and highest mountain in Pakistan outside the Karakoram/Himalayan giants.	9  Spantik (Golden Peak) Peak 📍 Chogo Lungma Glacier region 🏠 Shigar / Nagar, GB 🏔️ 7,027 m ★ Famous trekking/mountaineering peak; regarded as one of the more accessible 7,000-m peaks.	10  Diran Peak Peak 📍 Minapin / Nagar Valley 🏠 Nagar, GB 🏔️ 7,266 m ★ Famous pyramid-shaped Karakoram peak overlooking the Minapin Glacier.

Major Peaks of Pakistan



11

Ultr Sar

Peak

- 📍 Ultr Valley above Karimabad
- 📖 Hunza, GB
- 🏔️ 7,388 m
- ★ Dramatic peak above Hunza; prominent tourism and mountaineering landmark.

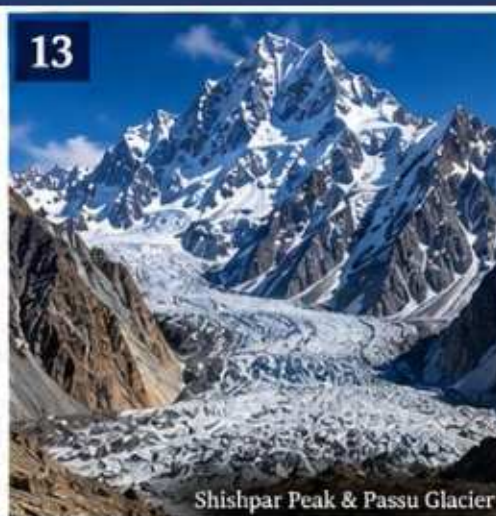


12

Passu Cones / Passu Sar

Peak Group

- 📍 Passu – Gojal
- 📖 Hunza, GB
- 🏔️ ~7,000 m class peaks
- ★ One of the most recognizable mountain landscapes of Pakistan; iconic tourism landmark.



13

Shishpar Peak

Peak

- 📍 Passu Glacier region
- 📖 Hunza, GB
- 🏔️ 7,611 m
- ★ Major high Karakoram peak associated with the Passu Glacier and Hunza landscape.



14

Malubiting

Peak

- 📍 Chogo Lungma / Haramosh region
- 📖 Nagar / Bagrot, GB
- 🏔️ ~7,458 m
- ★ Major Karakoram summit overlooking the Chogo Lungma region.



15

Mustagh Tower

Peak

- 📍 Baltoro – Mustagh region
- 📖 Shigar, GB
- 🏔️ ~7,276 – 7,350 m
- ★ Distinctive and historically important Karakoram climbing peak.



16

Batura Glacier

Glacier

- 📍 Batura Valley, Gojal
- 📖 Hunza, GB
- 🏔️ ~57 km class
- ★ One of the longest glaciers outside the polar regions; spectacular valley glacier.



17

Baltoro Glacier

Glacier

- 📍 Askole – Concordia
- 📖 Shigar, GB
- 🏔️ ~60+ km class
- ★ One of the world's most famous mountain glaciers; principal approach to K2, Broad Peak and Gasherbrums.



18

Biafo Glacier

Glacier

- 📍 Askole – Hispar region
- 📖 Shigar, GB
- 🏔️ ~60+ km class
- ★ One of the longest non-polar glaciers; forms the famous Biafo–Hispar glacial system.



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Hispar Glacier

Glacier

- 📍 Hispar Valley
- 📖 Nagar, GB
- 🏔️ ~49 km class
- ★ Forms the other half of the Biafo–Hispar traverse, one of the world's major high-altitude trekking routes.



20

Siachen Glacier

Glacier

- 📍 Eastern Karakoram
- 📖 Ghanche, GB / Siachen region
- 🏔️ ~70 km class
- ★ One of the world's longest non-polar glaciers and geopolitically significant high-altitude glacier.

Major Peaks of Pakistan

21  Chogo Lungma Glacier Chogo Lungma Glacier Glacier - Arandu / Chogo Lungma Valley - Shigar, GB ~40+ km class - Major Karakoram glacier and source region associated with Spantik and surrounding high peaks.	22  Hoper Glacier Hoper (Hopper) Glacier Glacier - Hoper Valley - Nagar, GB — - Easily accessible major glacier near Nagar; important tourism and landscape feature.	23  Miar Glacier Miar Glacier Glacier - Hoper Valley / Nagar - Nagar, GB — - Prominent glacier visible from the Hoper Valley; important trekking and tourism landmark.	24  Ghulkin Glacier Ghulkin Glacier Glacier - Ghulkin – Gojal - Hunza, GB — - Easily accessible glacier near Gulmit; important tourism feature and part of the upper Hunza cryosphere.	25  Passu Glacier Passu Glacier Glacier - Passu, Gojal - Hunza, GB — - Iconic glacier beneath the Passu massif; one of the most photographed glacier landscapes in Pakistan.
26  Gulkin Glacier Gulkin Glacier Glacier - Gulmit / Gojal - Hunza, GB — - Known for its accessible glacier landscape and proximity to Borith Lake and the Karakoram Highway.	27  Khunjerab Glacier Khunjerab Glacier Glacier - Khunjerab – Pak-China border region - Hunza, GB — - High-altitude glacier system in the Khunjerab region, associated with the upper Hunza cryosphere.	28  Yazghil Glacier Yazghil Glacier Glacier - Shimshal / Hoper region - Hunza / Nagar, GB — - Major high-altitude glacier system connected with the Hispar–Yazghil mountain environment.	29  Momhil Glacier Momhil Glacier Glacier - Shimshal Valley - Hunza, GB — - Important glacier of the remote Shimshal mountain system; surrounded by numerous 7,000-m peaks.	30  Kondus Glacier Kondus Glacier Glacier - Kondus Valley - Ghanche, GB — - Important glacier system beneath the Masherbrum–Kondus high mountains.

Major Peaks of Pakistan

 31 Gondogoro Glacier	 32 Abruzzi Glacier	 33 Godwin-Austen Glacier	 34 Rupal Glacier	 35 Raikot Glacier
Gondogoro Glacier Glacier 📍 Hushe – Gondogoro region 📖 Ghanche, GB — ★ Famous due to the Gondogoro La trek, providing spectacular views toward K2 and the Concordia group.	Abruzzi Glacier Glacier 📍 Baltoro / Concordia 📖 Shigar, GB — ★ Important glacier in the K2 climbing environment and associated with the Abruzzi Ridge route.	Godwin-Austen Glacier Glacier 📍 K2 eastern / southeastern flank 📖 Shigar, GB — ★ Glacier immediately associated with K2; feeds the upper Baltoro system.	Rupal Glacier Glacier 📍 Rupal Valley 📖 Diamer, GB — ★ Associated with the spectacular Rupal Face of Nanga Parbat, one of the world's greatest mountain walls.	Raikot Glacier Glacier 📍 Raikot Valley 📖 Diamer, GB — ★ Glacier system associated with the Nanga Parbat massif and the famous Fairy Meadows landscape.
 36 Chiantar Glacier	 37 Yarkhun Glacier	 38 Tirich Glacier	 39 Darkot Glacier	 40 Badswat Glacier
Chiantar Glacier Glacier 📍 Yarkhun / Chiantar region 📖 Upper Chitral, KP — ★ Major Hindu Kush glacier and important component of the Upper Chitral cryosphere.	Yarkhun Glacier Glacier 📍 Yarkhun Valley 📖 Upper Chitral, KP — ★ Important Hindu Kush glacier system and major high-altitude water source of northern Chitral.	Tirich Glacier Glacier 📍 Tirich Valley 📖 Upper Chitral, KP — ★ Major glacier system below Tirich Mir; important source of meltwater for the Chitral River system.	Darkot Glacier Glacier 📍 Darkot Valley 📖 Ghizer, GB — ★ Famous trekking glacier and important component of the upper Ghizer cryosphere.	Badswat Glacier Glacier 📍 Badswat / Ishkoman region 📖 Ghizer, GB — ★ Known for its glacial-lake environment and importance in GLOF and cryospheric hazard assessment.

Glacial Lakes



Pakistan's northern Hindu Kush, Karakoram and Himalayan ranges host an extensive cryospheric system of glaciers, snowfields and glacial lakes that plays a vital role in sustaining the Upper Indus River System and downstream water resources.

Rapid climatic and environmental changes, including rising temperatures, changing precipitation and altered snow and glacier melt, are affecting glacier dynamics and contributing to the formation and expansion of glacial lakes. These changes increase the potential for GLOFs, flash floods and associated cascading hazards, with implications for water security, infrastructure and mountain communities.

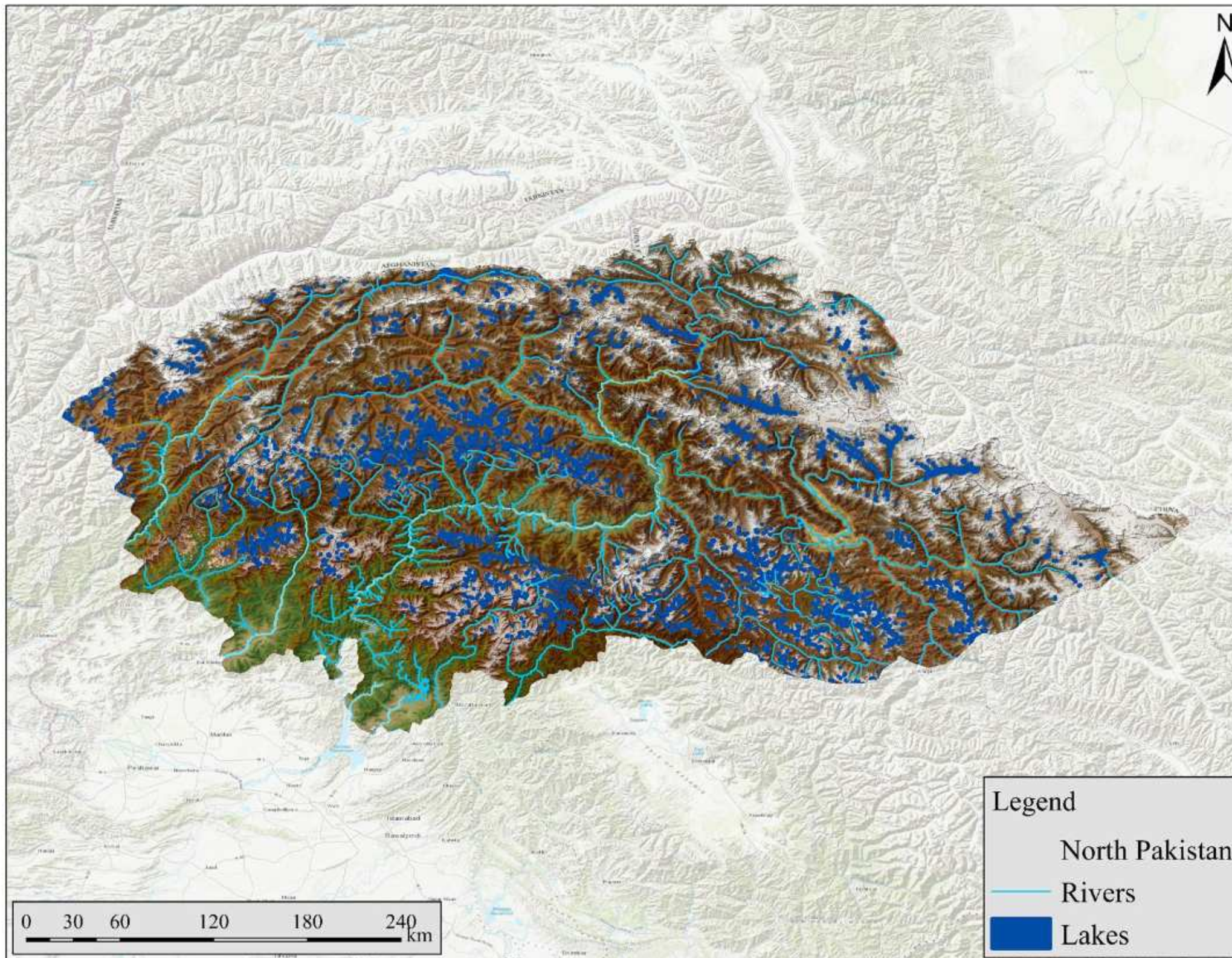
The National Glaciers and Glacial Lakes Atlas of Pakistan provides a standardized, geospatially consistent national reference of the country's glacier and glacial-lake resources. Integrating remote sensing, GIS, satellite observations, DEMs, field information and existing inventories, the Atlas documents their spatial distribution, physical characteristics, hydrological connectivity and changing dynamics.

Types of Glacial Lakes

1. EROSION LAKES  Formed by glacial erosion in bedrock basins.	2. DEPOSITIONAL LAKES  Formed by deposition of glacial sediments (till, outwash).	3. SUPRAGLACIAL LAKES  Located on the surface of glaciers, often on debris-covered ice.	4. MORaine-DAMMED LAKES  Impounded by moraine dams; highly prone to GLOFs.	5. LATERAL MORaine-DAMMED LAKES  Dam formed by moraine along the side of a glacier.
6. END MORaine-DAMMED LAKES  Dam formed by moraine at the end (toe) of a glacier.	7. ICE-DAMMED LAKES  Dammed by glacier ice; highly unstable and prone to sudden release.	8. BLOCKED LAKES (LANDSLIDE/ICE BLOCKAGE LAKES)  Formed when landslides or ice/debris block the river channel.	9. PROGLACIAL LAKES  Located in front of a glacier, often moraine-dammed.	10. ICE-MARGINAL LAKES  Along the edges of glaciers, often near retreating ice.
11. CIRQUE LAKES  Formed in cirques (amphitheater-like depressions) by glacial erosion.	12. VALLEY LAKES  Located in glacially carved valleys, may be long and narrow.	13. BEDROCK-DAMMED LAKES  Dammed by bedrock barriers; generally more stable.	14. ENGLACIAL LAKES  Occur within the ice mass of glaciers.	15. SUBGLACIAL LAKES  Located beneath glaciers; not directly visible.
16. DETACHED / UNCONNECTED GLACIAL LAKES  No longer in direct contact with glaciers; formed after glacier retreat.	17. THERMOKARST / KETTLE LAKES  Formed by melting of buried ice blocks in glacial sediments.	MOST VULNERABLE FOR GLOFs  Moraine-Dammed Lakes  Lateral Moraine-Dammed Lakes  End Moraine-Dammed Lakes  Ice-Dammed Lakes  Blocked Lakes (Landslide/Ice)  Proglacial Lakes		

Note: Vulnerability depends on lake size, dam type, depth, slope, and triggering factors (e.g., heavy rainfall, earthquakes, rapid snow/ice melt).

Glacial Lakes of Pakistan - 2026

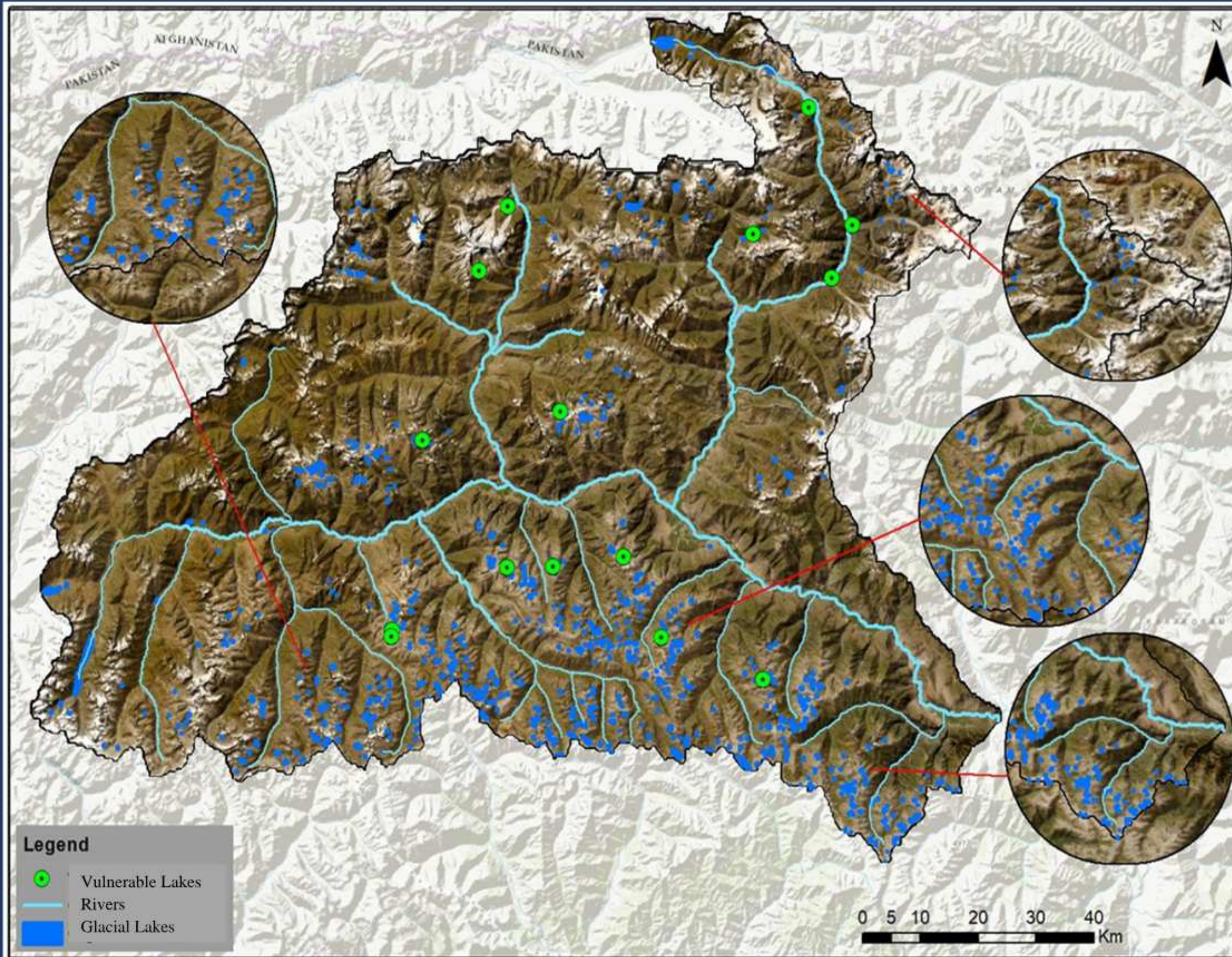


Northern Pakistan - Gilgit-Baltistan & Khyber Pakhtunkhwa

Northern Pakistan represents Pakistan's principal high-mountain cryosphere, encompassing the Hindu Kush, Karakoram and western Himalaya, where glaciers, seasonal snow and glacial lakes regulate headwater runoff to the Upper Indus Basin.

The compiled inventory records 9,357 glacial lakes covering 145.083 km², with an estimated total water volume of 2.575 billion m³ (2.088 MAF). This extensive and evolving lake system reflects ongoing glacier-lake interactions under a warming climate; national assessments have identified thousands of glacial lakes across GB and KP, including lakes requiring GLOF risk monitoring. The concentration of lakes in steep, highly dissected mountain valleys makes Northern Pakistan a critical zone for monitoring GLOFs, flash floods, debris flows and associated downstream water-security risks.

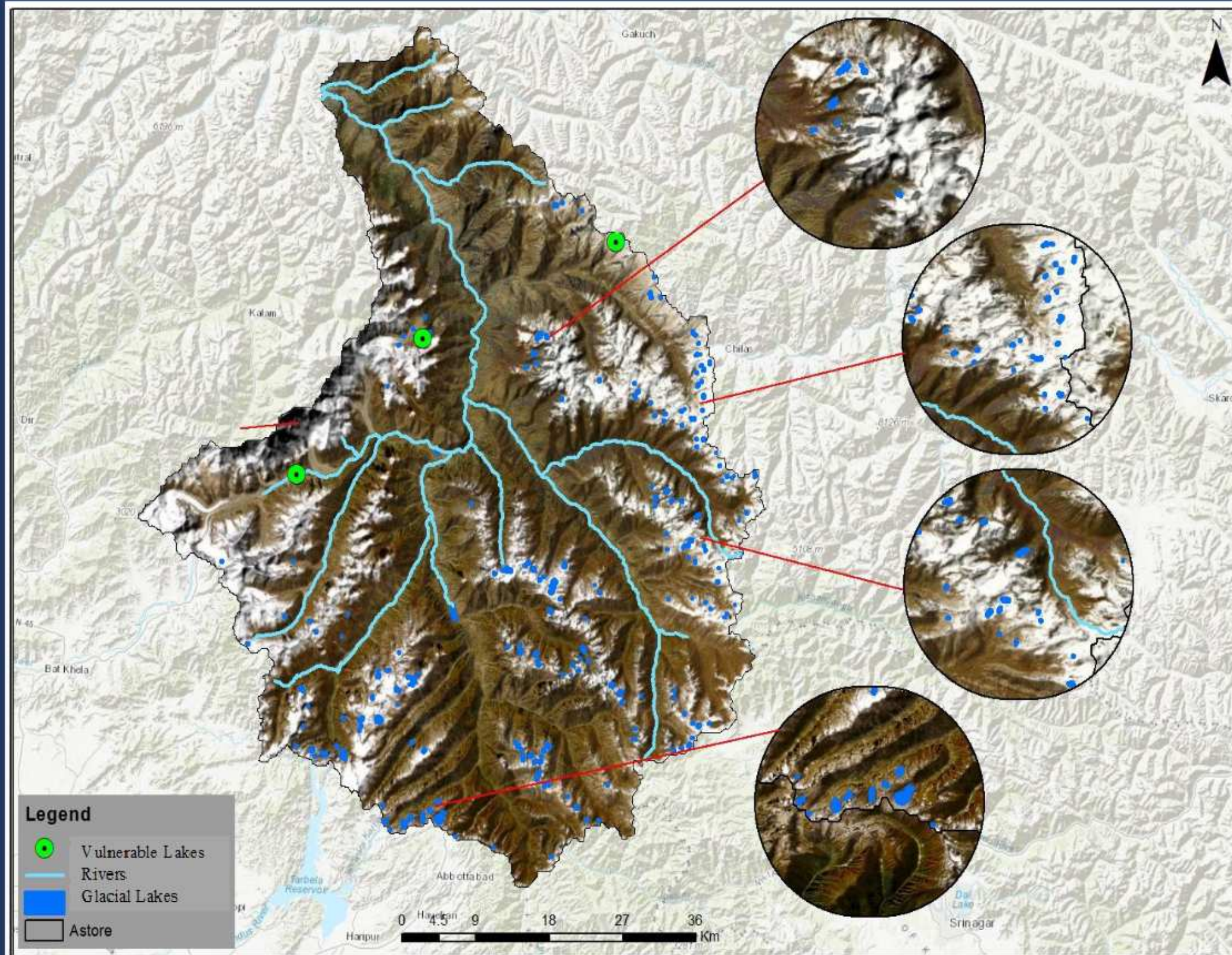
Glacial Lakes of Pakistan - 2026



Gilgit - Gilgit-Baltistan

Gilgit serves as a key hydrological and population centre where glacier- and snow-fed tributaries converge and support settlements, agriculture, infrastructure and regional connectivity. The district contains 240 glacial lakes covering 5.18 km², with an estimated 0.046 MAF of storage. Increasing temperatures and changing melt patterns can affect seasonal water availability while elevating risks from GLOFs, flash floods and debris flows in connected valleys.

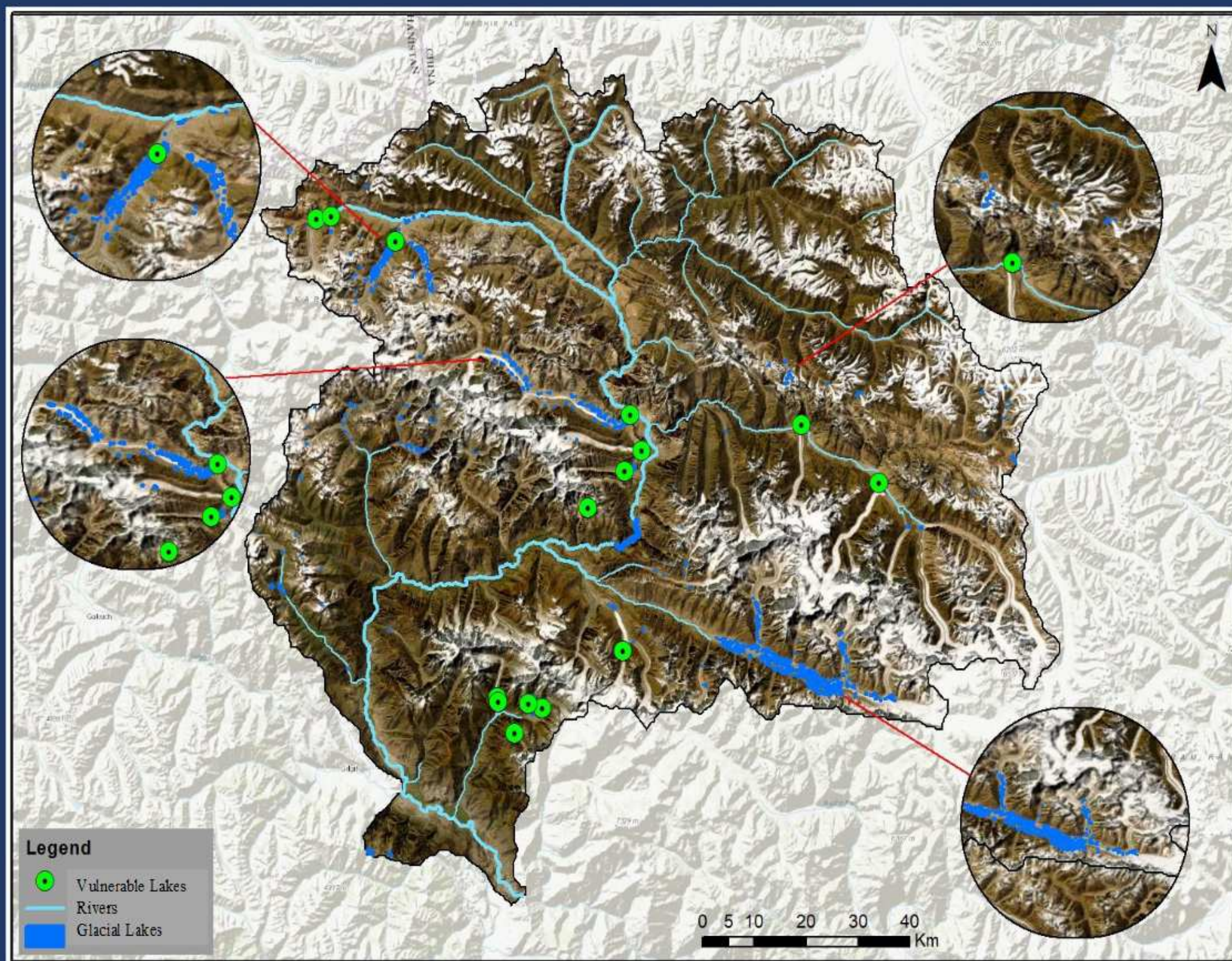
Glacial Lakes of Pakistan - 2026



Astore - Gilgit-Baltistan

Astore is an important glacier- and snow-fed headwater district contributing to the broader Indus hydrological system and supporting agriculture and mountain communities. Its 369 glacial lakes cover 9.06 km², representing approximately 0.106 MAF of estimated water storage. Changes in glacier mass, snow cover and lake conditions can alter seasonal runoff and increase the likelihood of GLOFs, flash floods, avalanches and landslides.

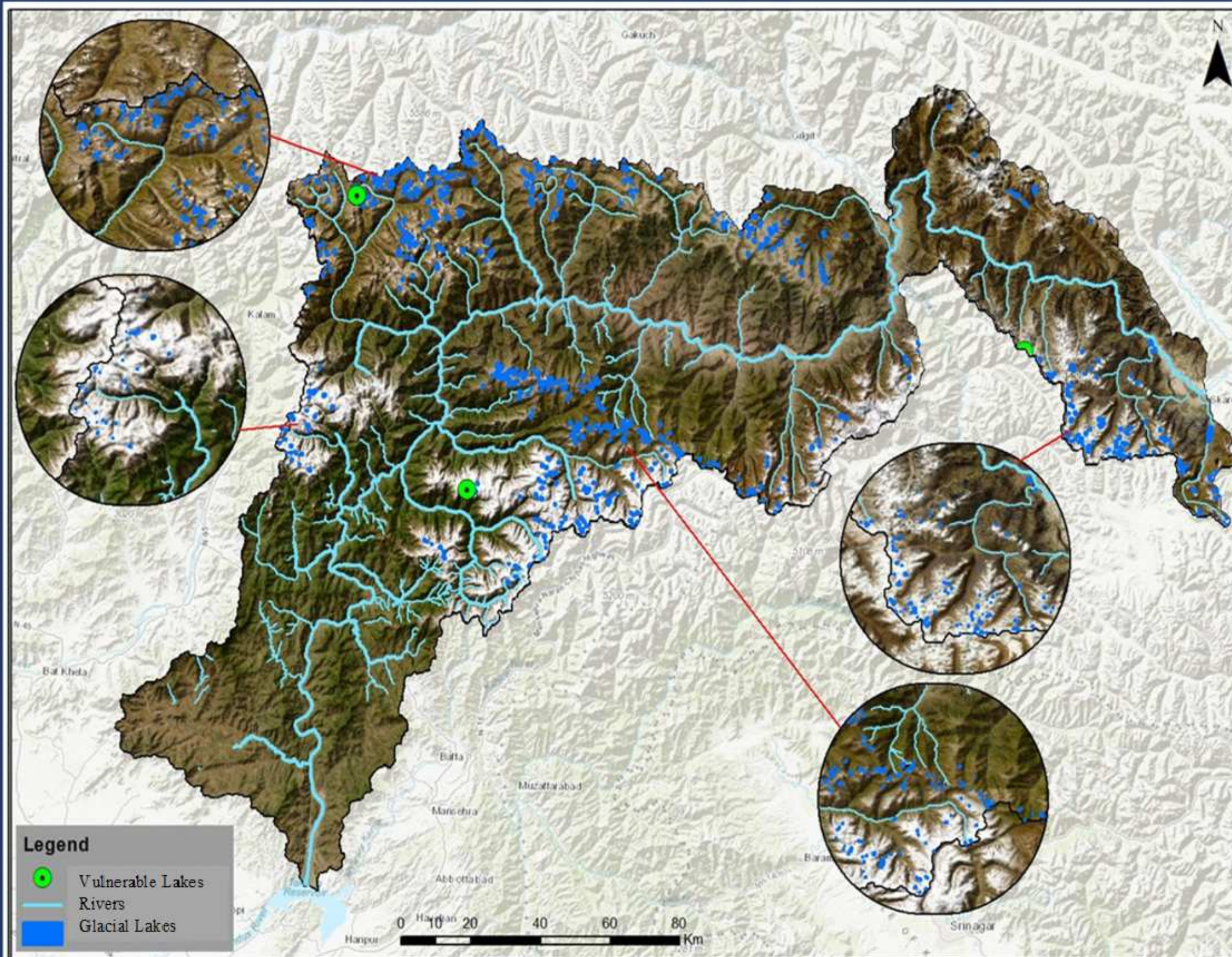
Glacial Lakes of Pakistan - 2026



Hunza-Nagar - Gilgit-Baltistan

Hunza-Nagar is one of the most glacier-dominated and cryospherically active landscapes of northern Pakistan, supporting extensive glacier-fed streams, agriculture and settlements in otherwise water-limited valleys. The district hosts 1,388 glacial lakes covering 7.29 km², with an estimated 0.214 MAF of storage, highlighting its importance as a high-altitude water reservoir. Rapid glacier retreat and lake expansion can increase the potential for GLOFs, debris flows and flash floods, posing risks to communities, infrastructure, agriculture and tourism.

Glacial Lakes of Pakistan - 2026

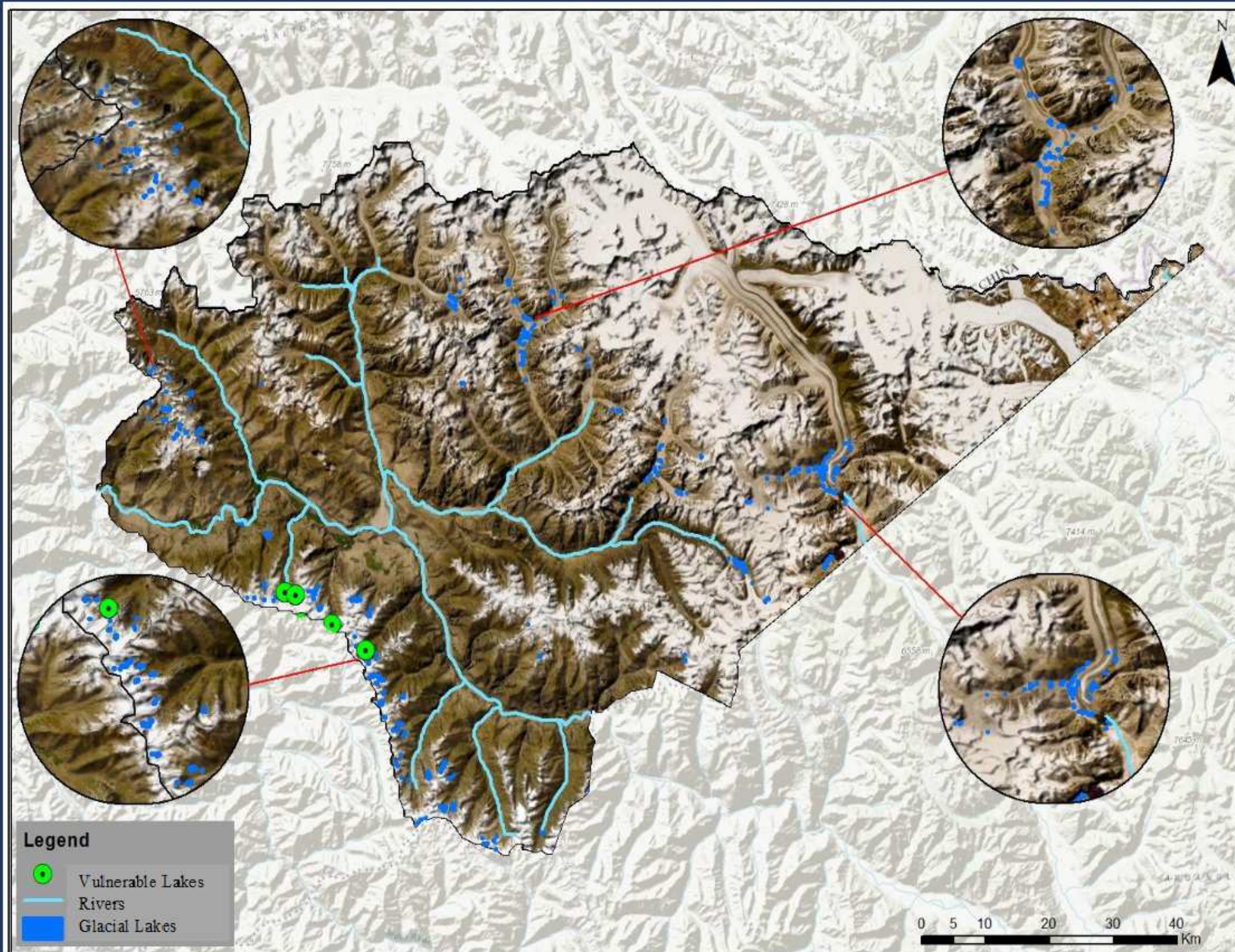


The Indus Basin

The Indus Basin forms the lifeline of Pakistan's water system, with its high-altitude cryosphere comprising 1,025 mapped glacial lakes covering 26.45 km² and holding an estimated 0.317 MAF of water. Fed by extensive glaciers, seasonal snow and glacial lakes, the basin provides vital meltwater that underpins water, food and energy security across the country.

However, its dynamic cryosphere also heightens exposure to GLOFs, flash floods, debris flows, avalanches and landslides, underscoring the need for sustained monitoring, risk assessment and early warning.

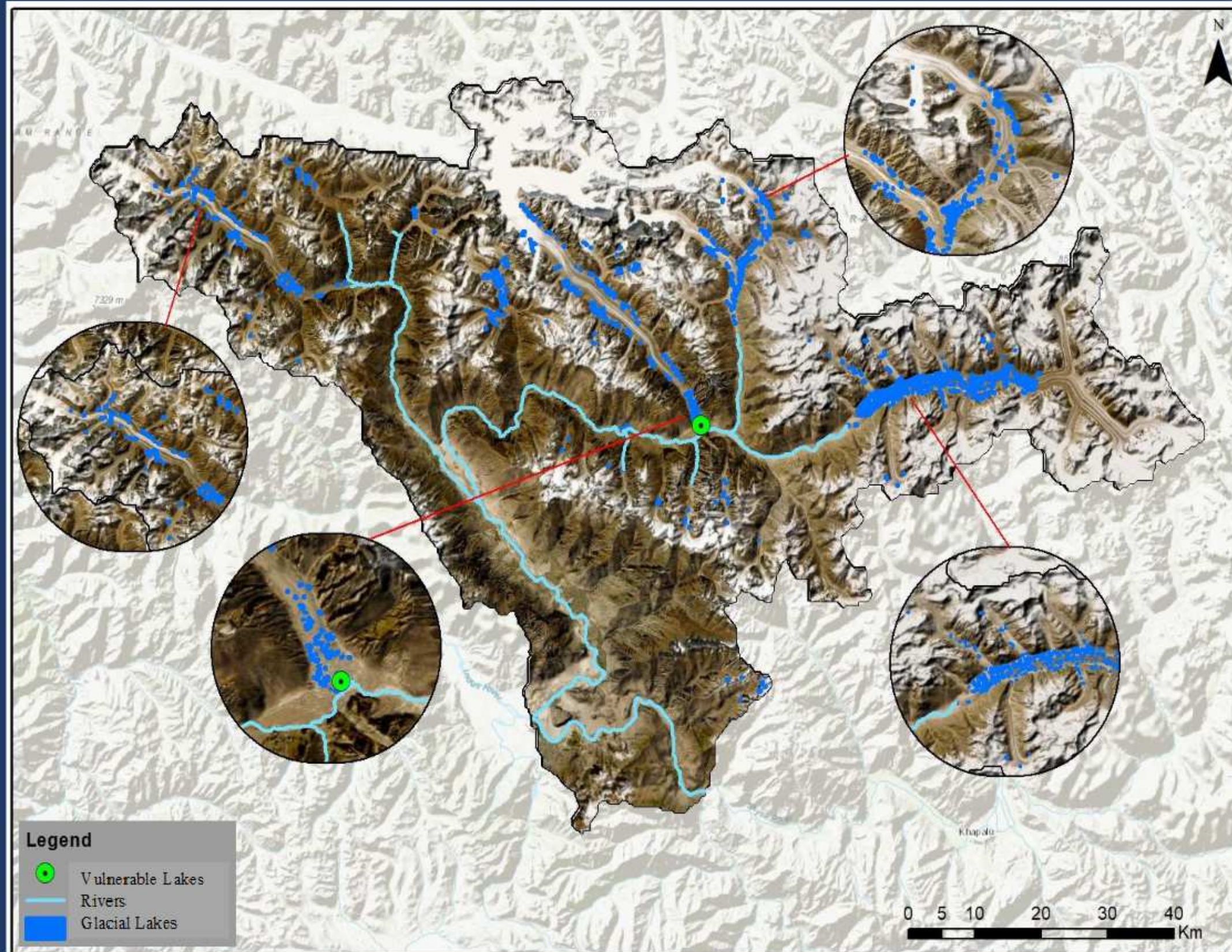
Glacial Lakes of Pakistan - 2026



Shyok- Gilgit Baltistan

The Shyok River Basin, a major Karakoram tributary of the Indus, contains 372 mapped glacial lakes covering 3.97 km² and holding an estimated 0.038 MAF of water. Fed by large glaciers, including the Siachen system through the Nubra River, and by seasonal snow, the basin delivers substantial summer meltwater to the upper Indus. Its glacier-dammed valleys have also produced damaging outburst floods in the past, so the basin's hazards can reach well beyond the mountains. Among the most glacierised tributaries of the Upper Indus, the Shyok therefore plays a significant role in both downstream water supply and flood risk, which makes sustained monitoring, risk assessment and early warning essential.

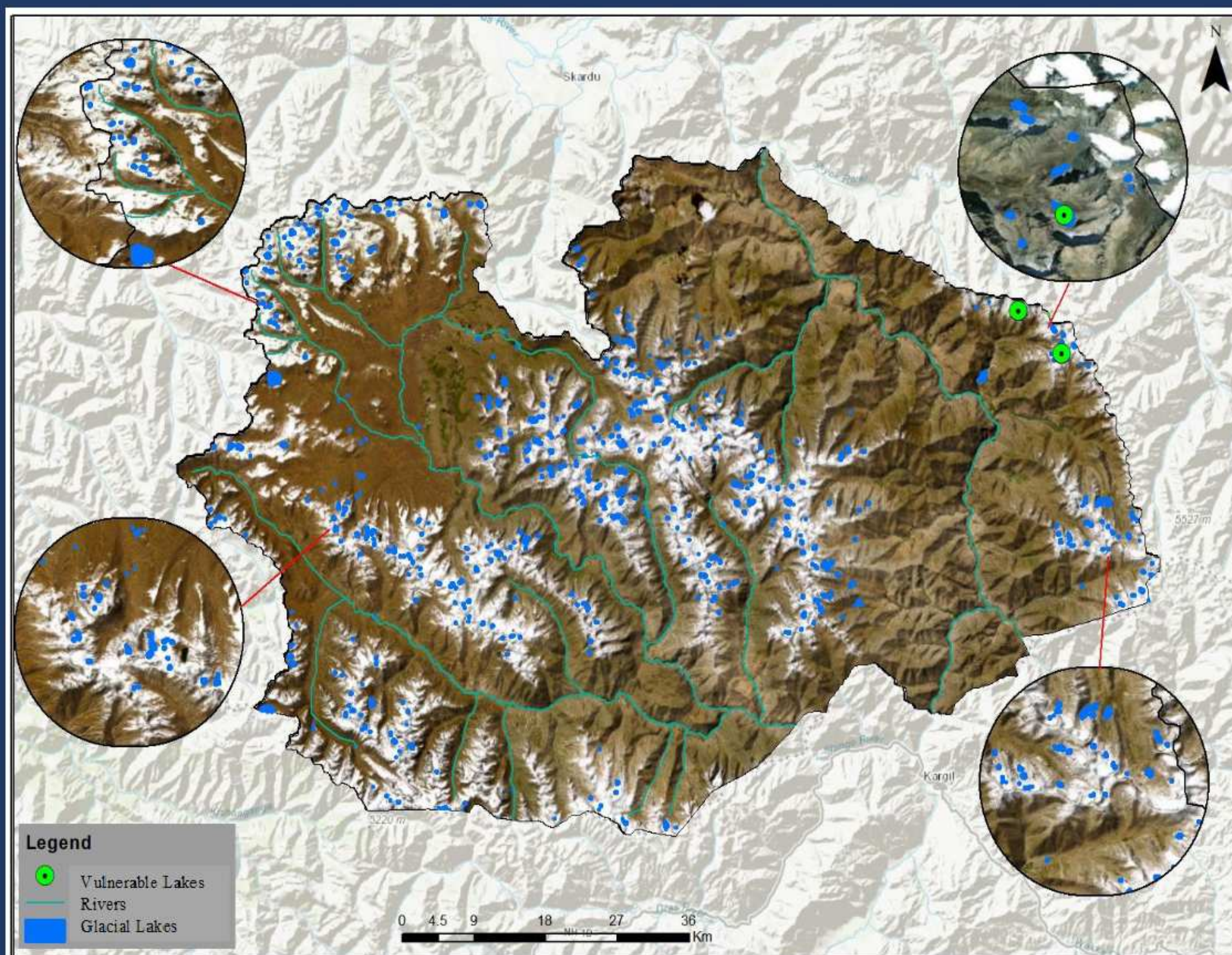
Glacial Lakes of Pakistan - 2026



Shigar- Gilgit Baltistan

The Shigar River Basin, a principal right-bank tributary of the Indus, contains 1,735 mapped glacial lakes covering 4.03 km² and holding an estimated 0.0202 MAF of water. Fed by the Baltoro and Biafo glaciers, among the largest outside the polar regions, together with seasonal snow, the basin sustains much of the summer flow that reaches the Indus at Skardu. Its dense cluster of small lakes, many lying on and beside the large glaciers, adds to the exposure to GLOFs, flash floods and debris flows. Because its flows depend heavily on glacier melt, the Shigar Basin is important for downstream water availability and for hazard management, which makes sustained monitoring, risk assessment and early warning essential.

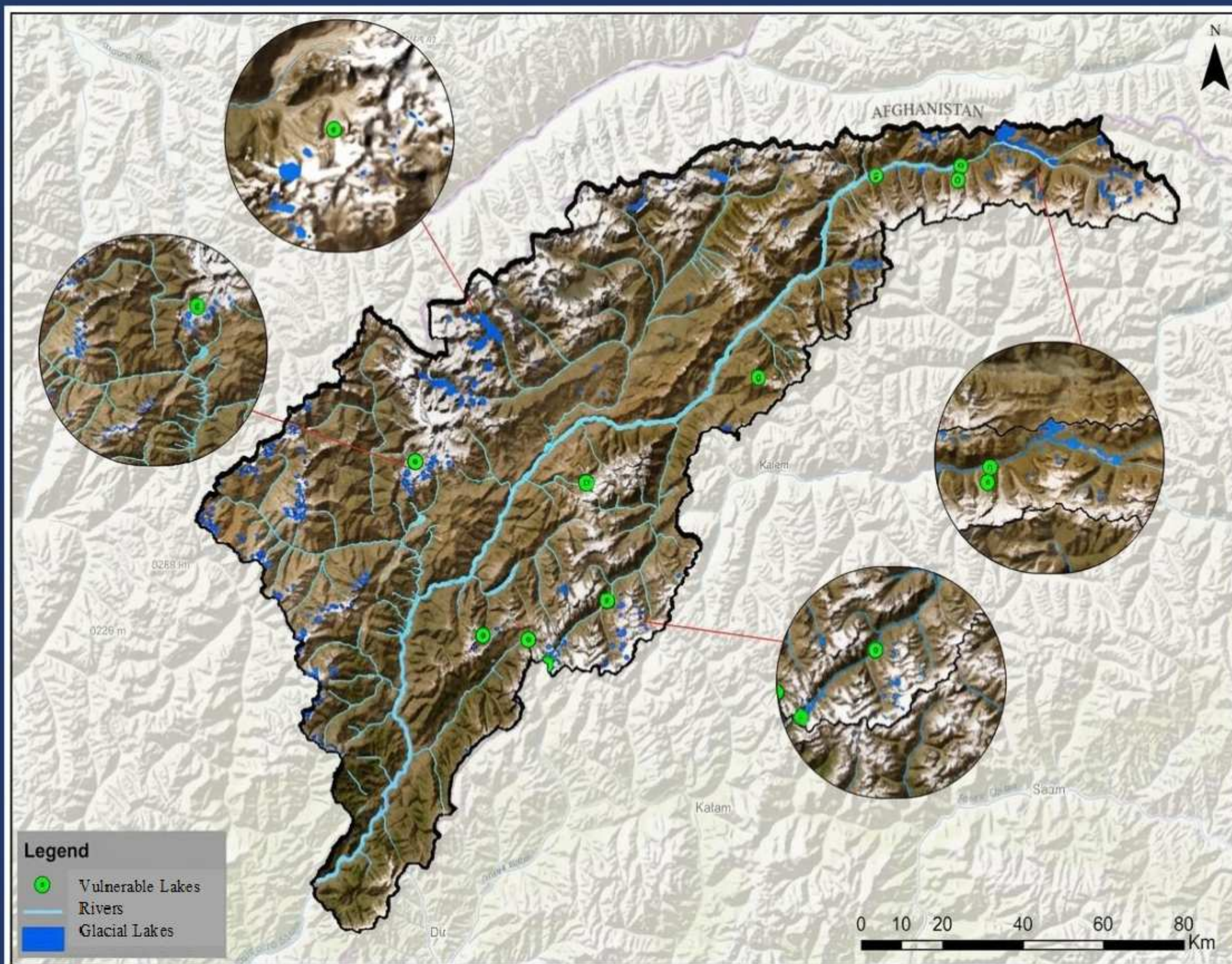
Glacial Lakes of Pakistan - 2026



Kharmang - Gilgit Baltistan

The Kharmang Basin, where the Indus enters Gilgit-Baltistan from Ladakh, contains 673 mapped glacial lakes covering 14.74 km² and holding an estimated 0.161 MAF of water. Fed by glaciers and seasonal snow in the headwaters of the Indus tributaries, including the Shingo and Suru, the basin carries meltwater into Baltistan and contributes to the flows of the upper Indus. Compared with the neighbouring Shigar and Shyok basins, it has fewer but larger lakes, which increases its potential for outburst floods and downstream impacts on the populated valley. As the entry point of the Indus into Pakistan, the Kharmang Basin is important for upstream monitoring, risk assessment and early warning.

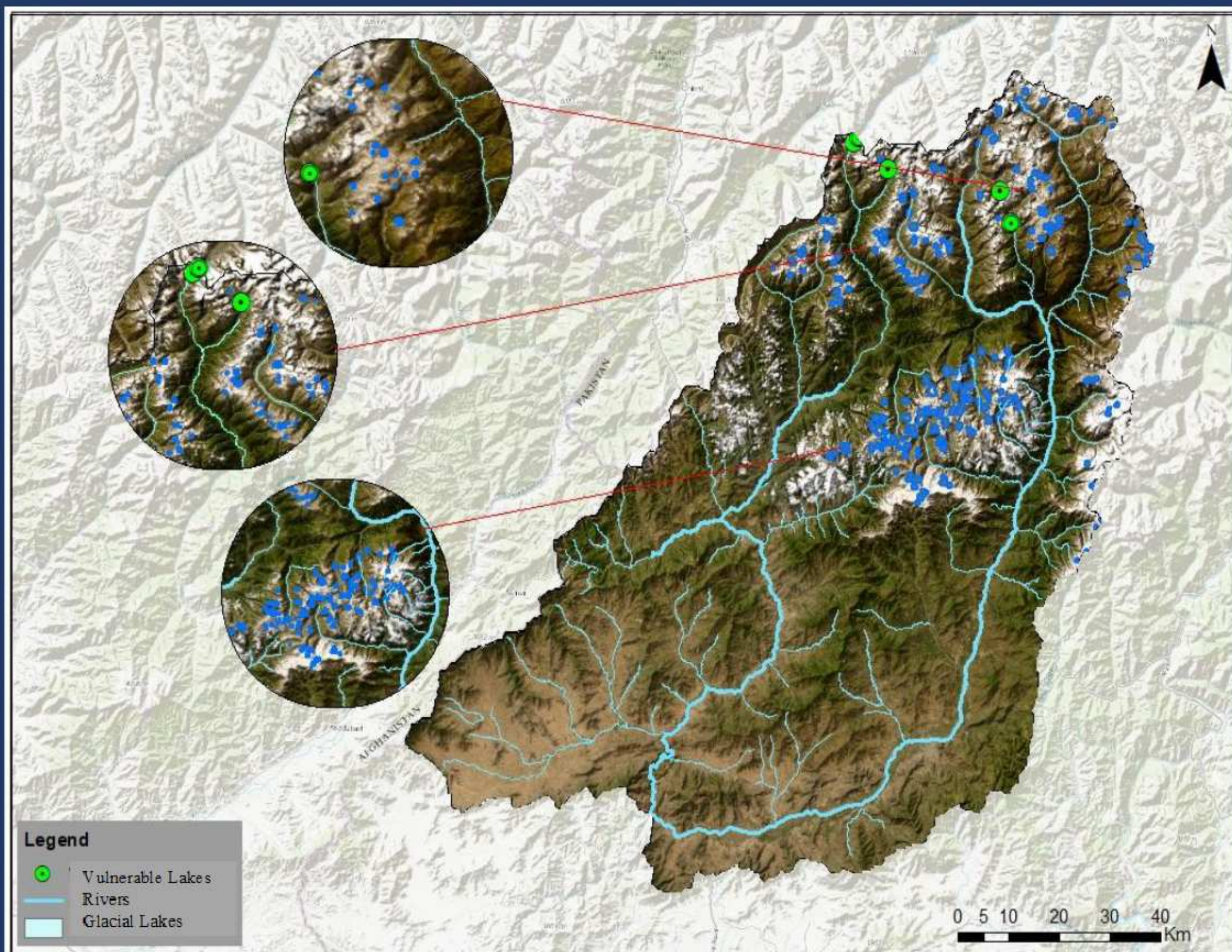
Glacial Lakes of Pakistan - 2026



Chitral - Khyber Pakhtunkhwa

Chitral is a strategically important western headwater region of the Upper Indus Basin, where glaciers and seasonal snow regulate river flows across an arid mountain environment. Its 1,221 glacial lakes cover 15.29 km² and contain an estimated 0.281 MAF of water, supporting downstream water availability, agriculture and ecosystems. The district's high relief, extensive glaciers and vulnerable valleys make it particularly exposed to GLOFs, flash floods, avalanches, landslides and debris flows.

Glacial Lakes of Pakistan - 2026



Swat - Khyber Pakhtunkhwa

Swat is a glacier- and snow-influenced mountain basin of the eastern Hindu Kush, where cryospheric melt contributes to seasonal runoff and downstream water resources. The inventory identifies 224 glacial lakes covering 8.736 km², with an estimated 130.17 million m³ (0.106 MAF) of stored water. Research has identified 16 potentially dangerous glacial lakes in Swat, while areas including Kalam, Bahrain and Madyan have documented downstream exposure to glacial-lake hazards. The combination of expanding glacial lakes, steep terrain and concentrated settlements along river corridors increases exposure to GLOFs, flash floods, landslides and debris flows.



CRYOSPHERE COMPONENTS



GLACIERS

~15,000 Glaciers in Pakistan
Covering 134,080 km²



GLACIAL LAKES

2,500+ Glacial Lakes
Potential GLOF Risk



SNOW COVER

Seasonal Snow Sustain
Water Resources



RIVERS & STREAMS

Headwaters of Indus Ecos
and Major River Systems



PERMAFFOST

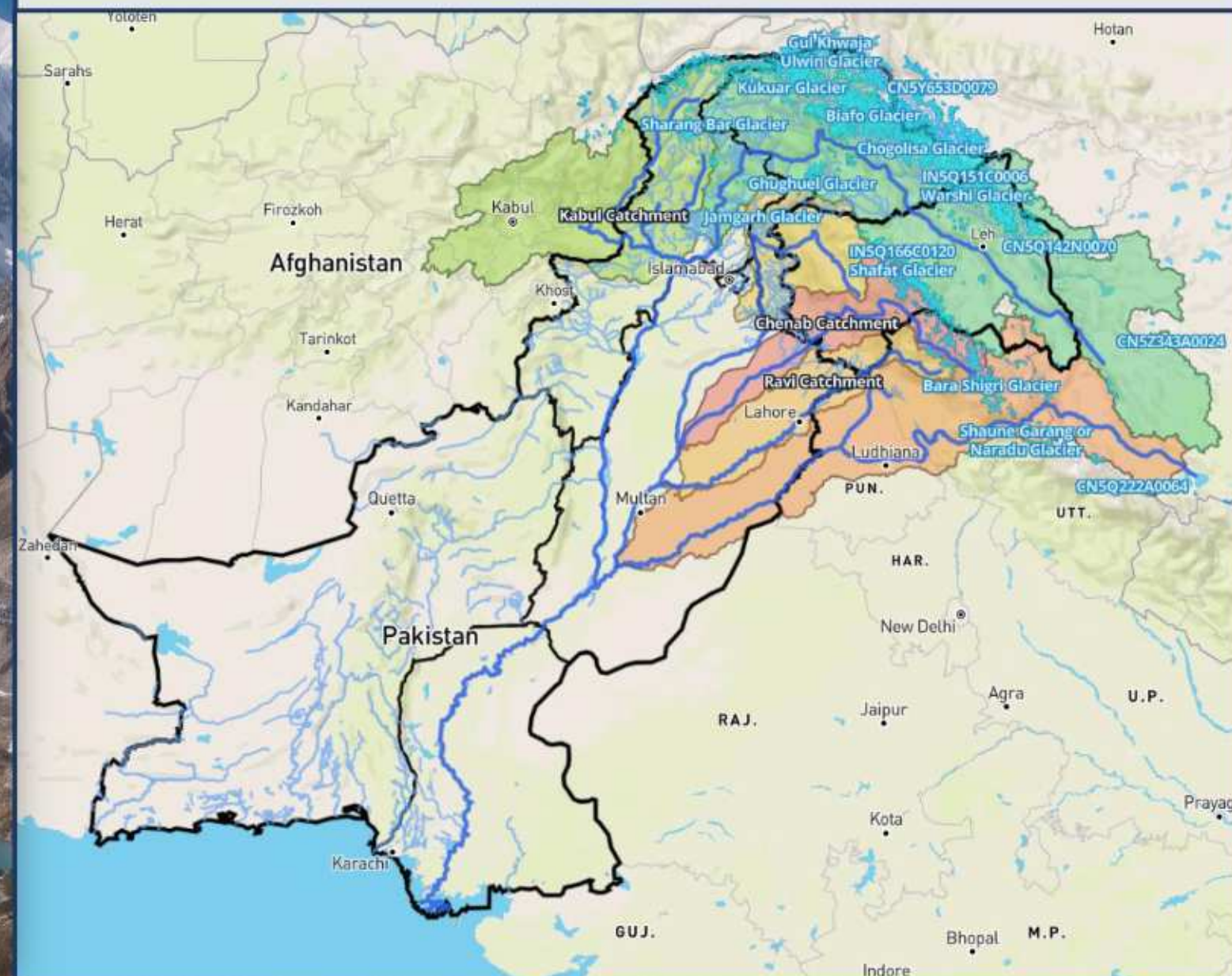
High Interacial Permafrost
in Cold And Rdgions



ICE RESERVES

Natural Water Storage
for Future Generations

Map of Pakistan



THE CRYOSPHERE – THE WATER TOWER OF PAKISTAN



~13,000
GLACIERS



~34,000 km²
GLACIALIZED AREA



3,000+
GLACIAL LAKES

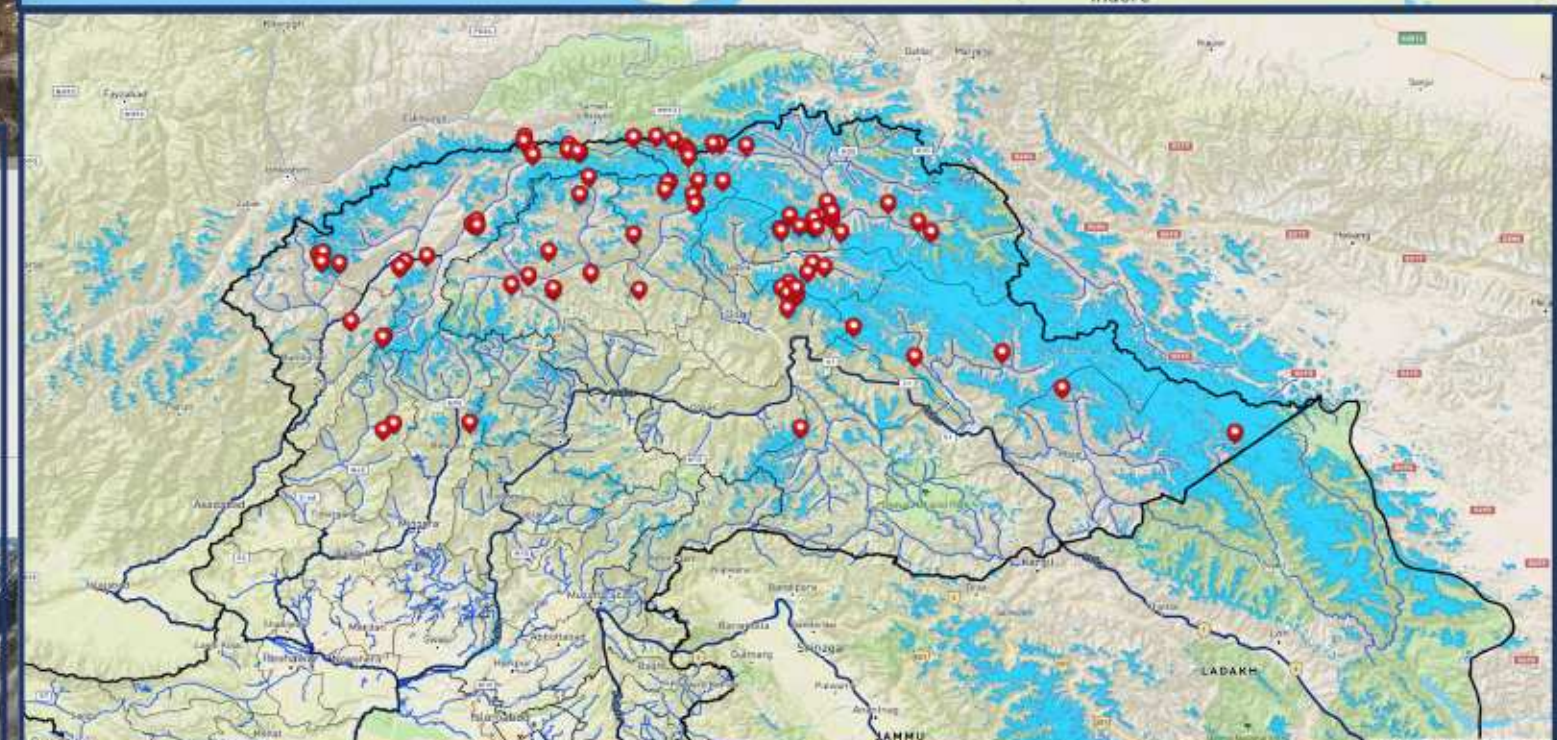


60–80%
OF INDIAN FLOW FROM
SNOW & GLACIER MELT



200+
MILLION PEOPLE
DEPENDENT

EXAMPLES OF GLACIAL LANDSCAPES IN PAKISTAN



Badswat Glacier

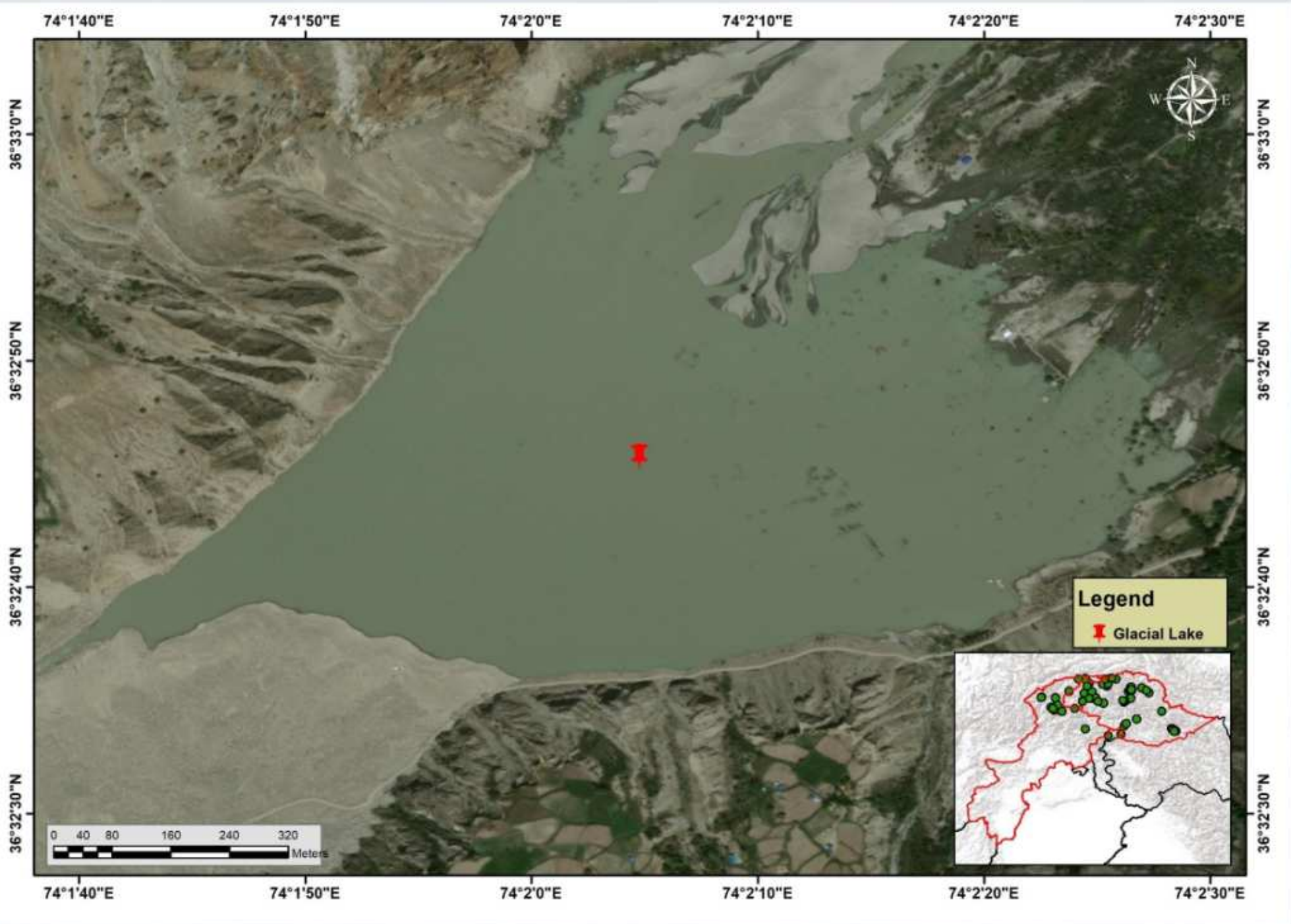
Badswat Glacier Lake is located in the Ishkoman Valley of Ghizer District, Gilgit-Baltistan, within the upper Indus River Basin. The lake is situated in a rugged high-mountain environment of the Hindu Kush–Karakoram region, characterized by steep slopes, deep glacial valleys, sharp ridgelines, and high relief. Elevations in the surrounding catchment range from approximately 850 m to over 8,500 m above mean sea level, creating strong topographic gradients that influence glacier dynamics, snow accumulation, and meltwater runoff. The basin is drained by glacial melt streams that ultimately contribute to the Ghizer and Gilgit rivers, making it an important component of the regional hydrological system.

The region experiences a cold alpine climate, with long, severe winters and short, cool summers. Most precipitation falls as snowfall at higher elevations, while summer temperatures promote seasonal snow and glacier melt. Recent warming trends have accelerated glacier retreat and the formation and expansion of glacial lakes throughout Gilgit-Baltistan. The combination of high relief, active glacial processes, and unstable moraine deposits makes the area highly susceptible to geomorphic hazards, including landslides, debris flows, and Glacial Lake Outburst Floods (GLOFs).

Badswat Glacial Lake has been identified as a potentially vulnerable glacial lake due to its high-altitude setting, continuous meltwater inflow, and the presence of steep surrounding slopes that may trigger mass movement into the lake. A sudden breach of the natural moraine dam or ice-related instability could generate downstream flooding, posing risks to local communities, agricultural land, bridges, roads, and other critical infrastructure in the Ishkoman Valley. Continuous monitoring using satellite observations, field assessments, and early warning systems is therefore essential to support disaster risk reduction and climate resilience in the region.



Badswat Glacial Lake, Ghizer, Gilgit Baltistan



Parameter	Description
Geographic Setting	Located in the upper Ishkoman Valley, Ghizer District, within the Hindu Kush–Karakoram transition zone of the Upper Indus Basin. Drainage follows Badswat Nullah → Ishkoman River → Ghizer River → Gilgit River → Indus River .
Central Coordinates	36°33'08"N, 74°02'45"E
Topography	Elevation ranges from 2,500–6,800 m asl, Glacial lakes occur between 3,300–3,900 m asl.
Hydrology	Glacier- and snowmelt-fed catchment with peak discharge during June–August .
Climate	Cold alpine climate with long, snowy winters and short, cool summers.
Geomorphology	Active glacial landscape comprising valley glaciers, moraine-dammed lakes, unstable debris deposits, and glacio-fluvial channels shaped by ongoing erosion and sediment transport.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

2023



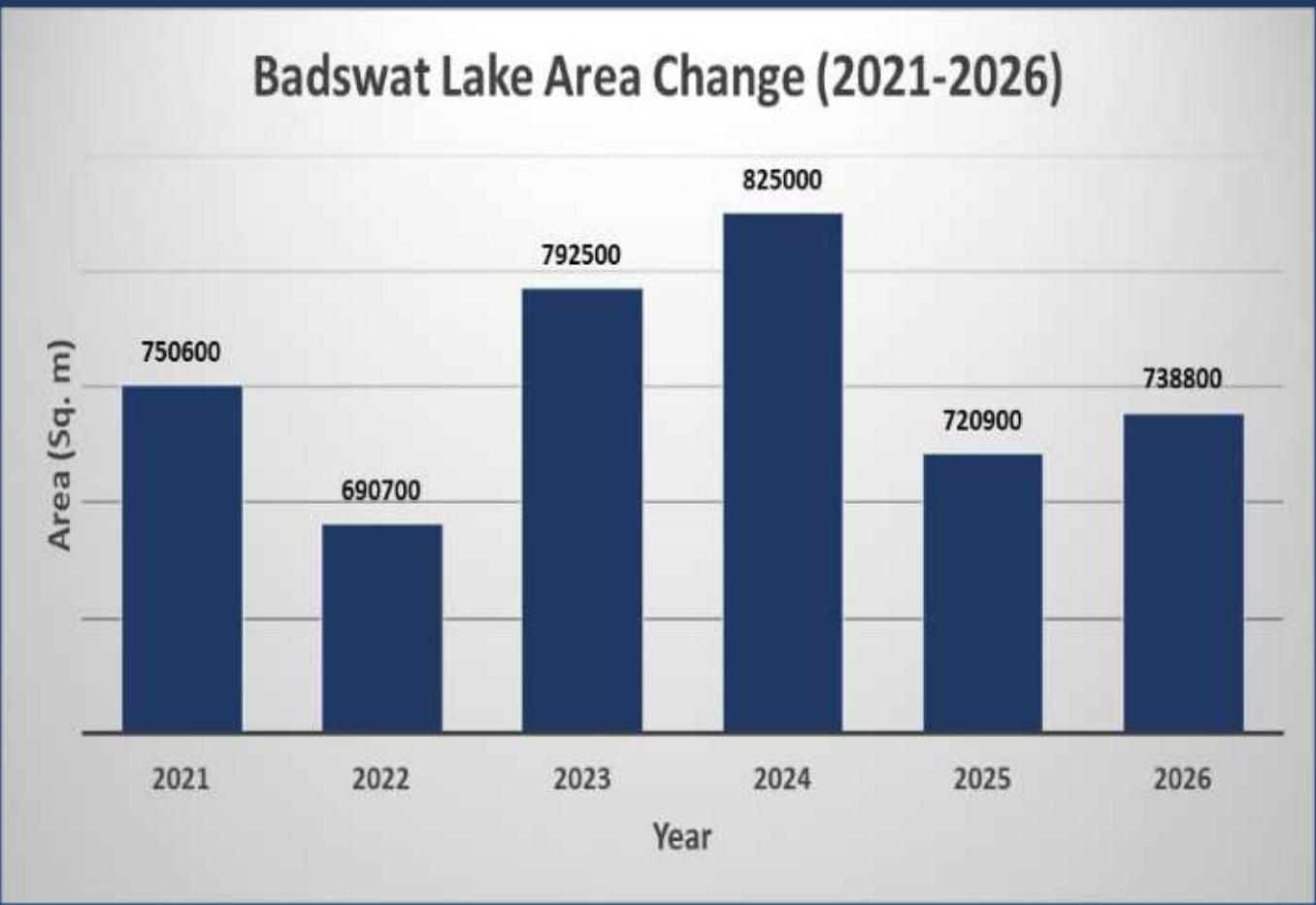
2024

2025

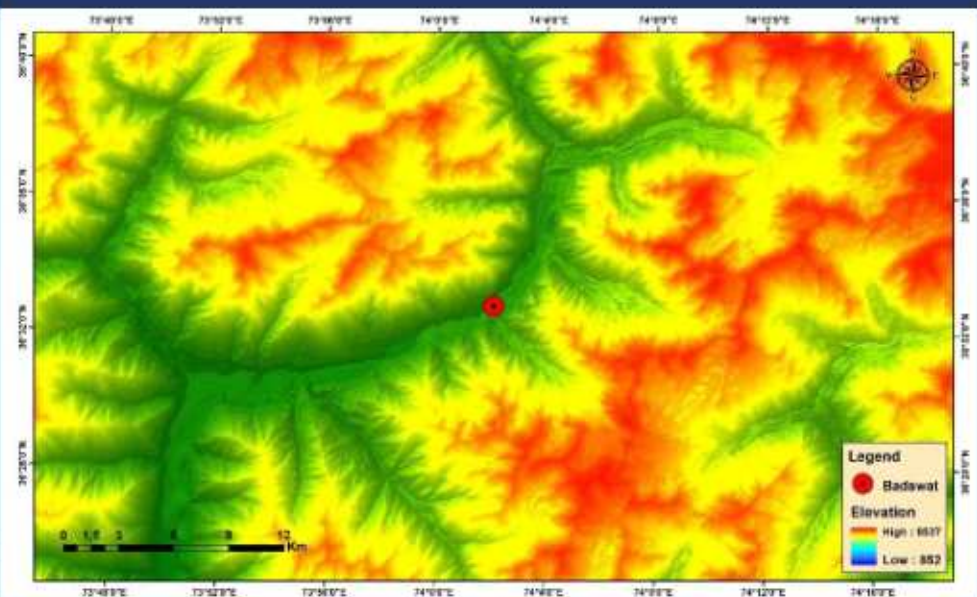
2026



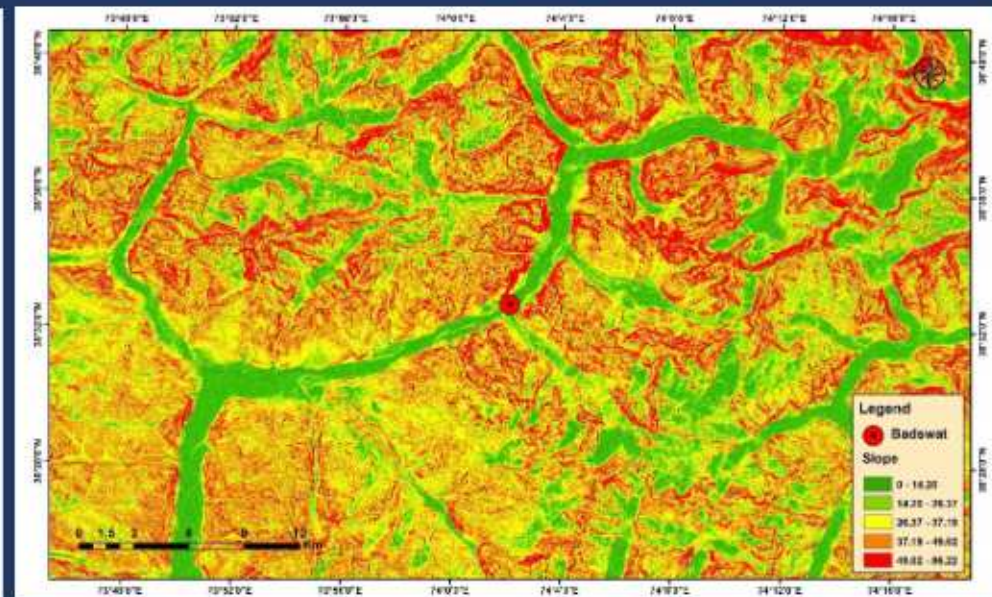
Geospatial Features



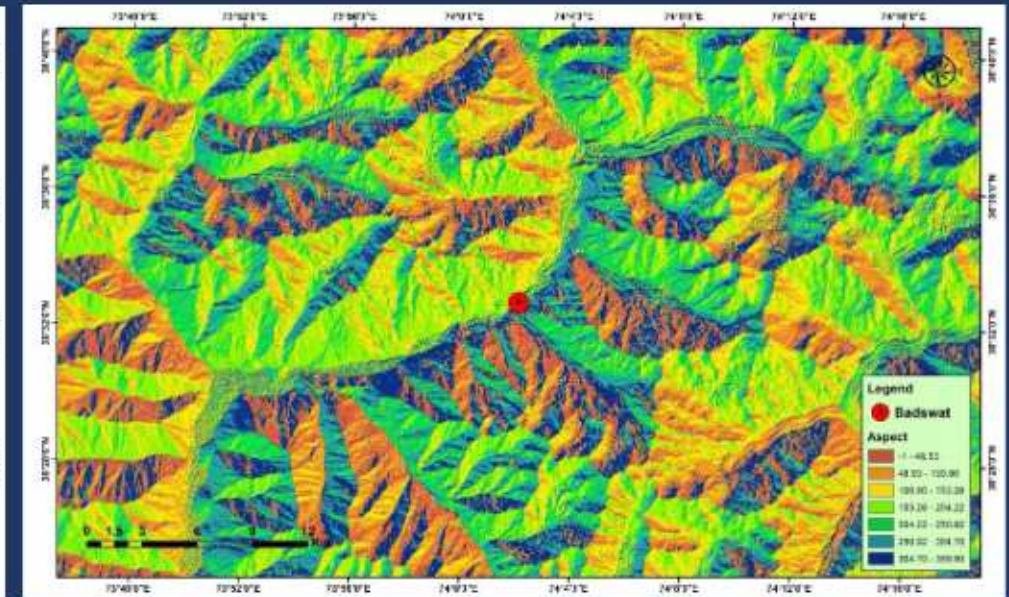
Elevation



Slope



Aspect



Ishkoman Glacier

Ishkoman Valley is a highly glacierised mountain valley located in **Ghizer District, Gilgit-Baltistan**, within the western Upper Indus Basin. The valley forms part of the Hindu Kush–Karakoram high-mountain system and is characterized by steep slopes, narrow river corridors, deep valleys, extensive snow and glacier cover, unstable moraines and high-altitude glacial lakes. The **Ishkoman River and its glacier-fed tributaries** drain the valley and ultimately contribute to the Gilgit River and the wider Upper Indus drainage system. The combination of high relief, active glaciers, seasonal snowmelt and glacier-fed hydrology makes the valley both an important regional water source and a highly sensitive cryospheric environment.

Ishkoman experiences a **cold, high-altitude alpine climate**, with long and severe winters and relatively short summers. Temperature and precipitation vary considerably with elevation, resulting in strong vertical gradients in snow accumulation, glacier melt and runoff. During summer, increasing temperatures accelerate the melting of seasonal snow, glacier ice and debris-covered glacier surfaces, producing enhanced meltwater discharge. Rainfall and rain-on-snow events can further increase runoff and destabilize snow, ice, moraine and slope materials.

The region is increasingly influenced by **rising temperatures, changing precipitation patterns and greater variability in extreme weather events**. Persistent warm conditions can extend the seasonal melt period, increase glacier surface melting and enhance water availability to glacial lakes. At the same time, intense rainfall, rapid snowmelt and slope instability can increase the likelihood of debris flows, landslides, river blockage and sudden lake formation or outburst.

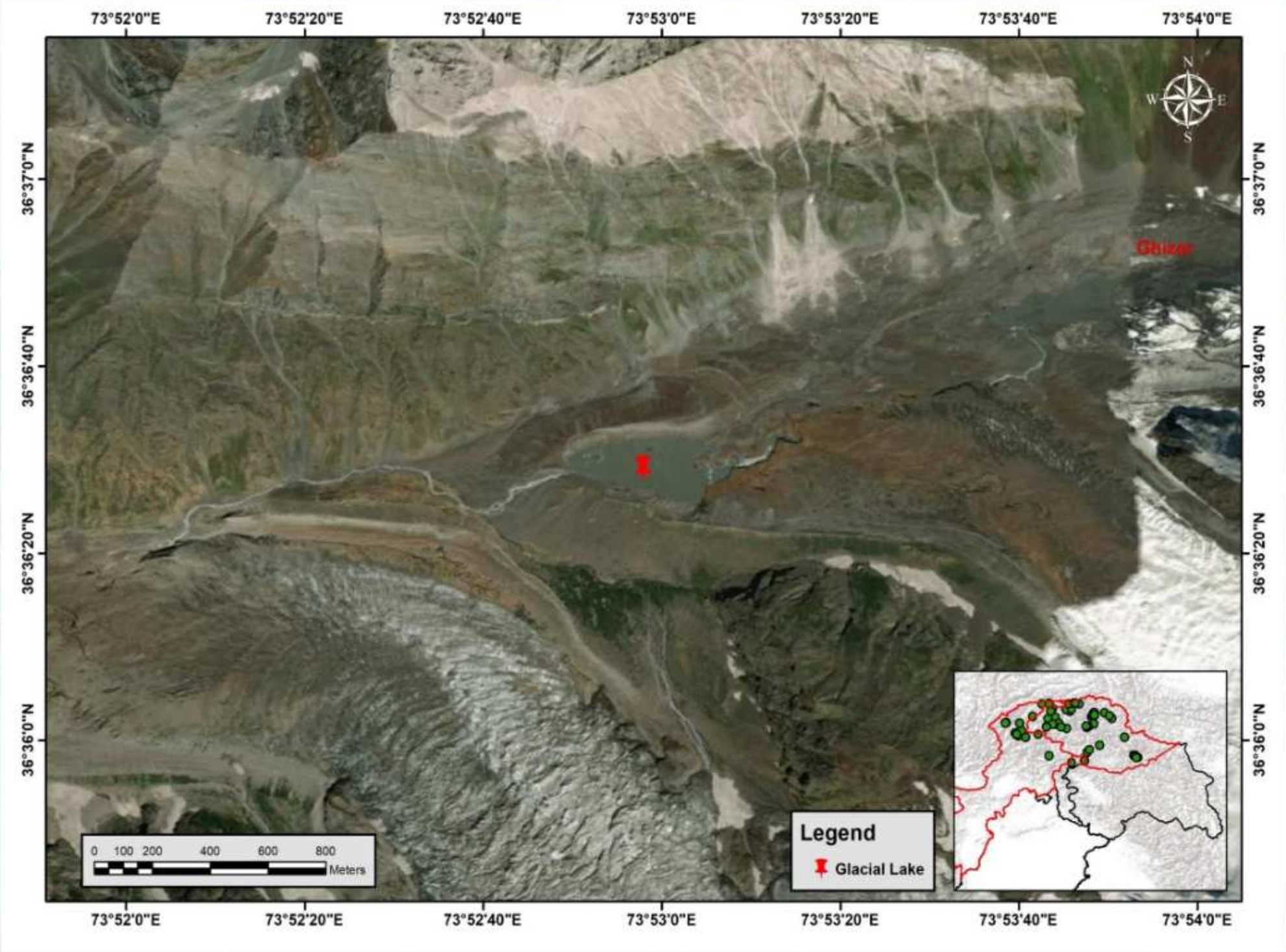
The valley contains several glacier-associated lakes and potentially hazardous glacial-lake systems, including the **Badswat and Deran areas**. These water bodies can undergo rapid changes in area and volume in response to glacier melt, precipitation and changes in their ice- or moraine-dammed boundaries. The Badswat area has demonstrated that cryospheric hazards can develop through a **cascading process**, in which glacier or debris-flow activity blocks a river, creates a temporary lake, and subsequently produces an outburst flood and downstream debris flow.

Consequently, GLOF risk in Ishkoman should not be assessed solely on the basis of existing lake size. **Glacier dynamics, lake expansion, meltwater discharge, moraine stability, surrounding slope conditions, rainfall, snowmelt and potential river blockage** all need to be considered in an integrated hazard assessment.

A GLOF, glacier-debris flow or sudden river blockage in the upper Ishkoman catchments could generate a rapidly propagating flood wave and debris-laden flow through downstream valleys.



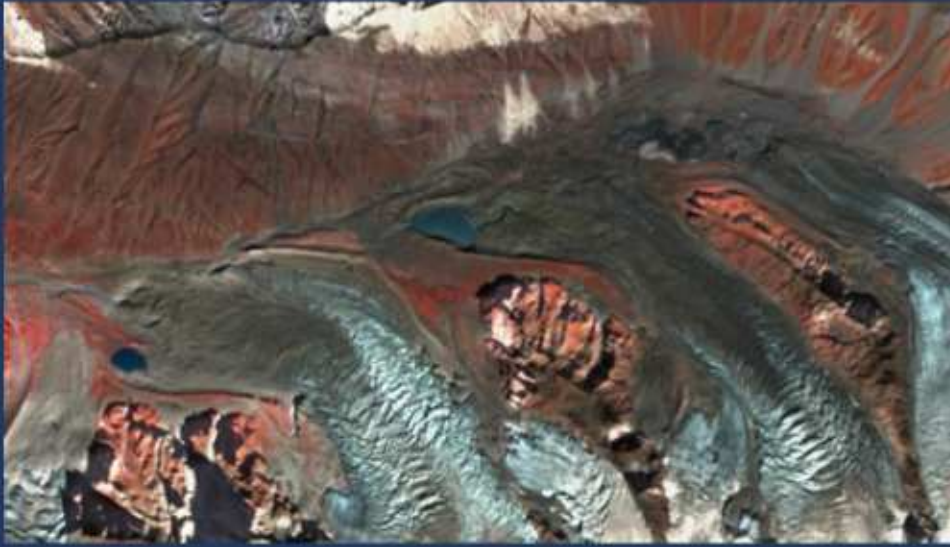
Ishkoman Glacial Lake, Ghizer, Gilgit Baltistan



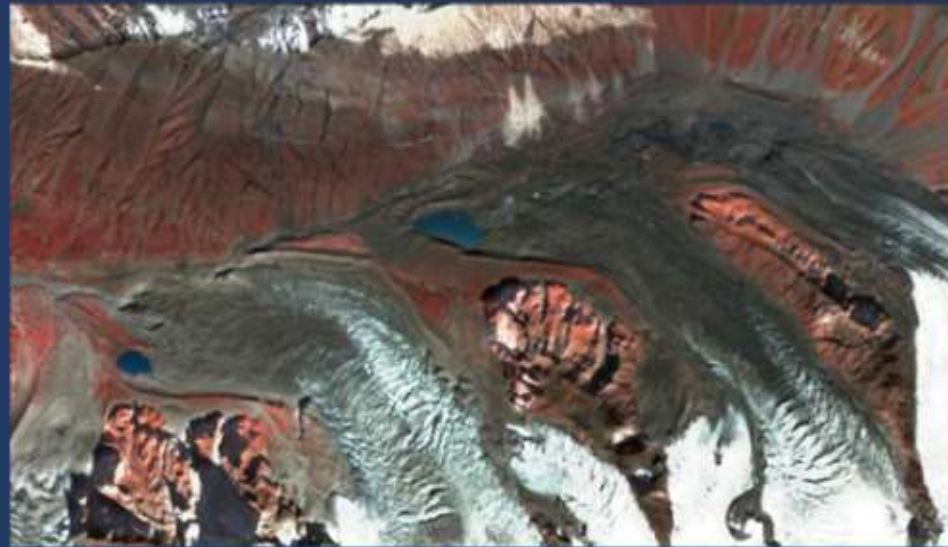
Parameter	Description
Geographic Setting	Located in Ishkoman Valley, Ghizer District, Gilgit-Baltistan, within the Hindu Kush–Karakoram region of the Upper Indus Basin. The valley drains through the Ishkoman River → Gilgit River → Indus River .
Central Coordinates	
Topography	Rugged, high-relief terrain with steep slopes, narrow valleys and extensive glacierized areas; elevations rise from the valley floor to peaks exceeding 6,000 m asl.
Hydrology	Predominantly snow- and glacier-melt fed.
Climate	Cold alpine climate with long, snowy winters and short, cool summers.
Geomorphology	Active glacial landscape comprising valley glaciers, moraine-dammed lakes, unstable debris deposits, and glacio-fluvial channels shaped by ongoing erosion and sediment transport.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

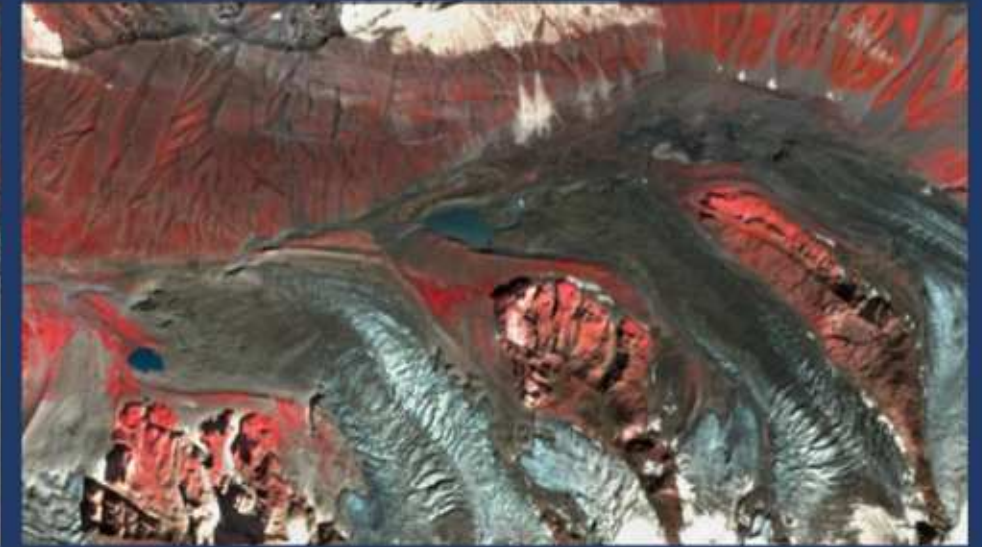
2021



2022



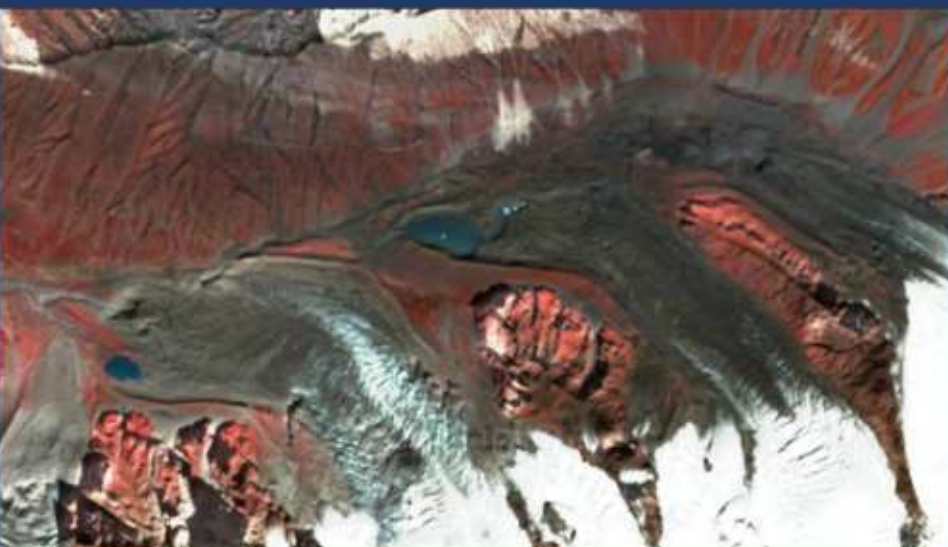
2023



2024



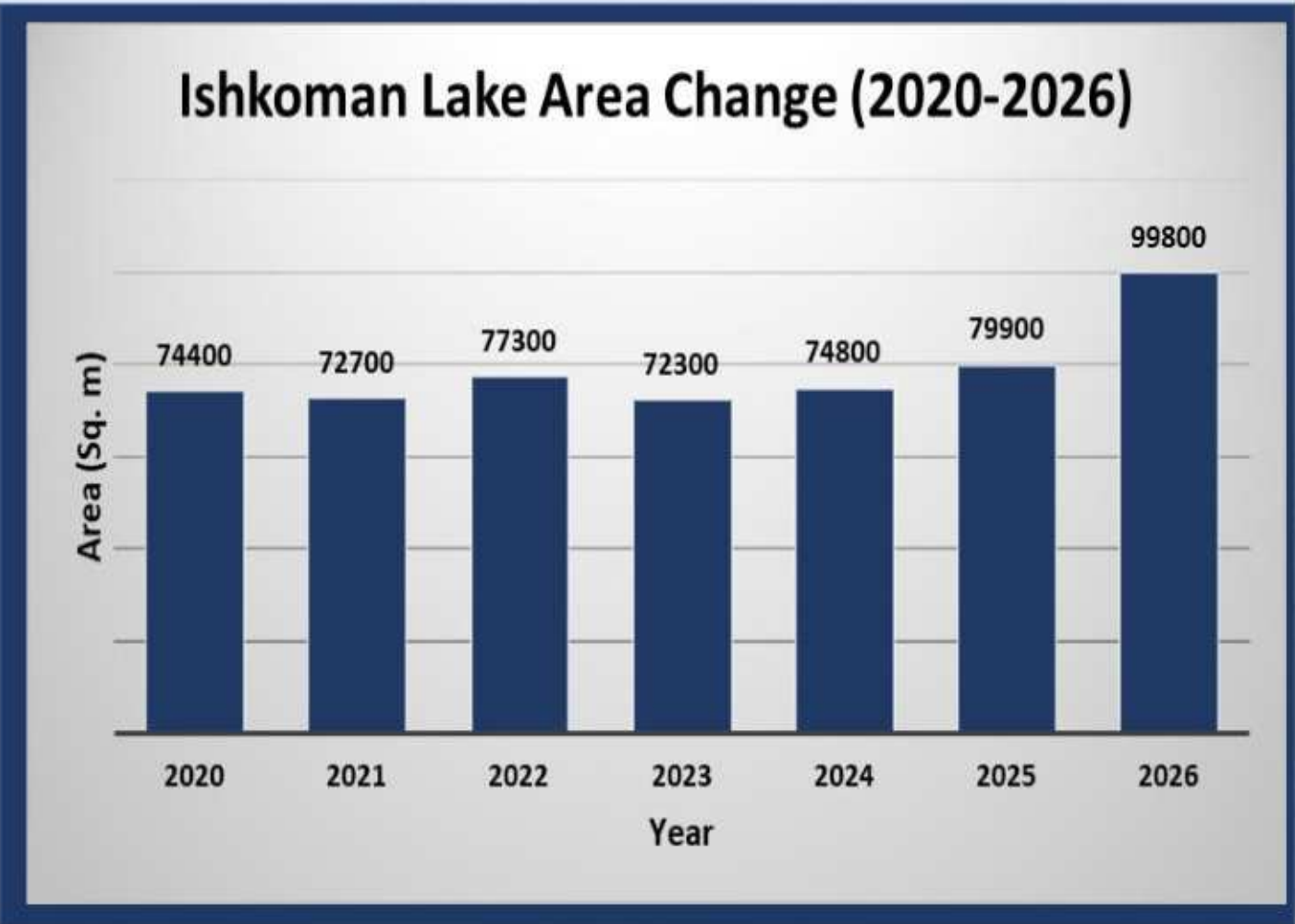
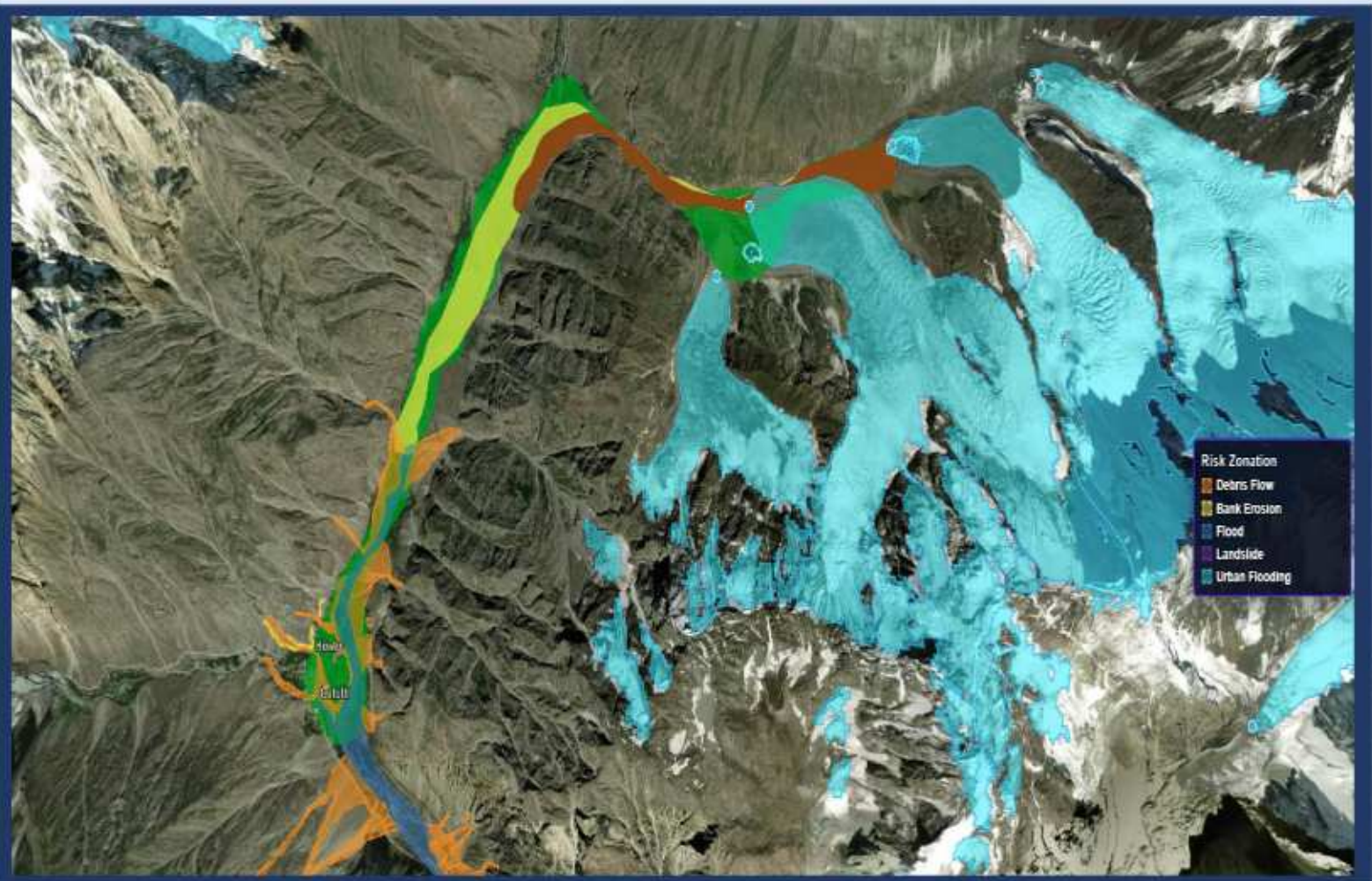
2025



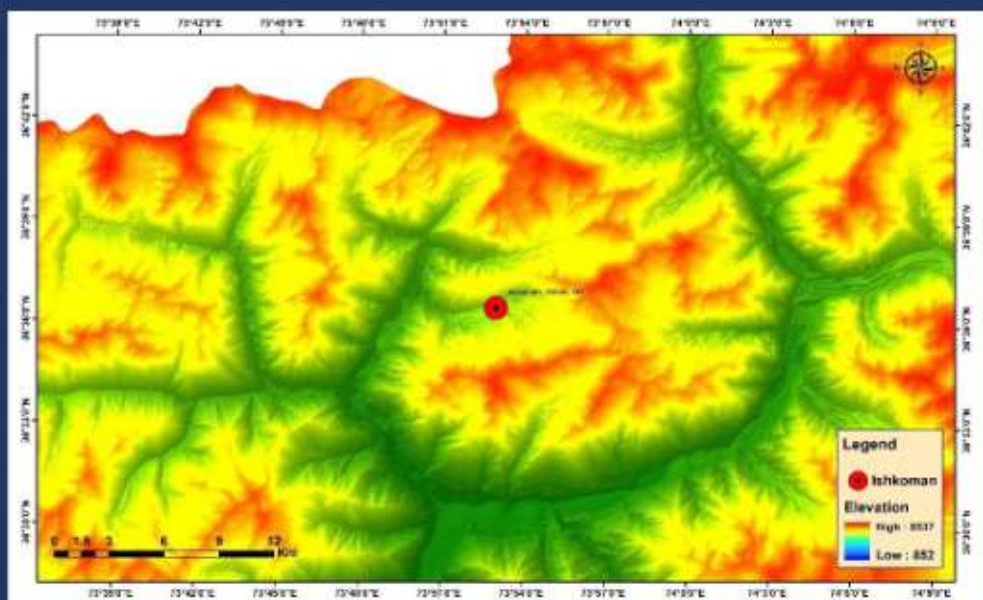
2026



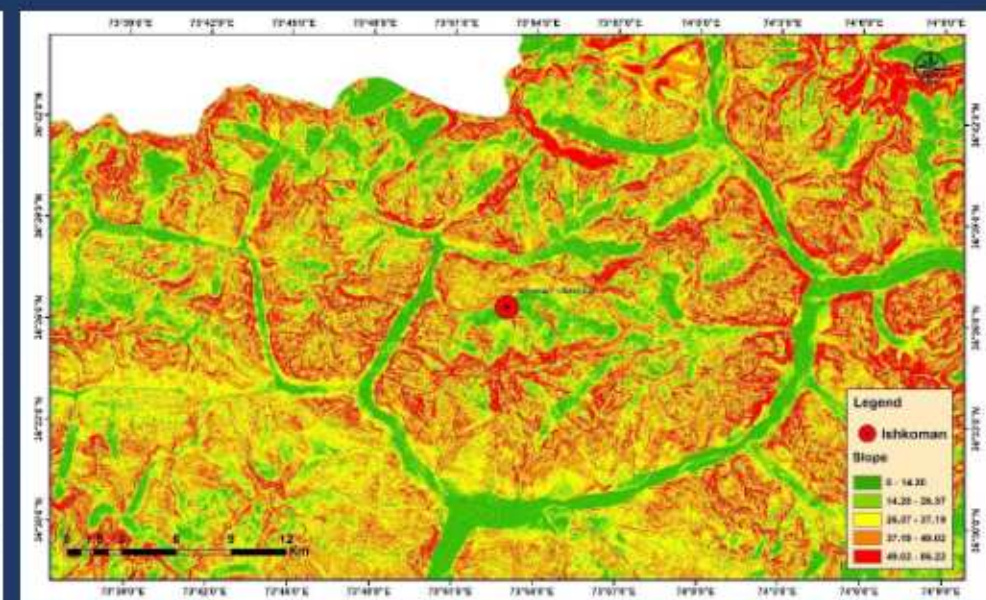
Geospatial Features



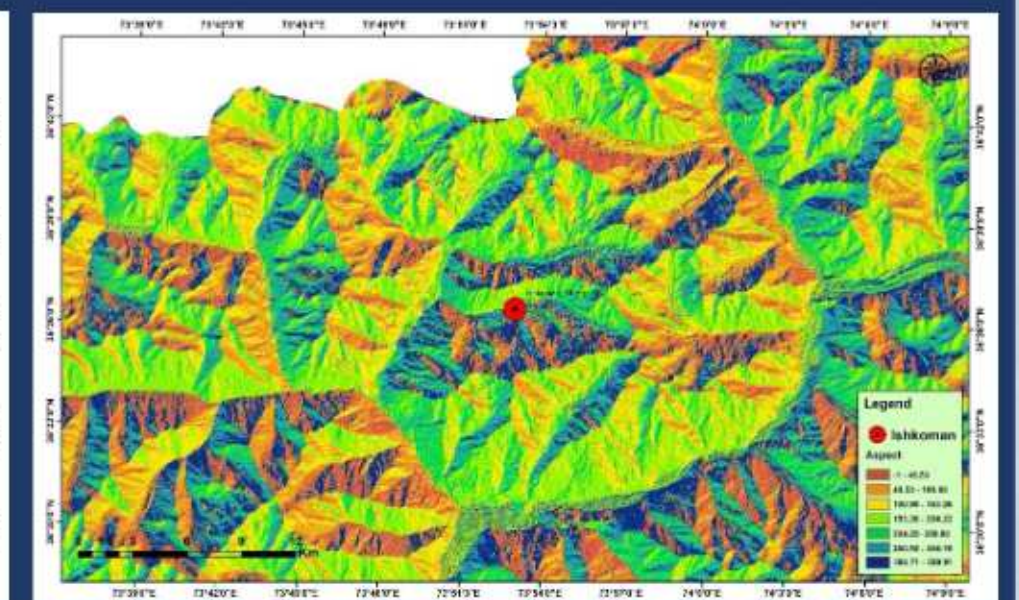
Elevation



Slope



Aspect



Darkut Glacier

Darkut Glacier is located in **Darkut Valley of Yasin Valley, Ghizer District, Gilgit-Baltistan**, within the high-mountain Hindu Kush–Karakoram region of the Upper Indus Basin. The glacier, also reported as **Ghamu Bar Glacier**, occupies a steep and deeply incised mountain environment characterized by rugged ridges, narrow valleys, extensive seasonal snow cover, debris-covered ice and active glacial and fluvial processes. Published observations report a glacier length of approximately **3.9 km** and an area of about **2.51 km²** during the study period. **Darkut Glacial Lake** is associated with the glacier-fed drainage system and has been reported near **36°38'32"N, 73°24'25"E**.

The valley has a **cold alpine climate**, with prolonged winters and short summers. Winter snowfall provides the principal seasonal snow storage, while summer warming produces substantial snow and glacier melt. Meltwater from Darkut Glacier contributes to the local stream network and supports downstream water availability for agriculture and settlements in the Yasin Valley. Seasonal rainfall, particularly during summer, can further increase runoff and intensify glacier and snowmelt-driven discharge.

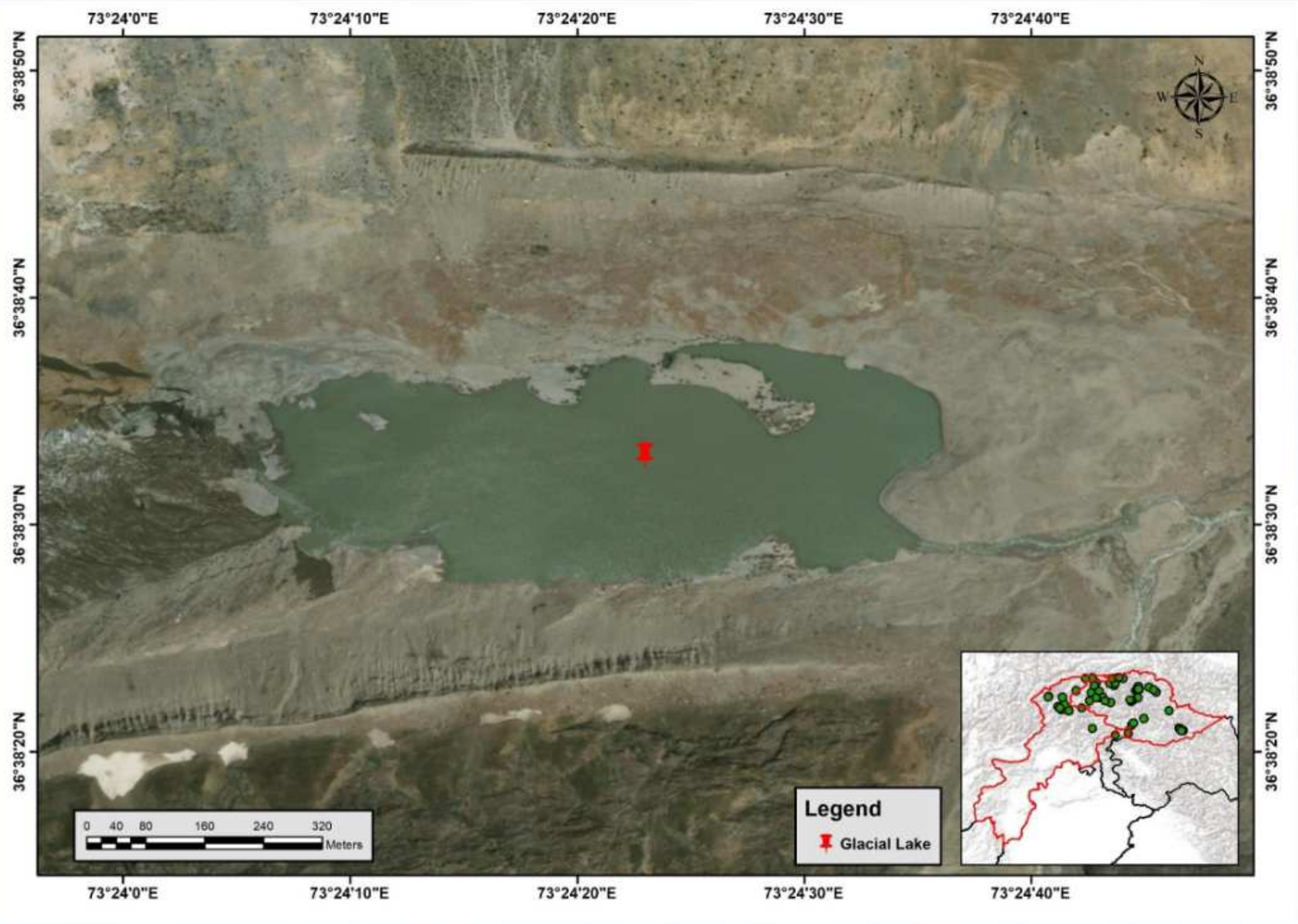
The physical environment is strongly controlled by **glacial erosion, freeze–thaw processes, slope instability and sediment transport**. Steep valley walls and unconsolidated glacial and fluvial deposits increase the sensitivity of the valley to landslides, rockfalls, debris flows and channel erosion. The glacier and associated glacial lake are also sensitive to changes in temperature and precipitation, which can influence glacier mass balance, meltwater production and lake conditions.

Darkut Valley has experienced increasing attention as a **cryospheric hazard-prone area** because of its glacier-fed hydrology, steep terrain and downstream exposure. A sudden change in glacial-lake conditions or rapid meltwater generation could produce flooding and debris flows along the confined valley, potentially affecting **settlements, agricultural land, irrigation infrastructure, roads, bridges and local livelihoods**. The narrow valley morphology may amplify the downstream effects of sudden high-discharge events.

Continued monitoring of **glacier area and terminus position, ice velocity, snow cover, glacier surface conditions, glacial-lake extent, temperature, precipitation and meltwater discharge** is therefore important for understanding ongoing changes. Integration of satellite observations with field measurements and local early-warning arrangements can support long-term assessment of glacier change, water-resource variability and GLOF risk in Darkut Valley.



Darkut Glacial Lake, Ghizer, Gilgit Baltistan



Parameter	Description
Geographic Setting	Darkut Valley, Ghizer District, Gilgit-Baltistan, within the Hindu Kush–Karakoram region of the Upper Indus Basin.
Central Coordinates	36° 38' 33.02" N, 73° 24' 23.01" E
Topography	Glacial lake elevation: 2780 m.a.s.l
Hydrology	Glacier and snowmelt fed system. The lake is formed at the glacier terminus.
Climate	Cold alpine climate, with substantial winter snow accumulation and summer snow and glacier melt.
Geomorphology	Proglacial glacial lake associated with the terminus of the Glacier, surrounded by moraines, debris-covered ice and active glacio-fluvial processes
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

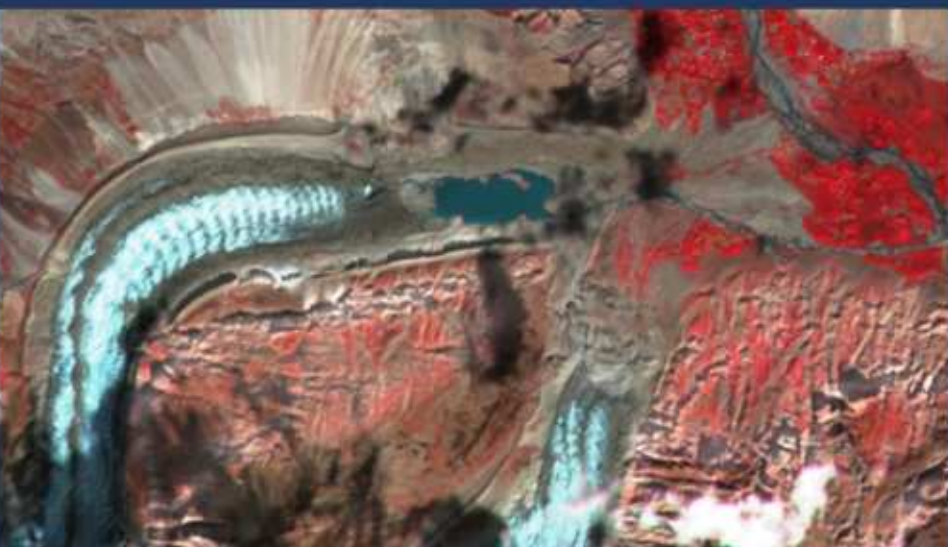
2023



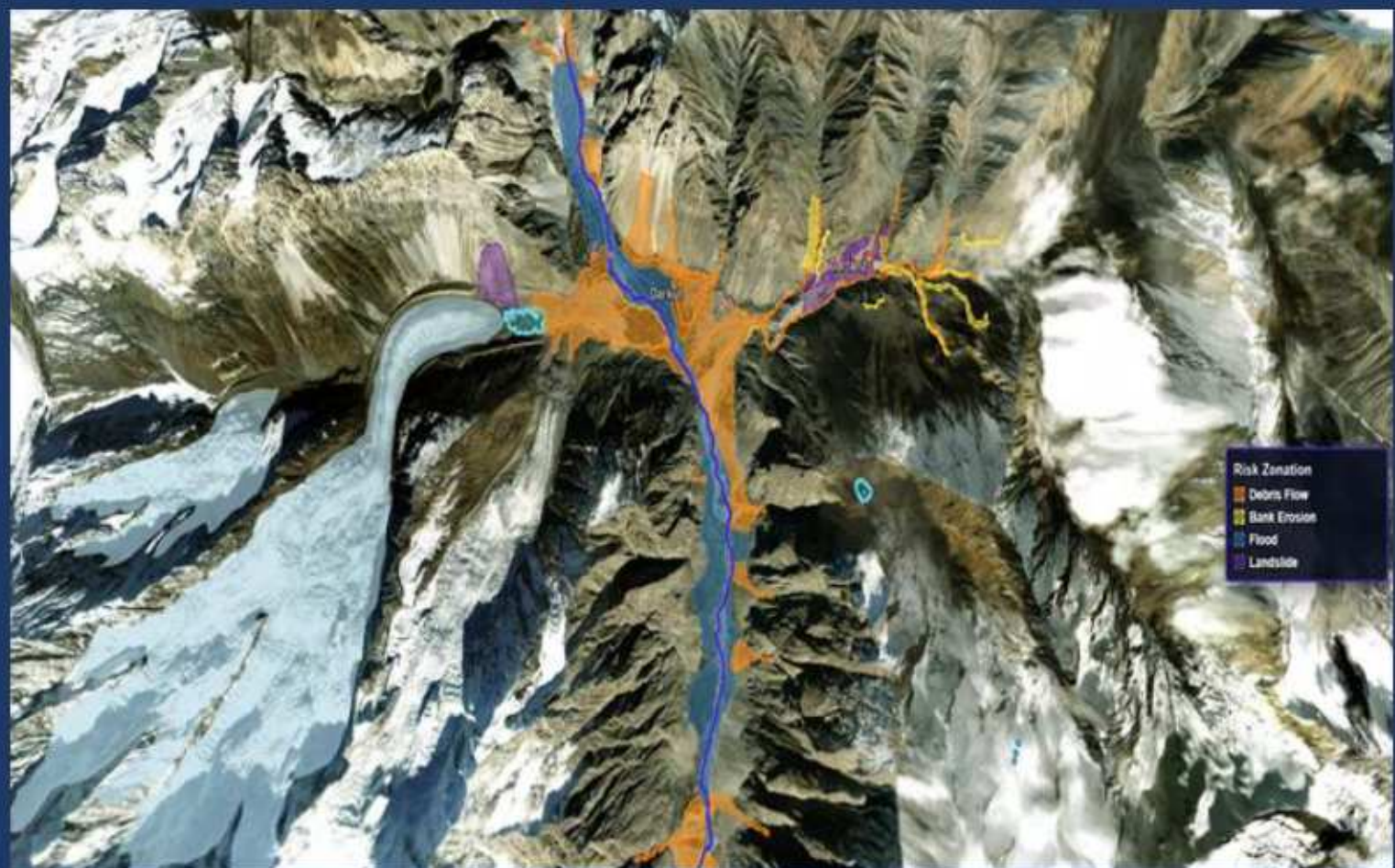
2024

2025

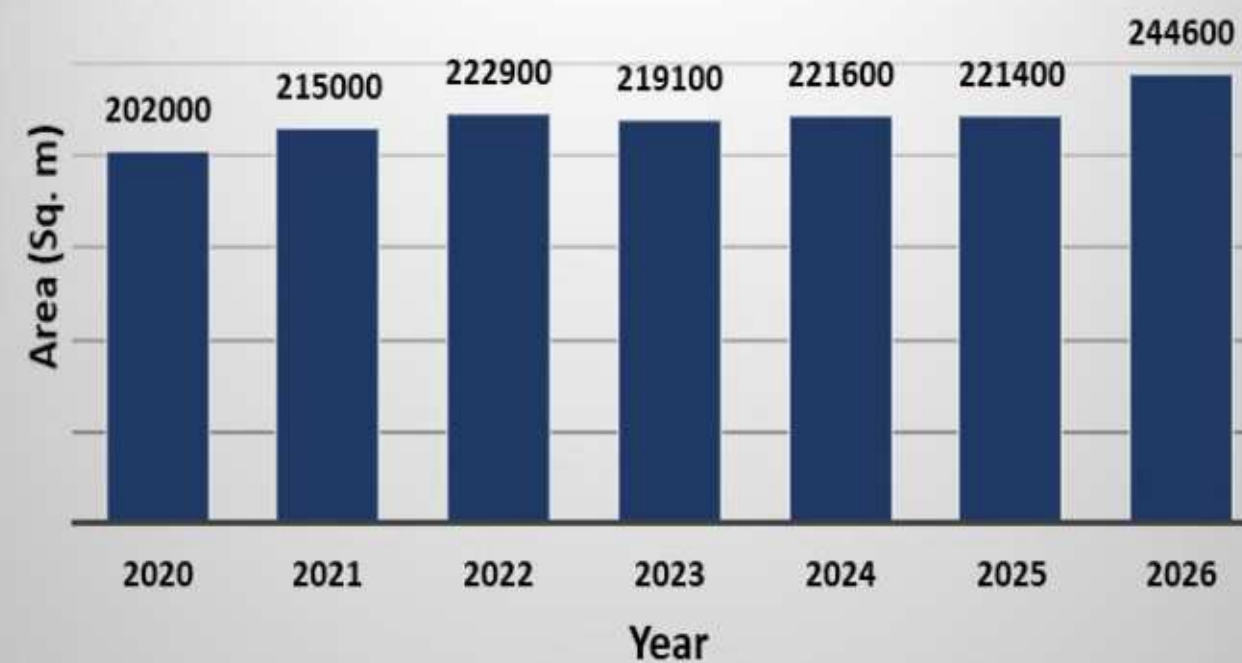
2026



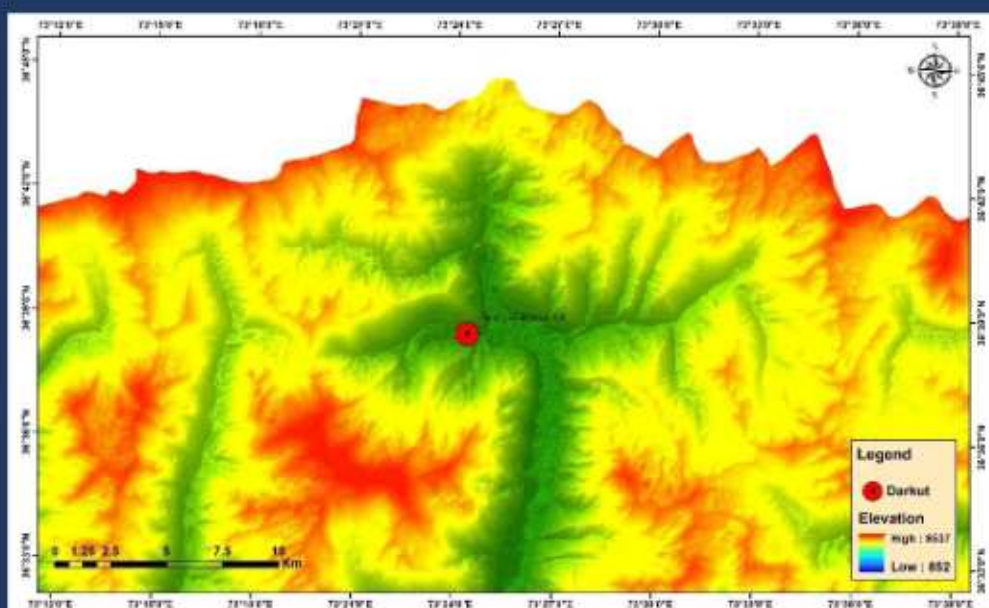
Geospatial Features



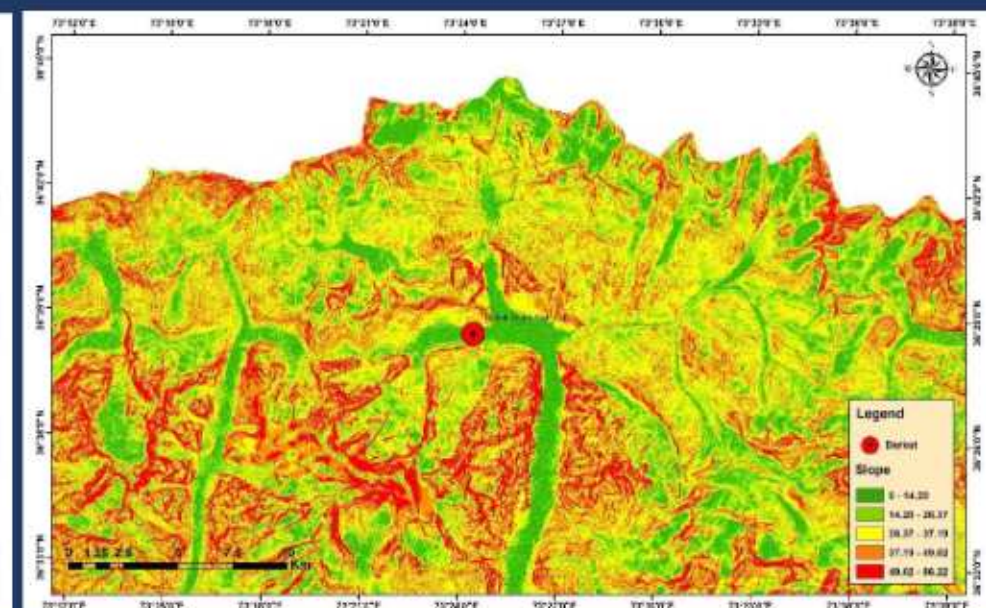
Darkut Lake Area Change (2020-2026)



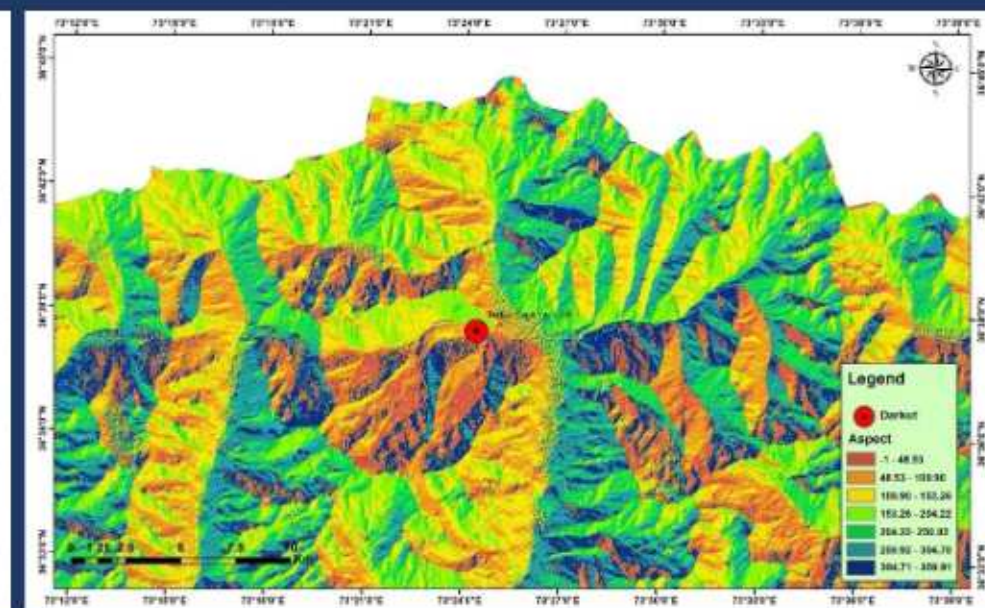
Elevation



Slope



Aspect



Lasht Glacier

Lasht is a high-altitude glacierised area of Yarkhun Valley in Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush mountain system and the Upper Indus Basin. The landscape comprises steep mountain slopes, glacier- and snow-covered peaks, narrow valleys, glacier-fed streams and extensive glacial and fluvial deposits. The valley supports scattered settlements and agriculture along the relatively wider valley floor, where communities depend on glacier- and snowmelt-fed water resources. The area experiences a cold alpine climate, with long winters, substantial winter snowfall and short summers. Seasonal warming produces snow and glacier melt, while summer rainfall can generate rapid increases in runoff. The interaction of high temperatures, snow and ice melt, intense rainfall and steep unstable slopes makes the valley sensitive to flash floods, debris flows, landslides and sudden changes in glacier-fed stream discharge.

A significant flash-flood and debris-flow event occurred at Lasht on 14 August 2020. Investigation by ICIMOD established that the event was not a conventional GLOF caused by the failure of a permanent glacial lake. Instead, intense rainfall triggered a landslide that partially blocked a glacier-fed stream upstream of the settlement. Water accumulated behind the temporary blockage and subsequently breached, producing a rapid flow of water, mud, boulders and debris through the valley. The event damaged settlements, agricultural land, livestock and local infrastructure and demonstrated the potential for short-lived natural dams to generate destructive floods in glacier-fed valleys.

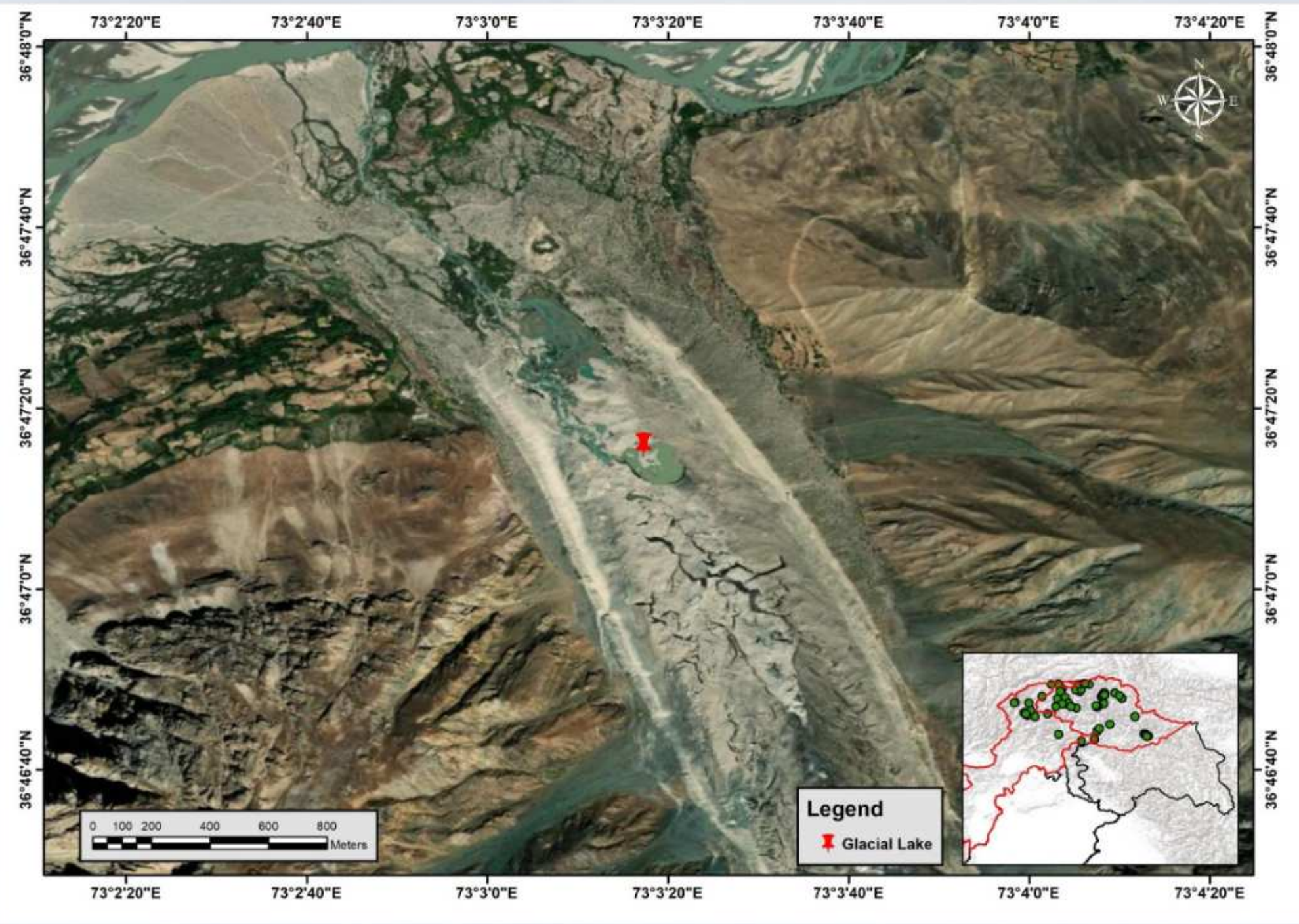
The Lasht event is important because it illustrates a compound cryospheric hazard, in which rainfall, slope instability, glacier-fed runoff and temporary channel blockage interact to produce a sudden flood without requiring a large pre-existing glacial lake. This makes monitoring of rainfall, glacier and snowmelt, stream channels, unstable slopes and temporary water accumulation essential alongside conventional glacial-lake monitoring.

The valley is increasingly sensitive to climate variability and warming, which can alter snowmelt timing, glacier melt rates and the intensity of runoff-producing rainfall. During the 2026 GLOF-risk season, Lasht and Yarkhun Valley were included among potentially exposed areas in national hazard advisories, reflecting the continued vulnerability of glacier-fed valleys of Upper Chitral.

Potential impacts include flooding and debris deposition, riverbank erosion, damage to settlements and agricultural land, disruption of roads and irrigation systems, livestock losses and temporary isolation of communities. Given the narrow valley morphology and limited access, rapid-onset events can have significant consequences even when their source is relatively localized.



Lasht Glacial Lake, Upper Chitral, Khyber Pakhtunkhwa



Parameter	Description
Geographic Setting	Lasht, Yarkhun Valley, Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush and Upper Indus Basin.
Central Coordinates	36° 47' 22.05" N, 73° 3' 11.61" E
Topography	Glacial lake elevation: 3267 m.a.s.l
Hydrology	Predominantly glacier and snowmelt fed.
Climate	Cold alpine climate, with prolonged winters
Geomorphology	Glacial and fluvial landscape containing glaciers, moraines, debris deposits, unstable slopes and confined stream channels.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

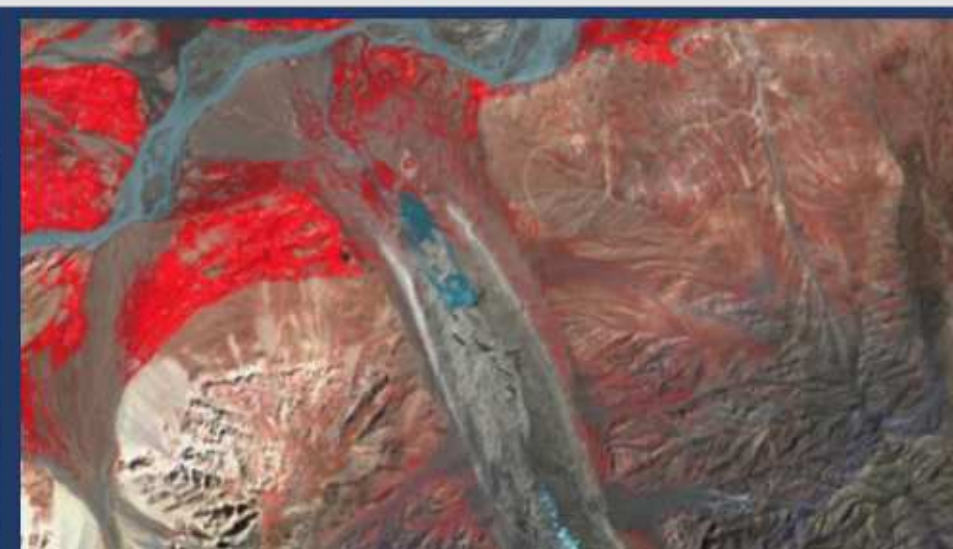
2023



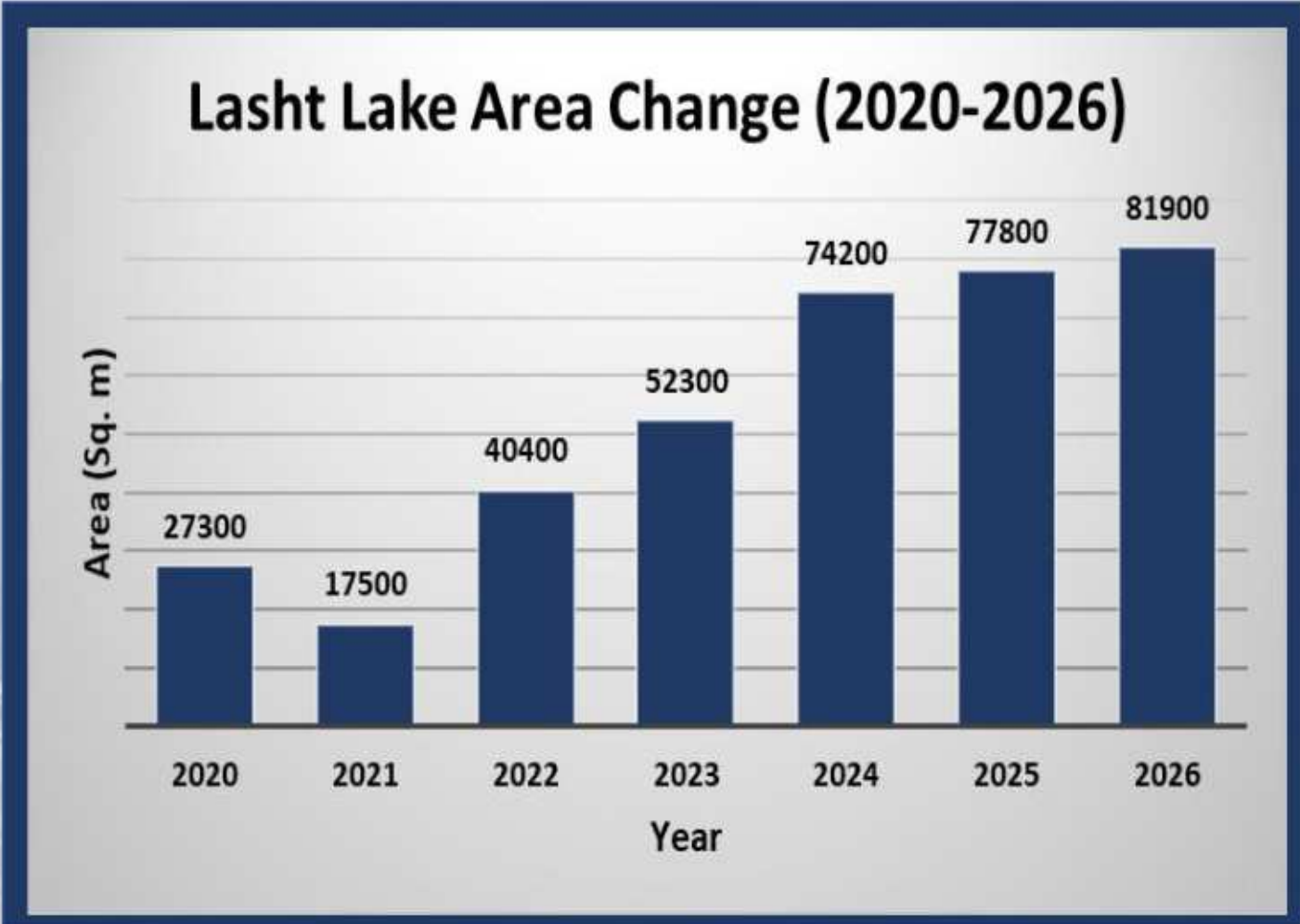
2024

2025

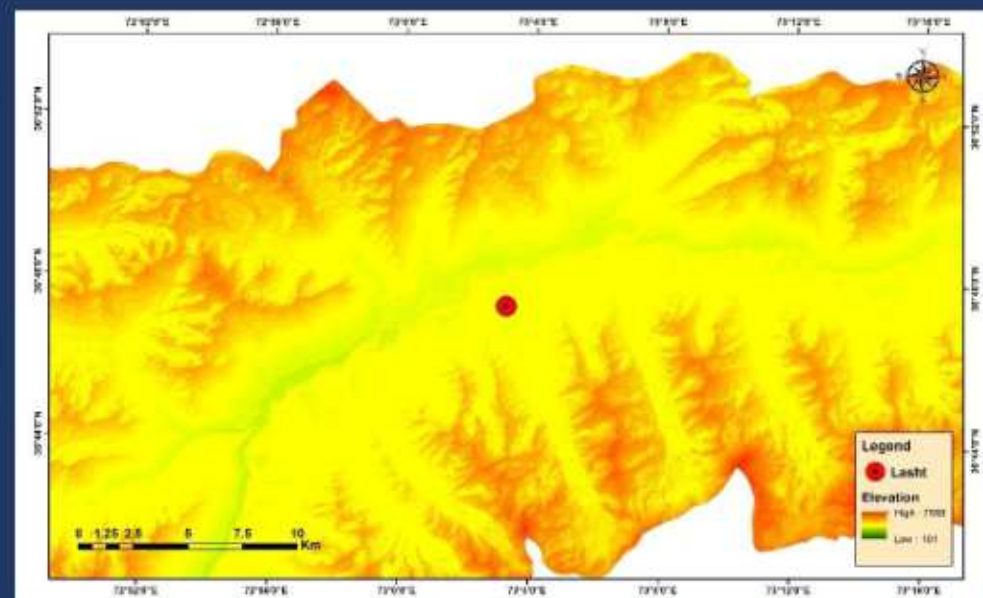
2026



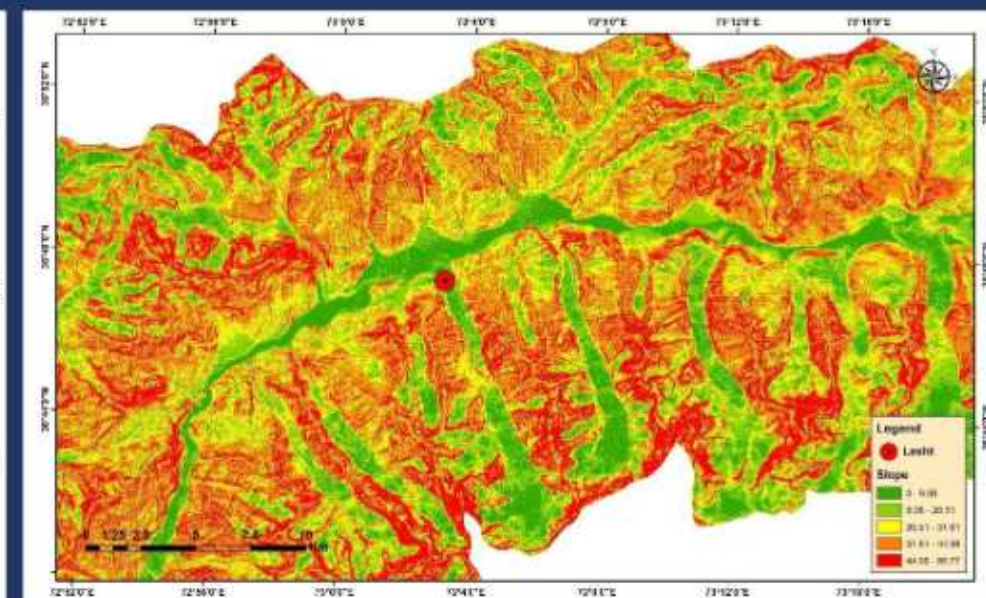
Geospatial Features



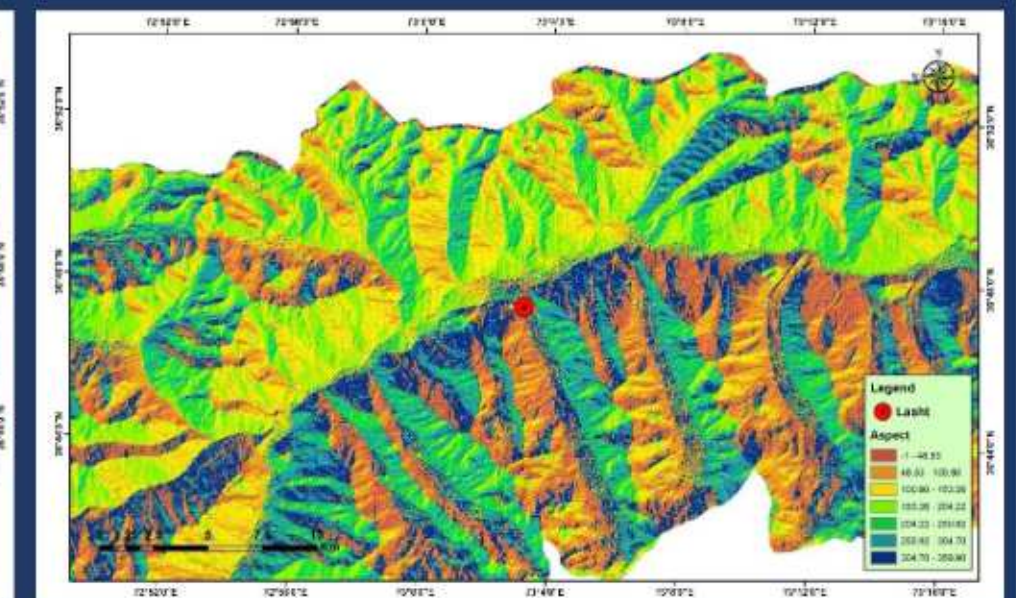
Elevation



Slope



Aspect



Chatiboi Glacier

Chatiboi Glacier, also spelled Chattiboi, is a prominent glacier of the Yarkhun Valley in Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush–Hindu Raj mountain system of the Upper Indus Basin. Historical geographical accounts describe Chatiboi as a major valley glacier descending from the surrounding high mountains and reaching the Yarkhun River. A reconnaissance of the region identified Chatiboi among the principal glaciers flowing toward the Yarkhun Valley, while more recent mountaineering literature places it within the sequence of glaciers along the valley.

The glacier is particularly notable for its terminus configuration and direct interaction with the Yarkhun River. Historical observations described the glacier as extending directly to the river, with a prominent ice front and frequent ice fall from the terminus. The name Chattiboi has also historically been associated with lake-forming glaciers in Chitral, reflecting the ability of some glaciers of this type to extend across or obstruct valley drainage.

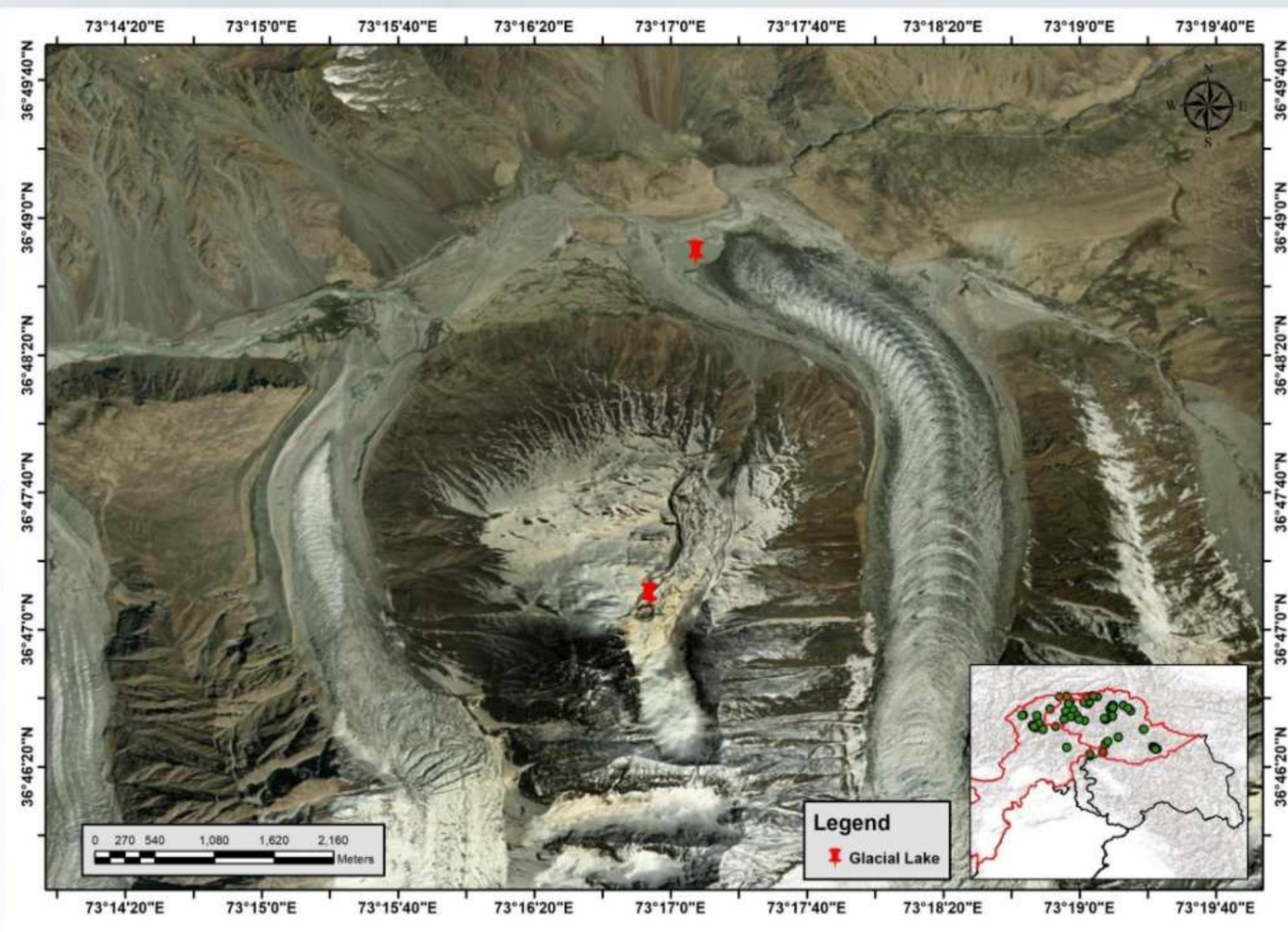
The surrounding Yarkhun Valley has a cold, high-altitude alpine climate, with prolonged winters, substantial snowfall at higher elevations and short summers during which snow and glacier melt contribute to river discharge. The glacier therefore forms an important component of the valley's seasonal water system. Increasing temperatures and changes in the timing and intensity of snow and ice melt can influence glacier mass balance, meltwater generation and downstream hydrological conditions. The broader Chitral region has also experienced increasing concern over intense summer rainfall, rapid glacier melt and associated flood hazards.

Chatiboi has undergone substantial long-term changes in its terminus and ice extent. Historical photographic comparisons reported a dramatic reduction of the visible ice front between the 1970s and 2010s, illustrating the sensitivity of the glacier to changing climatic and cryospheric conditions. However, such historical observations should not be interpreted as a precise current glacier-area estimate without a standardized satellite-derived assessment.

The glacier and its surrounding valley are exposed to glacier meltwater surges, flash floods, debris flows, ice avalanches, rockfalls and channel erosion. Direct interaction between the glacier terminus and the Yarkhun River also increases the importance of monitoring changes in the ice front, river channel and sediment accumulation. Sudden glacier- or slope-related disturbances can potentially modify drainage and produce downstream impacts along the Yarkhun River.



Chatiboi Glacial Lake, Upper Chitral, Khyber Pakhtunkhwa



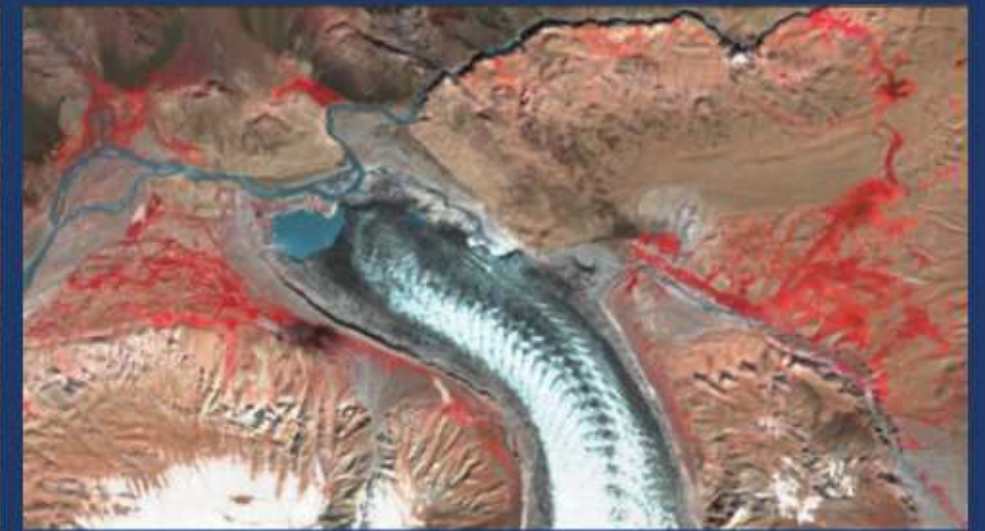
Parameter	Description
Geographic Setting	Chatiboi Glacier Lake system, Yarkhun Valley, Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush. The glacier terminates toward the Yarkhun River.
Central Coordinates	36° 48' 49.41" N, 73° 17' 7.56" E
Topography	Glacial lake elevation: 3391 m.a.s.l
Hydrology	Glacier and snowmelt-fed system draining toward the Yarkhun River.
Climate	Cold alpine climate, with substantial winter snow accumulation and summer snow and glacier melt
Geomorphology	Proglacial/ice-contact lake environment associated with the retreating Chatiboi Glacier, with glacial debris and sediment separating the glacier front from the Yarkhun River.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

2023



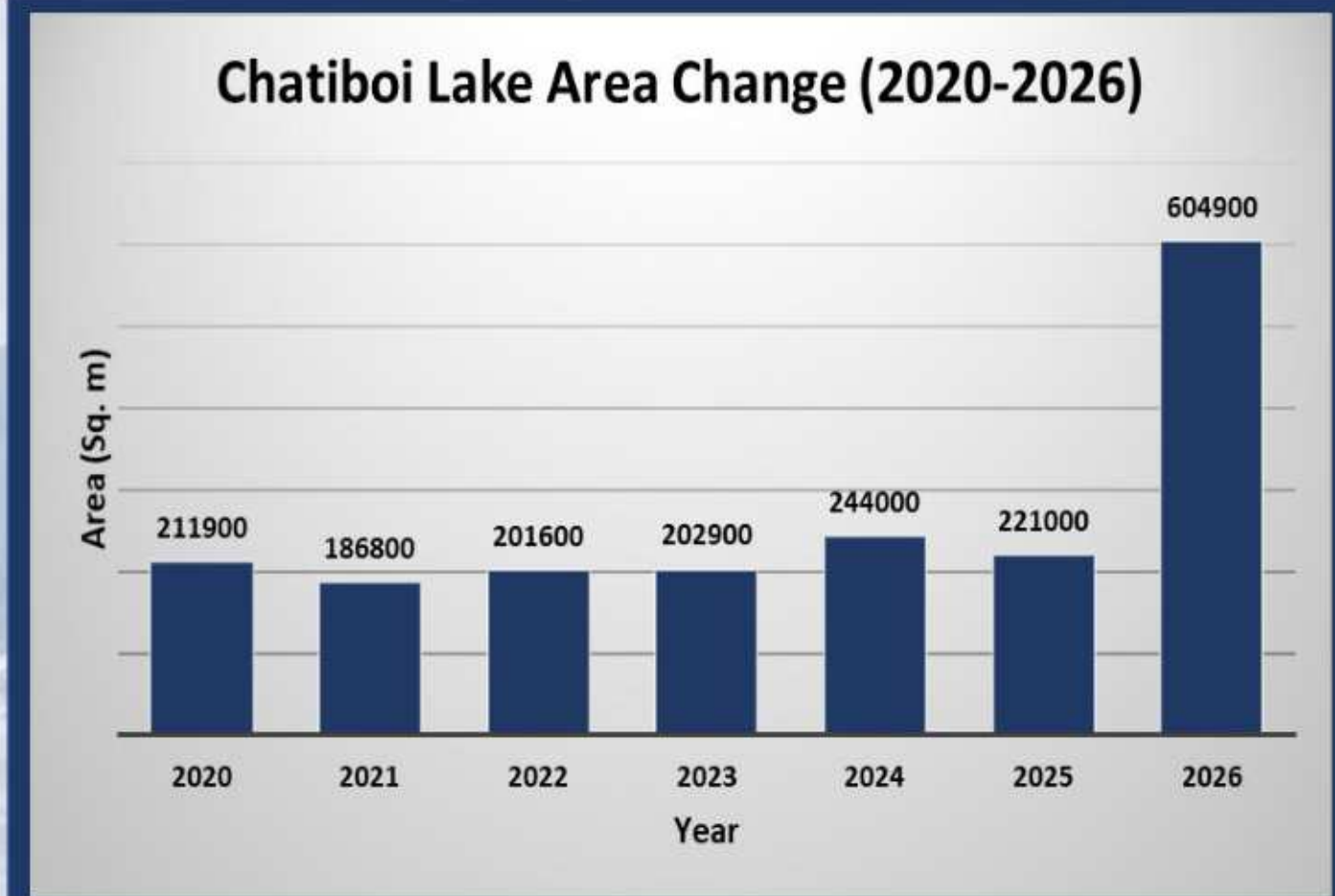
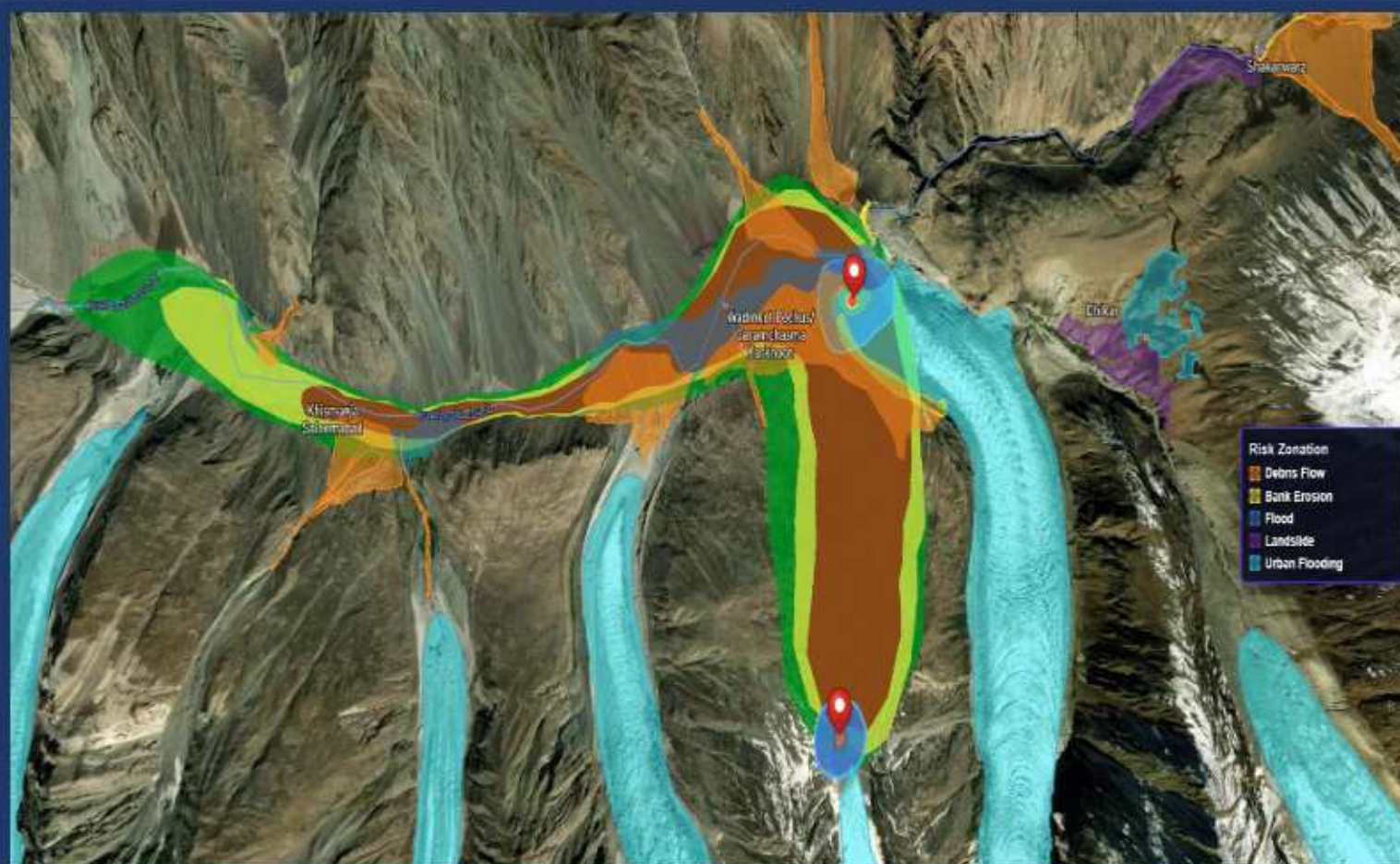
2024

2025

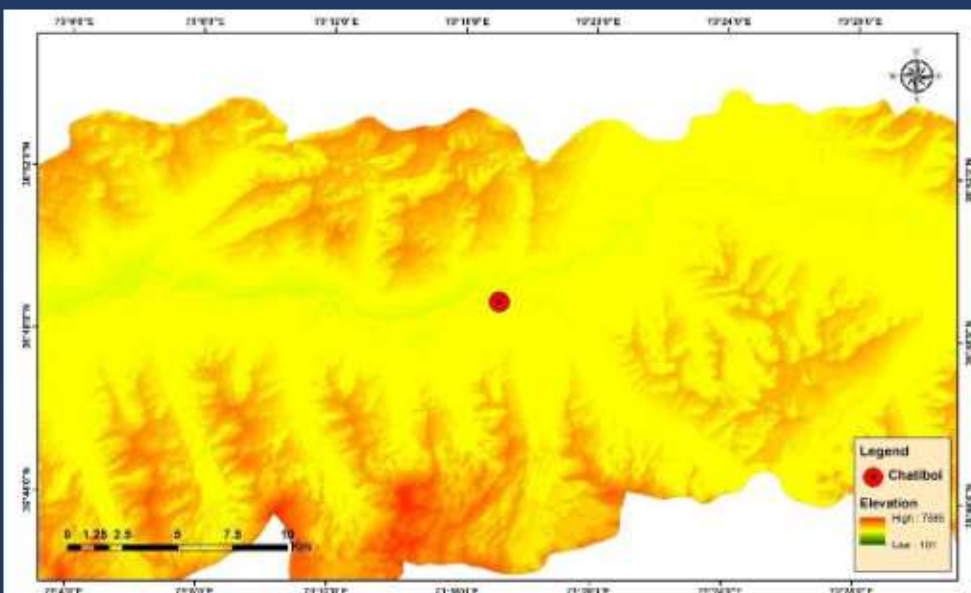
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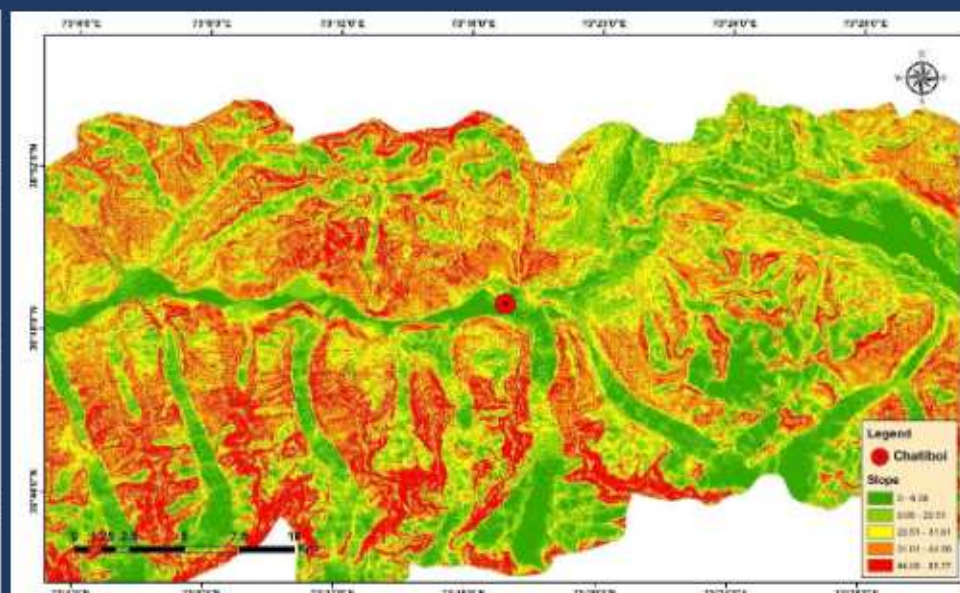
Geospatial Features



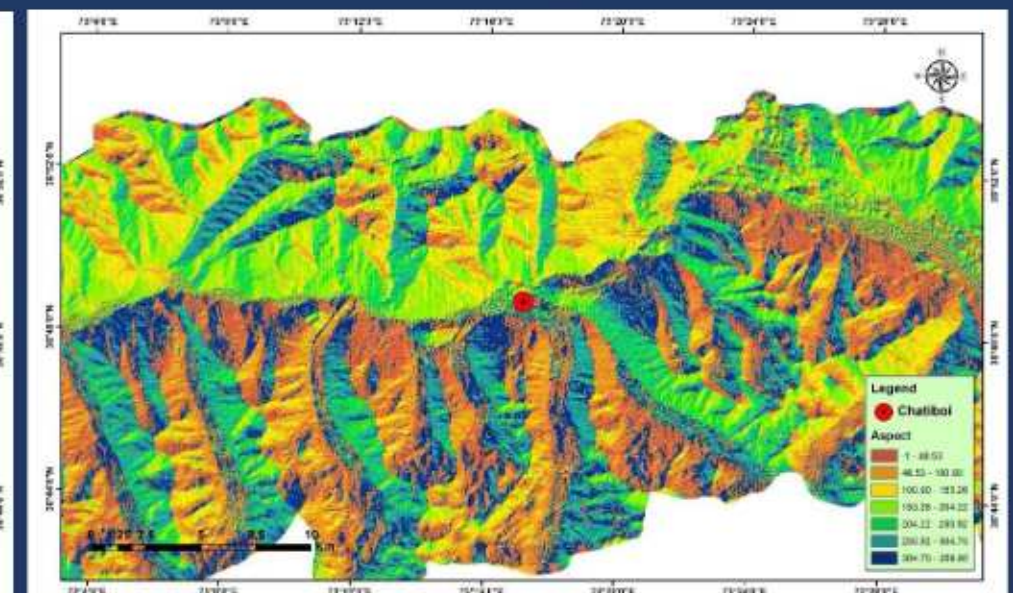
Elevation



Slope



Aspect



Pindoru Chaat Glacier

Pindoru Chaat is a remote, high-altitude glacierised area of Arkari Valley in Upper Chitral District, Khyber Pakhtunkhwa, within the rugged Hindu Kush mountain system. The area forms part of the high-mountain landscape between Arkari Valley and the Susoom side of Chitral, with the Oxhor Pass (approximately 5,200 m) providing a high-altitude connection between Pindoru Chaat and Susoom. The terrain is characterized by steep mountain slopes, extensive snow and ice cover, narrow valleys and glacier-fed drainage channels.

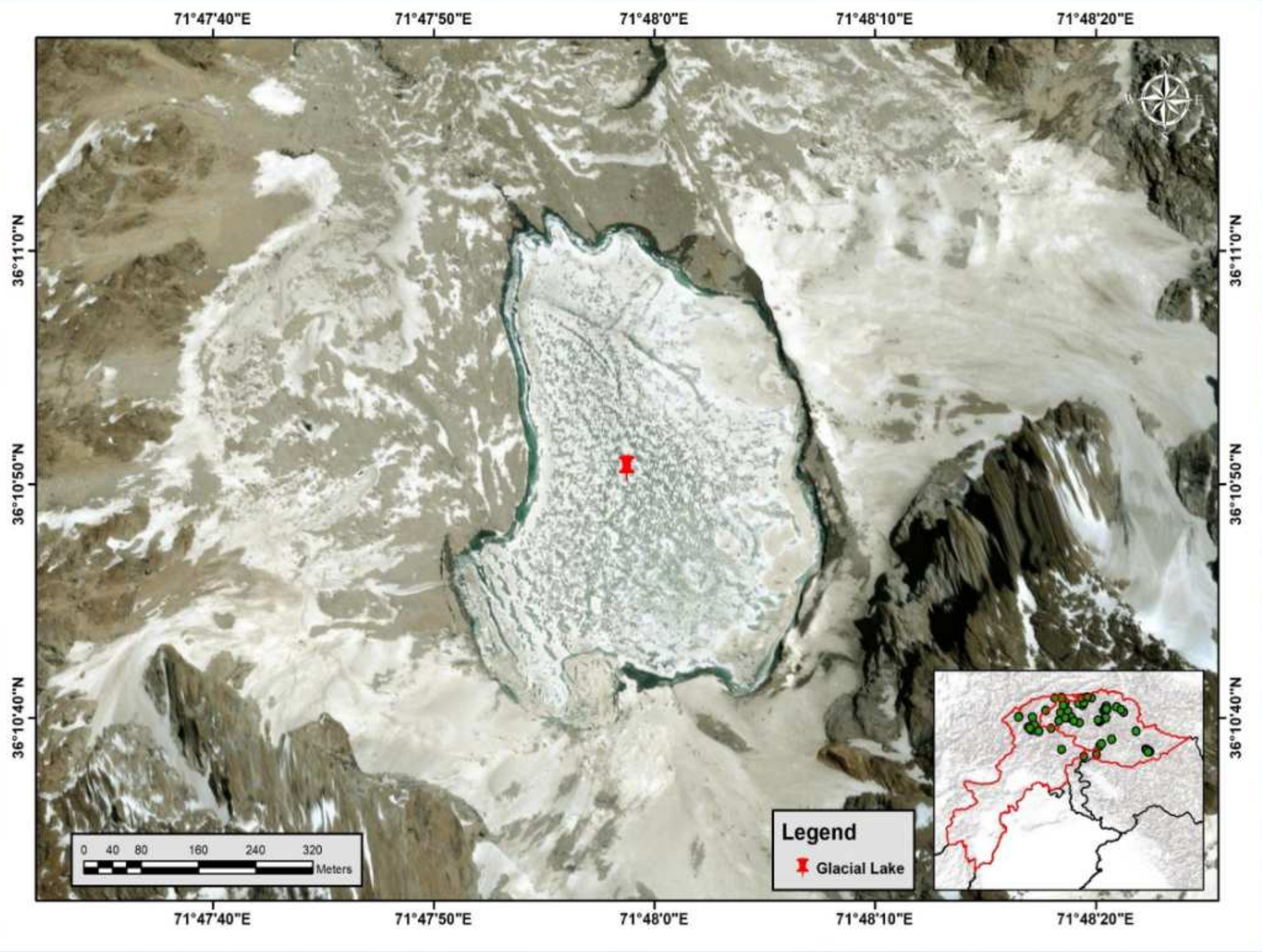
The region experiences a cold alpine climate, with severe winters, substantial snow accumulation at higher elevations and short summers. Seasonal warming promotes snow and glacier melt, while rainfall and thunderstorms during the warmer season can rapidly increase runoff from glacierised catchments. The combination of high relief, snow and ice storage, steep slopes and intense precipitation makes the area sensitive to rapid hydrological and geomorphic changes.

Pindoru Chaat is important from a cryospheric hazard perspective because glacier- and snowmelt-fed streams in such steep terrain can respond rapidly to warming and heavy precipitation. Potential processes include sudden increases in streamflow, debris flows, landslides, channel erosion and, where unstable ice or moraine-dammed water bodies are present, GLOF-type flooding. The confined mountain valleys can further amplify downstream flow and debris impacts.

Potential impacts include flash flooding, debris deposition, erosion of river channels and agricultural areas, damage to roads and bridges, disruption of irrigation and communication links, and temporary isolation of remote communities. Because of the area's remoteness and difficult terrain, rapid-onset hazards may also create challenges for emergency access and response.



Pindoru Chaat Glacial Lake, Upper Chitral, Kyber Pakhtunkhwa



Parameter	Description
Geographic Setting	Pindoru Chaat, Arkari Valley, Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush high-mountain region
Central Coordinates	36° 10' 50.65" N, 71° 47' 58.77" E
Topography	Glacial lake elevation: 4576 m.a.s.l
Hydrology	Snow and glacier melt fed, with rainfall contributing to rapid runoff during intense precipitation events.
Climate	Cold alpine climate, with substantial winter snow accumulation and summer snow and glacier melt
Geomorphology	Active glacial and periglacial terrain comprising glaciers, moraines, debris deposits, steep slopes and glacier-fed channels.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, sudden increases in glacier-fed streamflow and channel aggradation.

Spatio-Temporal Analysis

2021



2022



2023



2024



2025



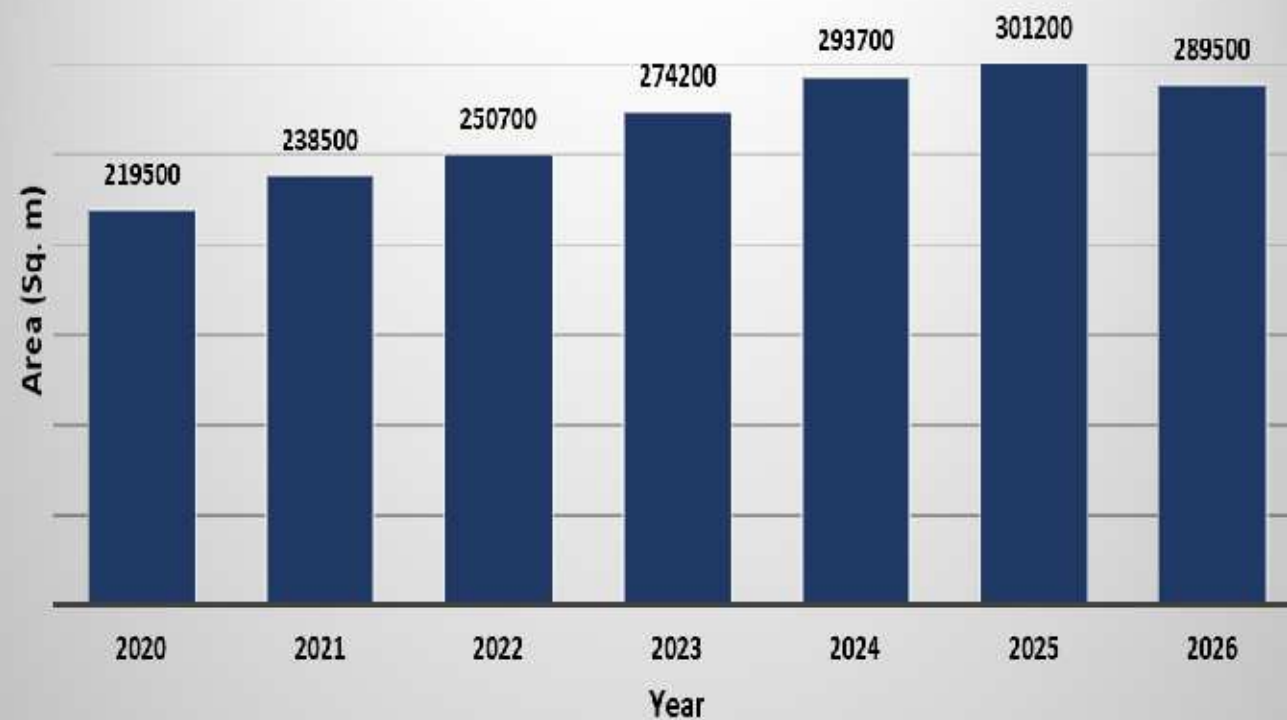
2026



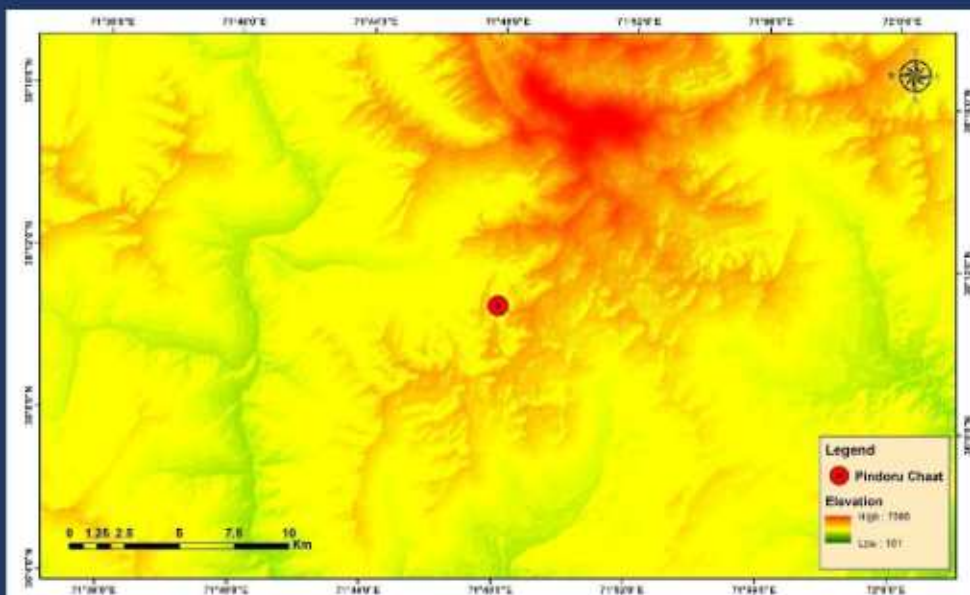
Geospatial Features



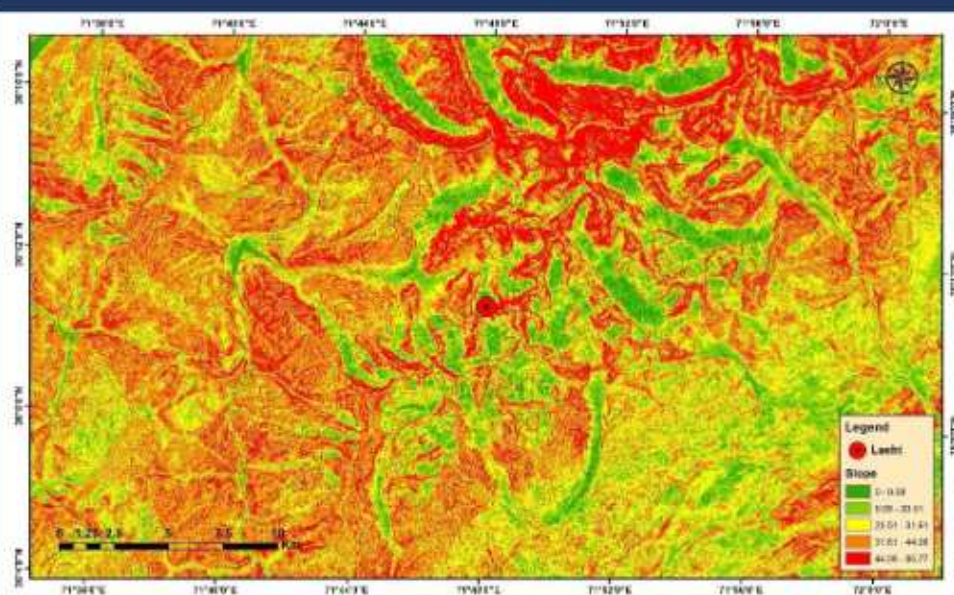
Pindoru chaat Lake Area Change (2020-2026)



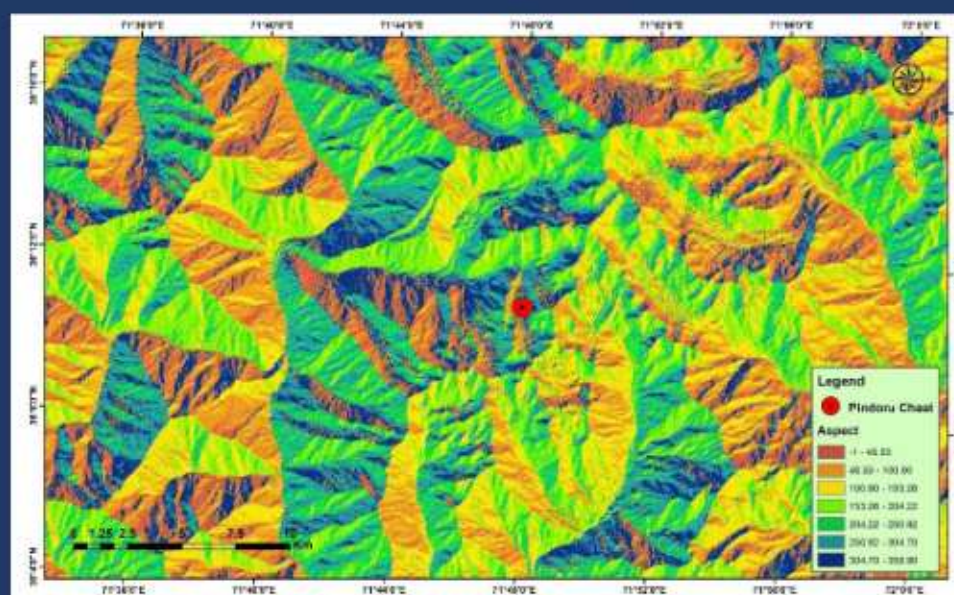
Elevation



Slope



Aspect



Brep Glacier

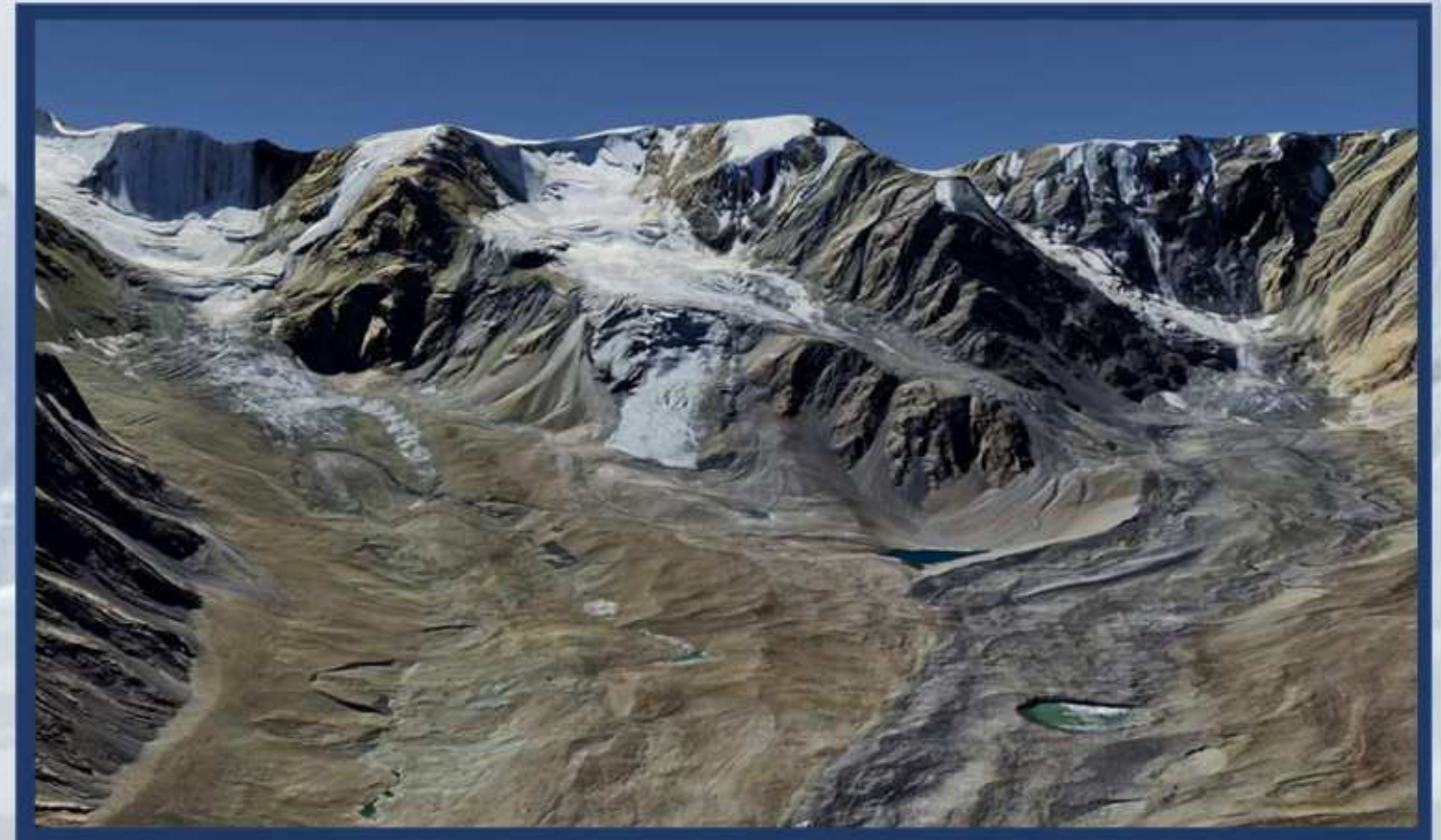
Brep is a glacier-fed high-mountain valley in Mastuj Tehsil, Upper Chitral District, within the Hindu Kush and Upper Indus Basin. The surrounding catchments contain glacierised headwaters, steep slopes and narrow drainage channels, with meltwater feeding the Brep Nullah system and downstream river network. Settlements, cultivated land and orchards are concentrated along the valley floor and drainage corridors, increasing exposure to sudden changes in streamflow.

The valley has a cold alpine climate, with long winters, seasonal snow accumulation and short summers. Summer warming drives snow and glacier melt, while rainfall can produce rapid runoff. The combination of high relief, glacier melt, intense precipitation and unstable slopes makes Brep sensitive to GLOFs, flash floods, debris flows and landslides.

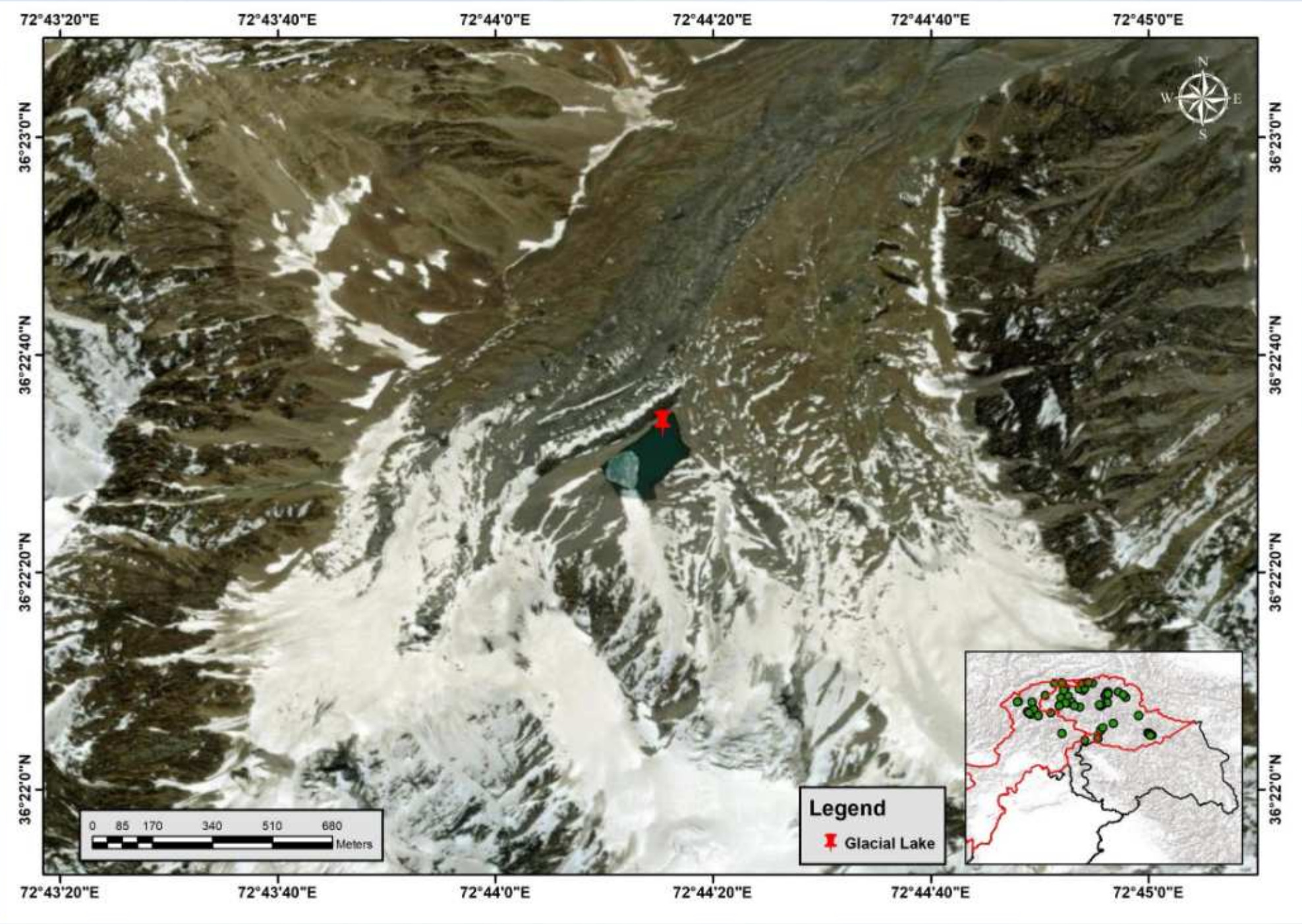
Brep has experienced recurrent glacier-related flooding, including a major GLOF in 2005 and subsequent damaging events in 2015, 2022 and 2023. These events have affected agricultural land, orchards, settlements, roads, irrigation systems and public infrastructure. The repeated occurrence indicates that the valley's risk is persistent rather than associated with a single isolated event.

The hazard environment is influenced by changing temperature and precipitation conditions. Increasing summer temperatures can enhance snow and glacier melt, while intense rainfall may rapidly increase runoff and mobilize loose glacial and slope sediments. Consequently, flood impacts can extend beyond lake outburst to include debris flows, channel erosion and sediment deposition.

Brep remains a nationally recognized vulnerable area. NDMA's 2026 GLOF advisory included Brep among potentially exposed locations in Upper Chitral during the March–September risk period, when warming temperatures and seasonal precipitation can increase glacier-fed runoff and slope instability.



Brep Glacial Lake, Upper Chitral Khyber Pakhtunkhwa



Parameter	Description
Geographic Setting	Brep, Mastuj Tehsil, Upper Chitral District, Khyber Pakhtunkhwa, in the Hindu Kush and Upper Indus Basin. Glacier-fed tributaries drain the surrounding high-mountain catchments toward the Brep Nullah and Mastuj River system.
Central Coordinates	36° 22' 30.66" N, 72° 44' 14.23" E
Topography	Glacial lake elevation: 4480 m.a.s.l
Hydrology	Snow- and glacier melt dominated, with rainfall contributing to rapid runoff during summer. Sudden discharge increases can occur during intense rainfall and accelerated melt.
Climate	Cold alpine climate, with snow accumulation in winter and snow and glacier melt in summer
Geomorphology	Active glacial-fluvial environment with glaciers, moraines, debris deposits, unstable slopes and sediment-laden channels
Primary Hazards	Glacial Lake Outburst Flood (GLOF), flash floods, debris flows, landslides, riverbank erosion and sediment deposition.

Spatio-Temporal Analysis

2021

2022

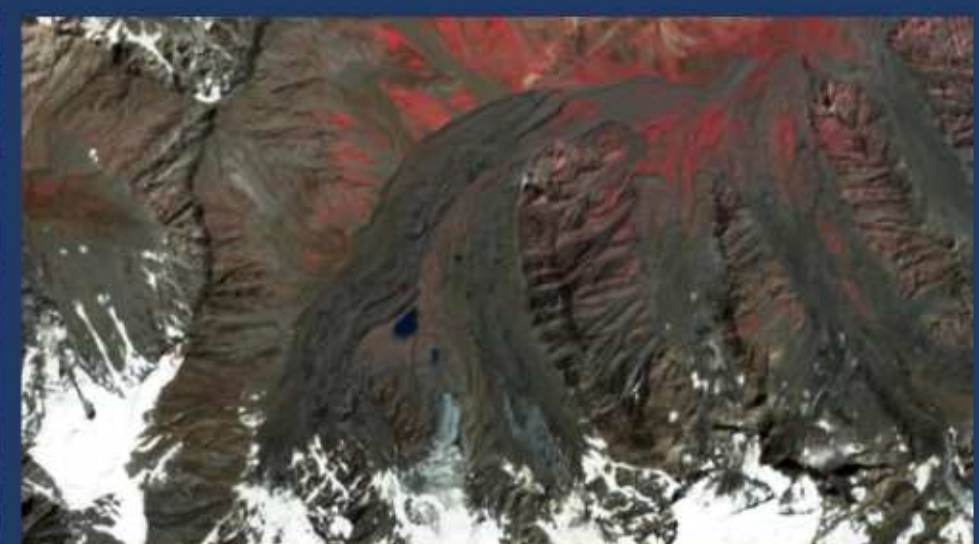
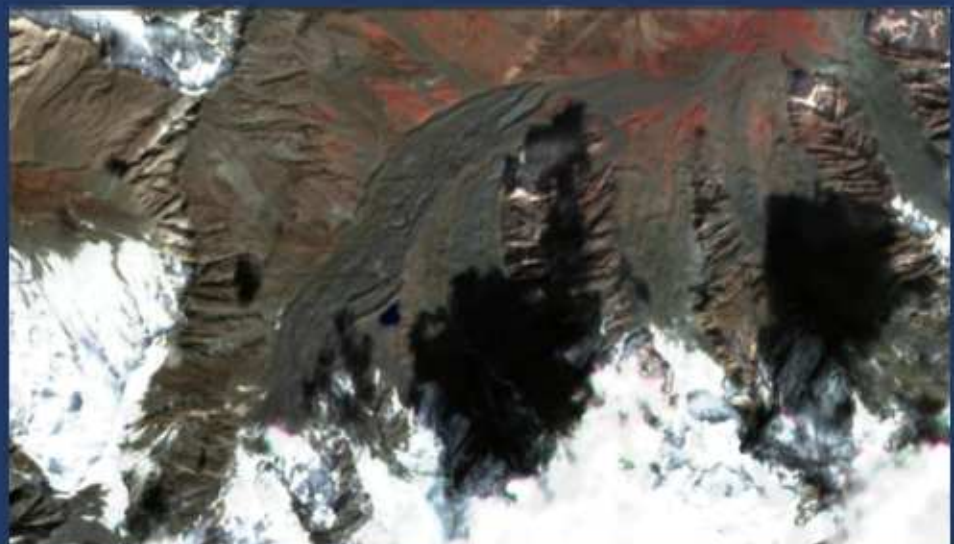
2023



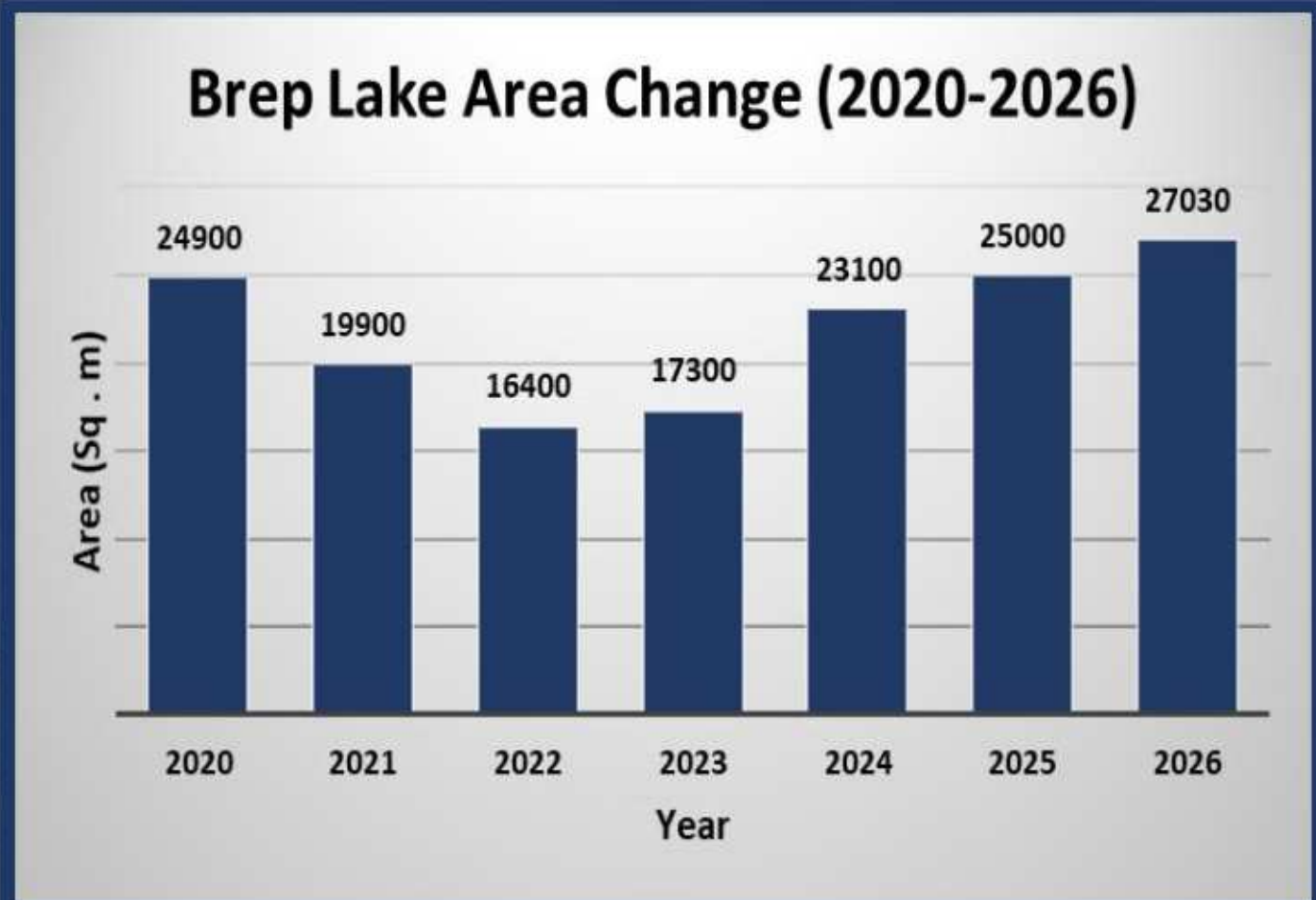
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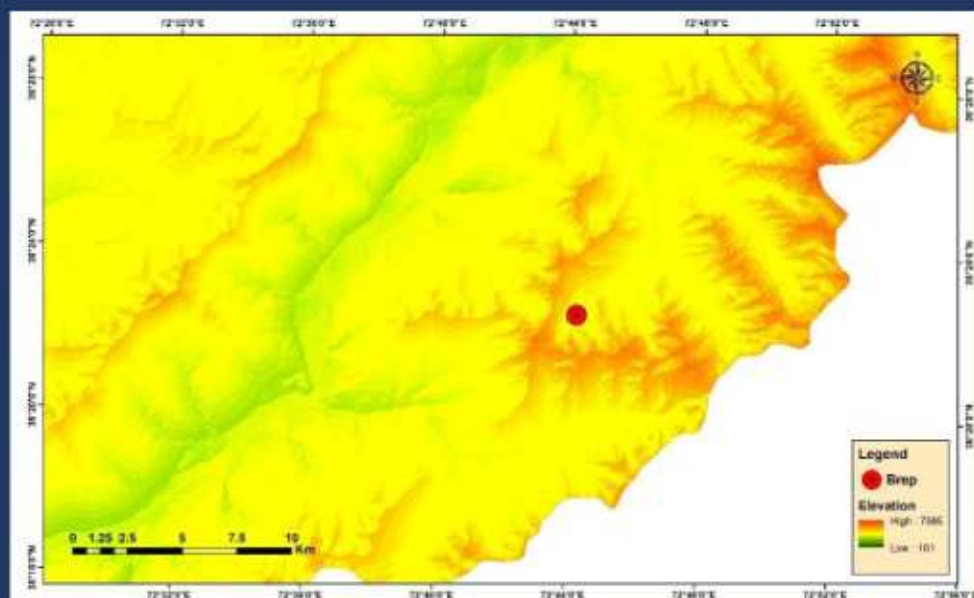
2026



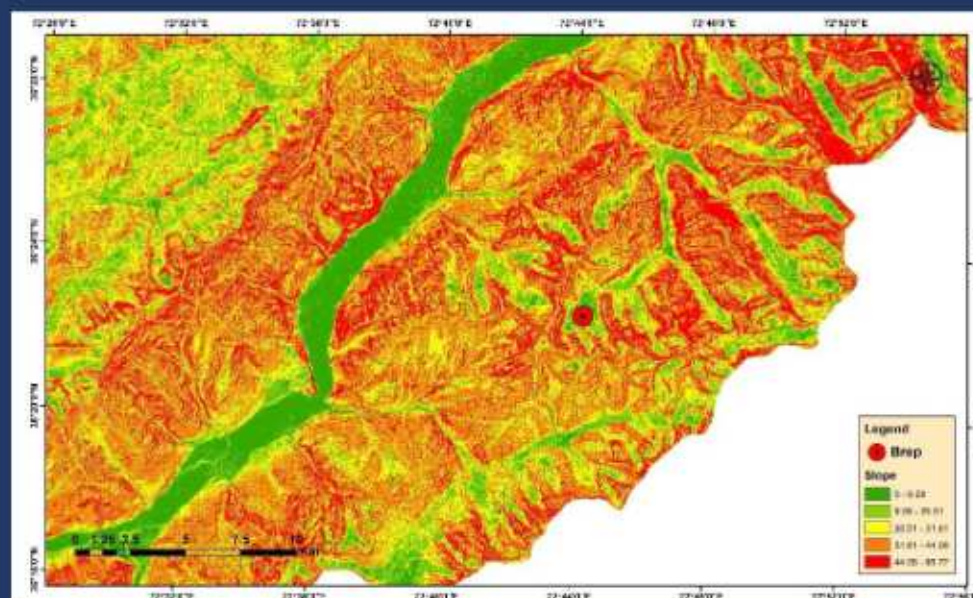
Geospatial Features



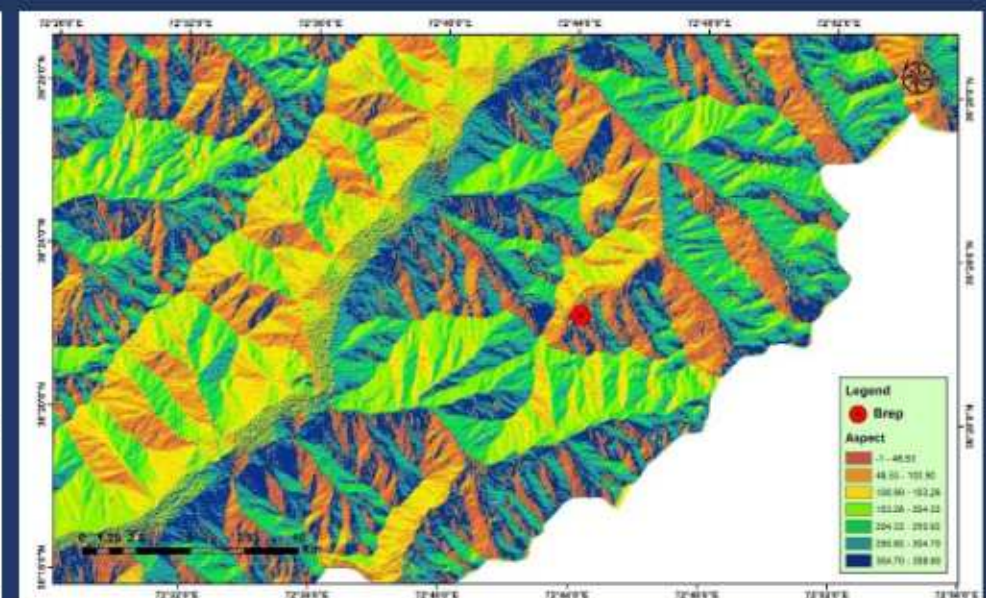
Elevation



Slope



Aspect



Reshun Glacier

Reshun Glacier is situated in the Reshun area of Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush high-mountain region of the Upper Indus Basin. The glacier and its surrounding catchment form part of the glacier-fed mountain environment of the Mastuj River system. The landscape is characterized by steep slopes, high mountain ridges, seasonal snow cover, glacierised headwaters and narrow valleys, with settlements and cultivated land occupying relatively lower and wider parts of the valley.

The area experiences a cold alpine climate, with long winters and short summers. Snow accumulation during winter provides seasonal water storage, while summer warming drives snow and glacier melt and increases runoff into downstream channels. Rainfall during the warmer season can further enhance discharge and, when combined with rapid melt, may produce short-duration high flows. Changes in temperature and precipitation therefore have direct implications for glacier mass balance and downstream water availability.

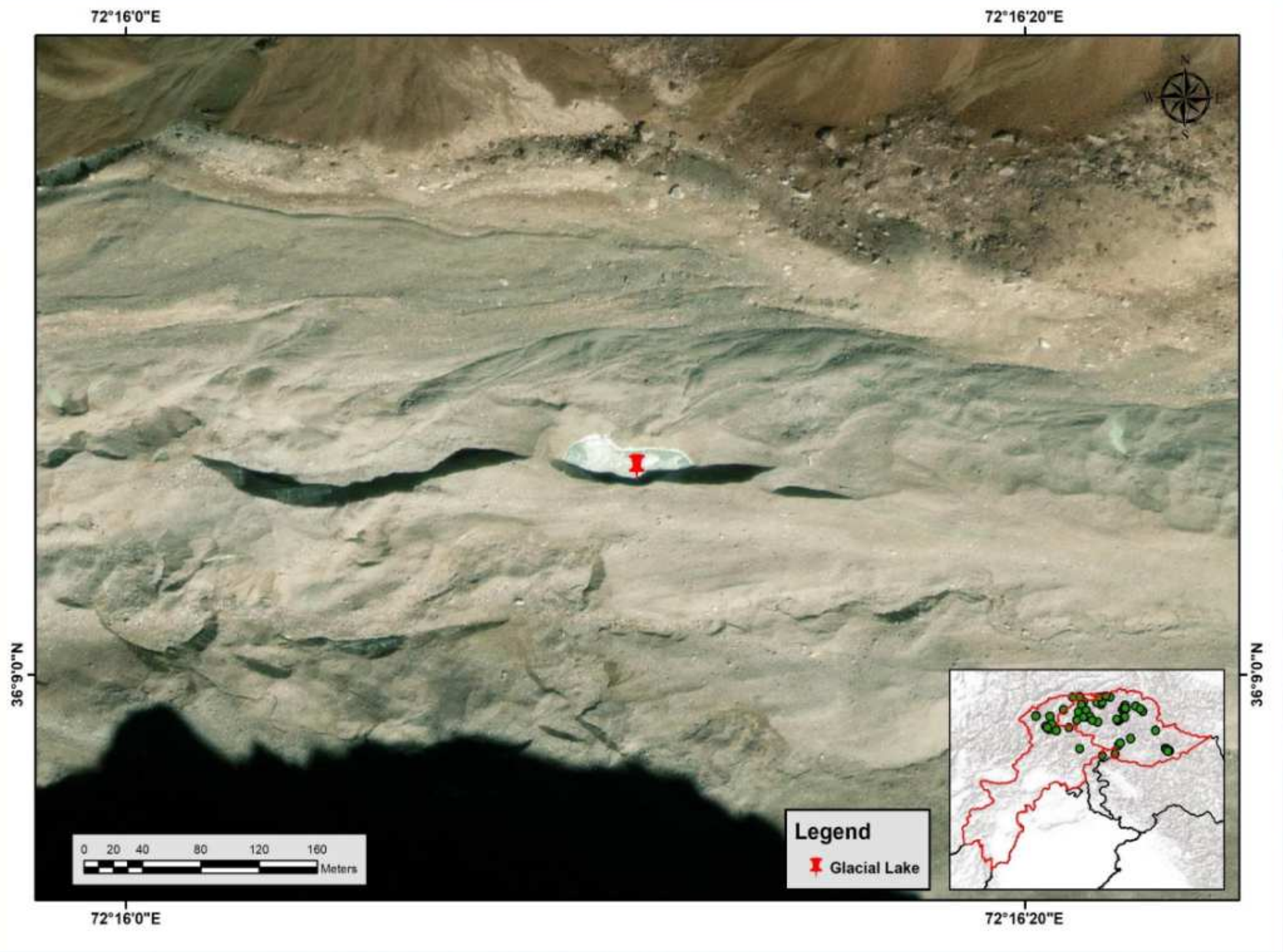
The Reshun glacierised catchment is geomorphologically active, with glacial erosion, moraine formation, debris transport, slope instability and river-channel adjustment occurring across the valley. Steep slopes and unconsolidated glacial and fluvial deposits increase susceptibility to landslides, rockfalls and debris flows. These processes can temporarily obstruct drainage and increase downstream flood potential.

Reshun is also relevant from a cryospheric hazard perspective because of the interaction between glacier melt, steep terrain and downstream settlements. Rapid snow or glacier melt, intense rainfall or slope failure can generate sudden increases in streamflow and sediment transport. Where temporary ice- or debris-dammed water accumulations develop, their sudden release may produce localized outburst flooding and debris-laden flows.

The wider Upper Chitral region has experienced increasing concern regarding warming temperatures, changing precipitation patterns and extreme rainfall events. Warmer conditions can extend the seasonal melt period and increase short-term meltwater production, while longer-term glacier retreat can modify runoff characteristics and potentially alter the location and behaviour of glacier-fed water bodies. These changes make continued observation of Reshun Glacier and its associated drainage system important for both water-resource assessment and hazard management. Potential impacts from glacier- and rainfall-related hazards include flooding and erosion of agricultural land, damage to settlements and irrigation channels, disruption of roads and bridges, sediment deposition and impacts on local livelihoods. The narrow valley morphology can concentrate floodwater and debris along established drainage corridors, increasing exposure of infrastructure located near streams.



Reshun Glacial Lake, Upper Chitral, Khyber Pakhtunkhwa



Parameter	Description
Geographic Setting	Reshun Valley, Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush and Upper Indus Basin. The glacier-fed drainage contributes to the Mastuj River system.
Central Coordinates	36° 9' 4.41" N, 72° 16' 11.38" E
Topography	Glacial lake elevation: 4544 m.a.s.l
Hydrology	Glacier and snowmelt fed, with summer rainfall contributing to runoff. Peak meltwater generally occurs during the summer season.
Climate	Cold alpine climate, substantial snow accumulation at higher elevations, Summer warming drives seasonal snow and glacier melt.
Geomorphology	Active glacial and fluvial environment comprising glaciers, moraines, debris deposits, steep unstable slopes and sediment laden channels.
Primary Hazards	Glacial Lake Outburst Flood (GLOF), flash floods, debris flows, landslides, steep terrain can amplify downstream impacts.

Spatio-Temporal Analysis

2021

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2023



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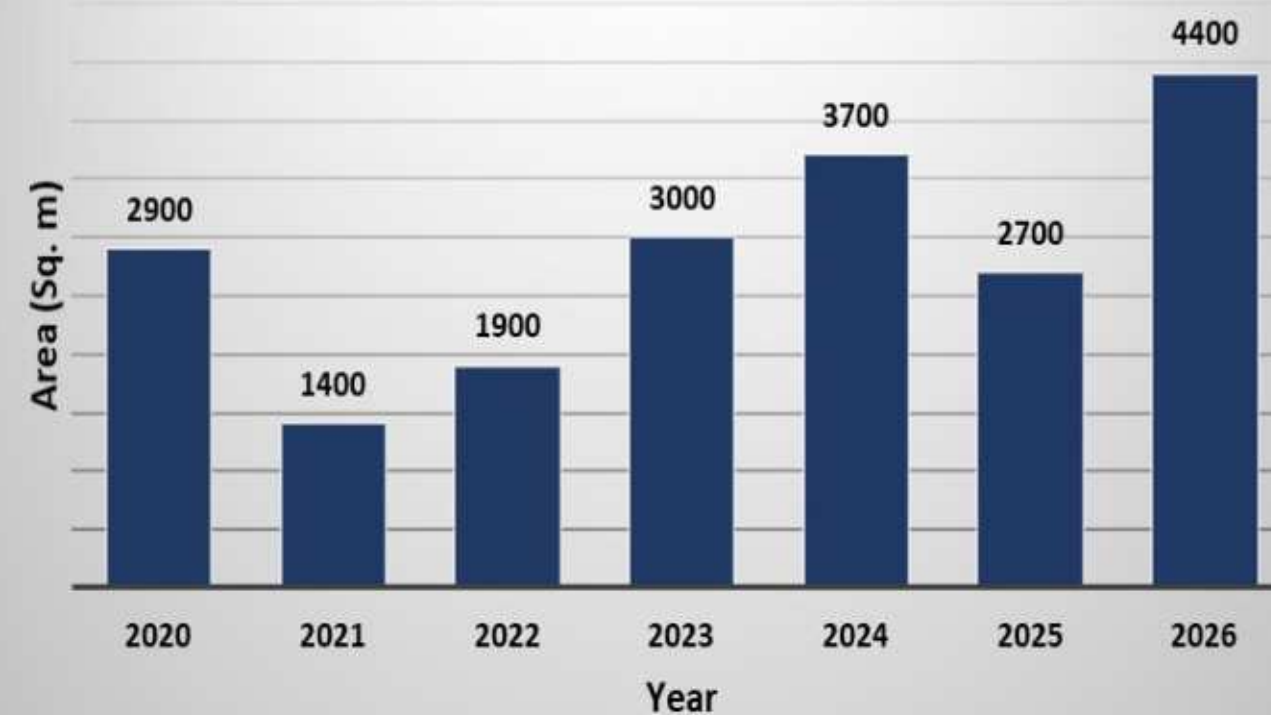
2026



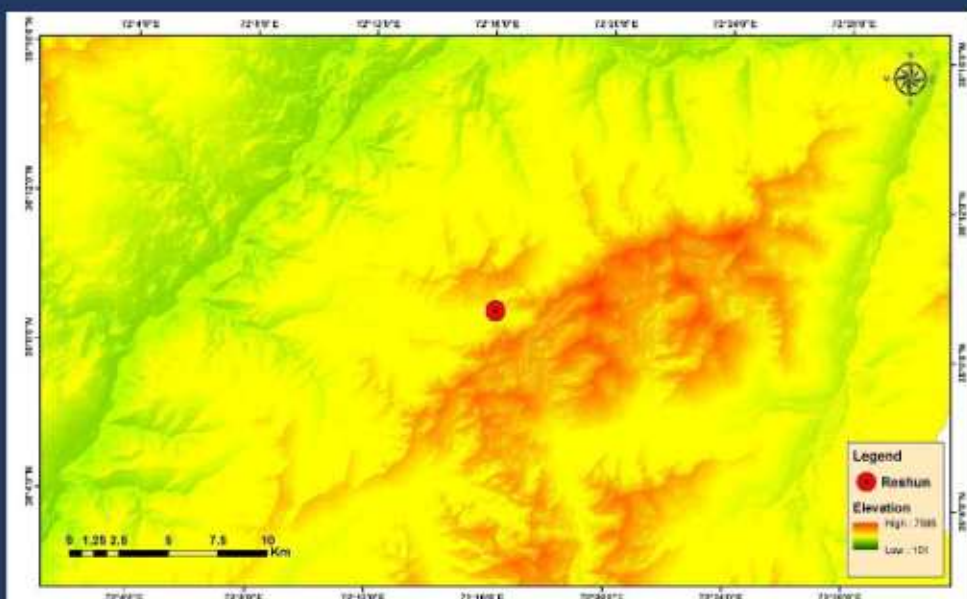
Geospatial Features



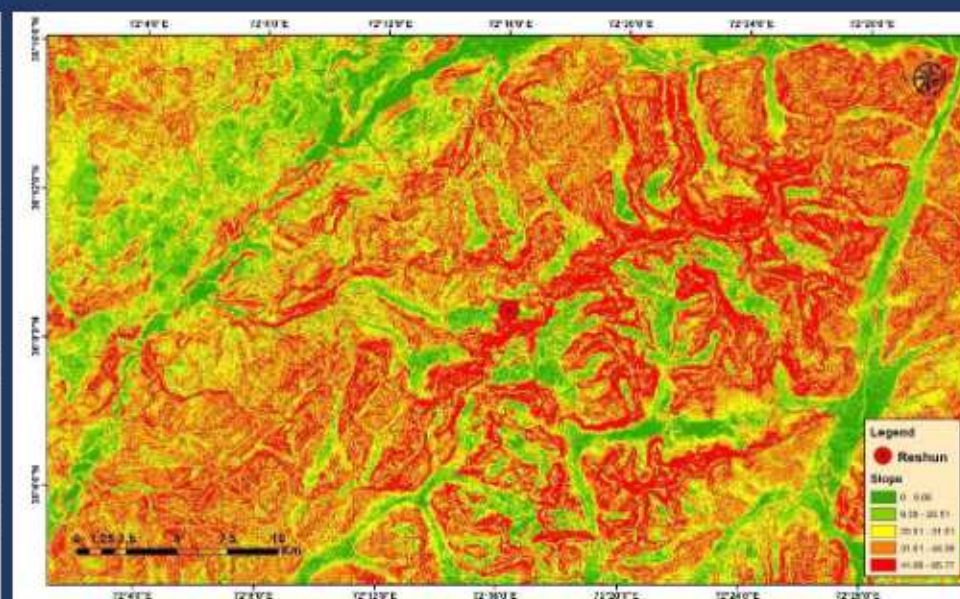
Reshun Lake Area Change (2020-2026)



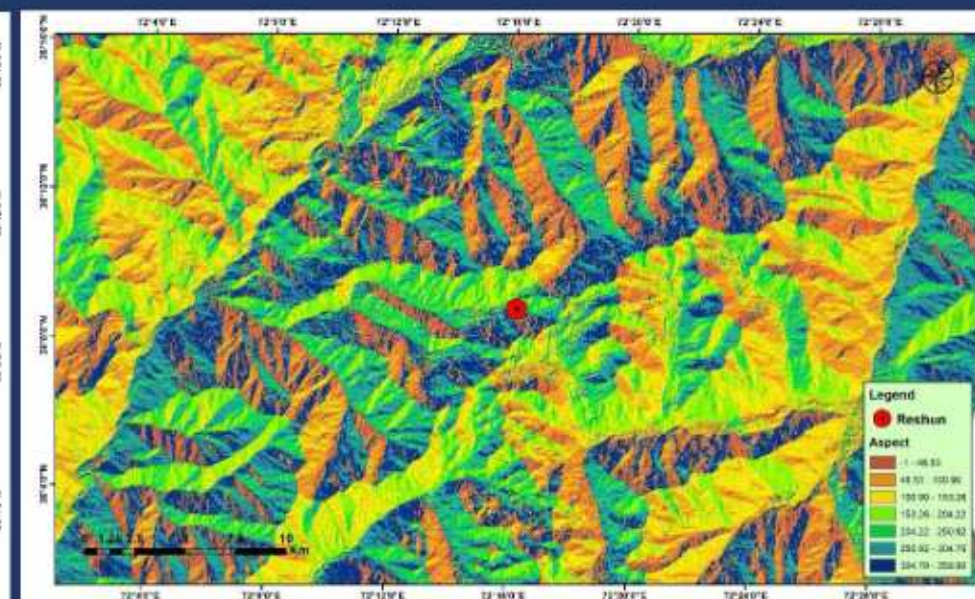
Elevation



Slope



Aspect



Tersat Hundur Glacier

Tersat Hundur Glacier is a high-altitude glacierised feature of the Upper Chitral mountain region of Khyber Pakhtunkhwa, situated within the rugged Hindu Kush landscape of the Upper Indus Basin. The surrounding terrain is characterized by steep mountain slopes, high ridges, snow- and ice-covered headwaters, narrow valleys and glacier-fed streams. The glacier forms part of the wider cryospheric system that provides seasonal meltwater to downstream mountain valleys and contributes to the region's highly variable summer runoff.

The glacier occurs in a cold alpine environment, with prolonged winters and substantial snow accumulation at higher elevations. Summers are relatively short but provide the principal period of snow and glacier melt. Seasonal warming increases meltwater production, while rainfall during the warmer months can further enhance runoff. The balance between winter accumulation and summer ablation is therefore important for determining the glacier's seasonal contribution to downstream water resources.

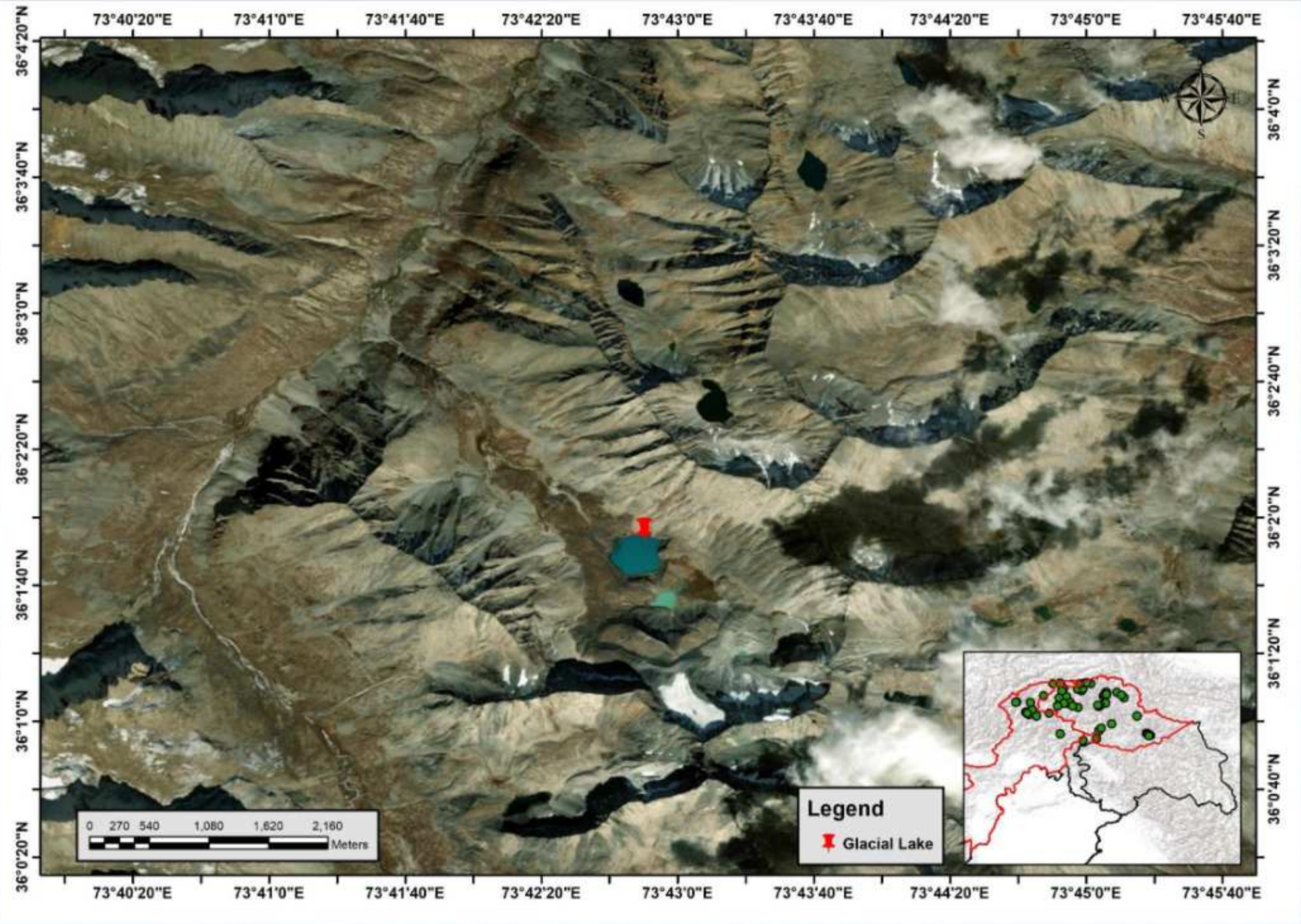
The surrounding landscape is geomorphologically active, with glacial erosion, moraine development, debris transport, freeze-thaw processes and slope instability shaping the terrain. Steep slopes and unconsolidated glacial and fluvial materials provide conditions for rockfalls, landslides and debris flows. Meltwater channels can also undergo rapid changes in response to variations in glacier discharge and sediment supply.

Like other glaciers of Upper Chitral, Tersat Hundur is sensitive to climatic variability and long-term warming. Increasing temperatures can alter snow accumulation, accelerate seasonal ablation and influence the timing and magnitude of meltwater discharge. Changes in precipitation, particularly the balance between snowfall and rainfall, may further affect glacier mass balance and downstream hydrology. These processes are important not only for understanding glacier change but also for assessing future water availability in glacier-dependent valleys.

From a hazard perspective, the glacierised catchment may be affected by rapid meltwater increases, flash floods, debris flows, landslides and channel erosion. Where unstable ice, moraine deposits or temporary water accumulations occur, sudden releases may generate localized outburst-type flooding. The potential consequences are greatest along confined drainage corridors where settlements, agricultural land and infrastructure are located close to streams.



Tersat Hundur Glacial Lake, Ghizer, Gilgit Baltistan



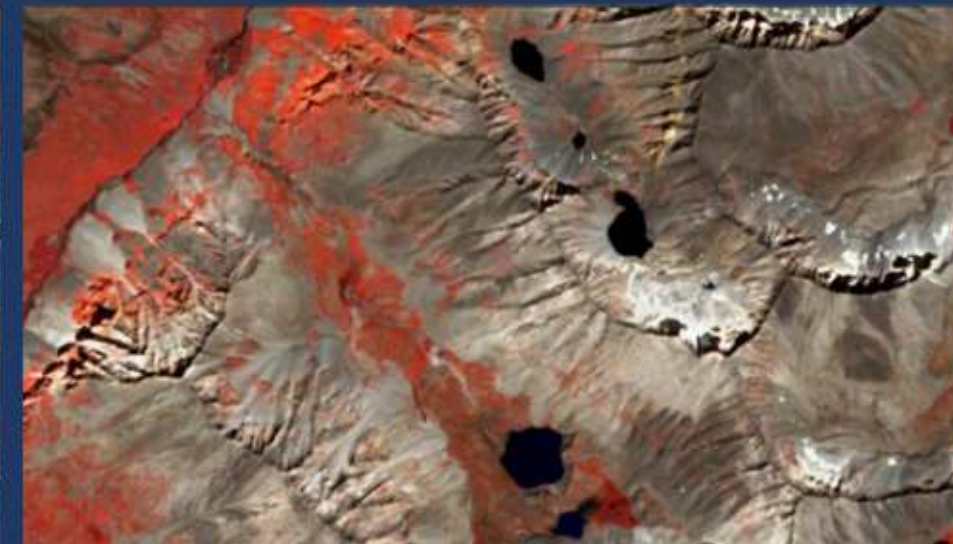
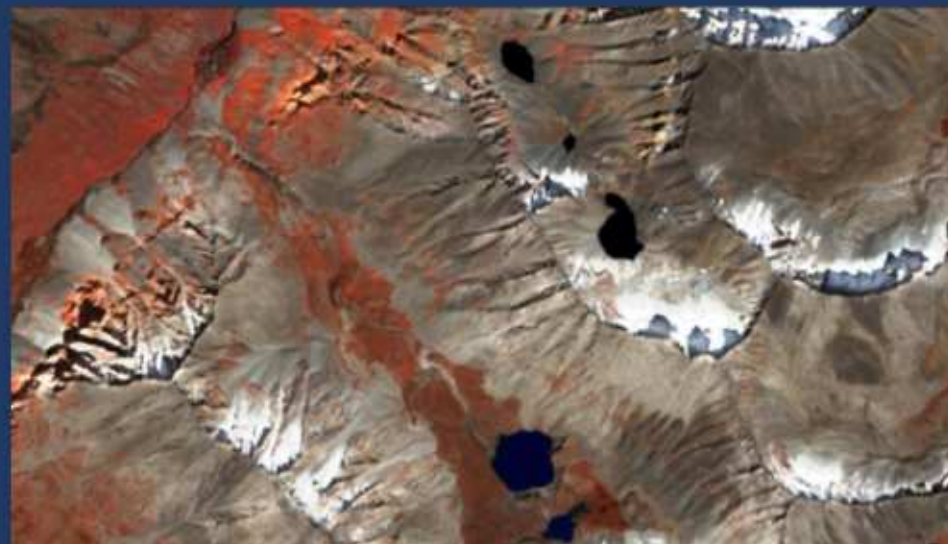
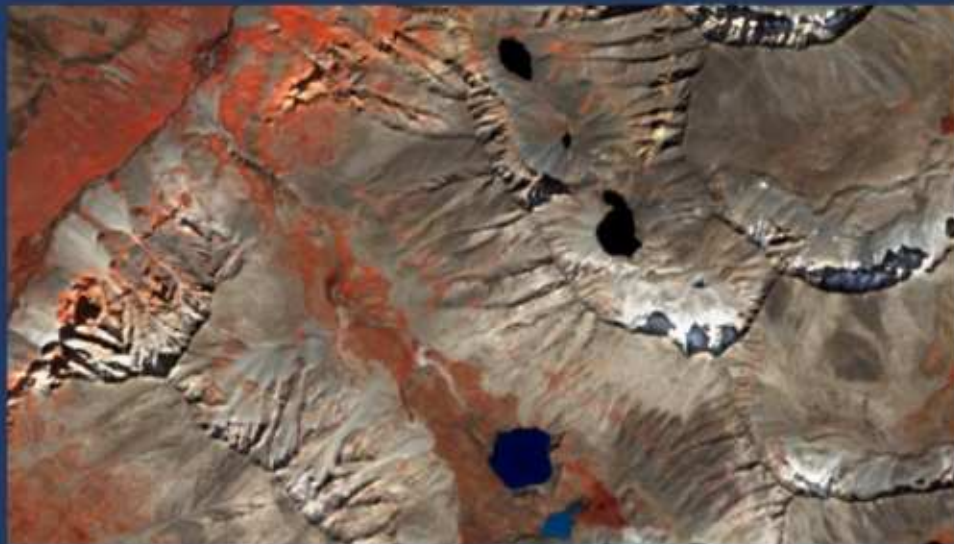
Parameter	Description
Geographic Setting	Upper Chitral District, Khyber Pakhtunkhwa, within the Hindu Kush and Upper Indus Basin; situated in a high-altitude glacier-fed mountain environment.
Central Coordinates	36° 1' 48.24" N, 73° 42' 47.77" E
Topography	Glacial lake elevation: 4348 m.a.s.l
Hydrology	Primarily snow and glaciermelt fed, with summer rainfall contributing to runoff; meltwater production increases during the summer ablation season
Climate	Cold alpine climate with prolonged winters, high-elevation snowfall and short summers; warming conditions influence seasonal glacier melt.
Geomorphology	Active glacial terrain comprising ice, moraines, debris deposits and steep unstable slopes, with active erosion and sediment transport
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

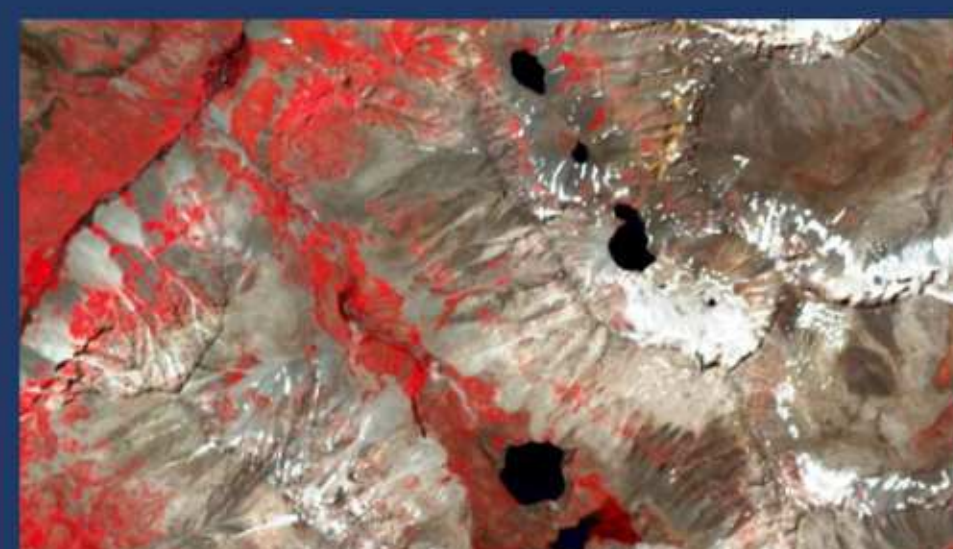
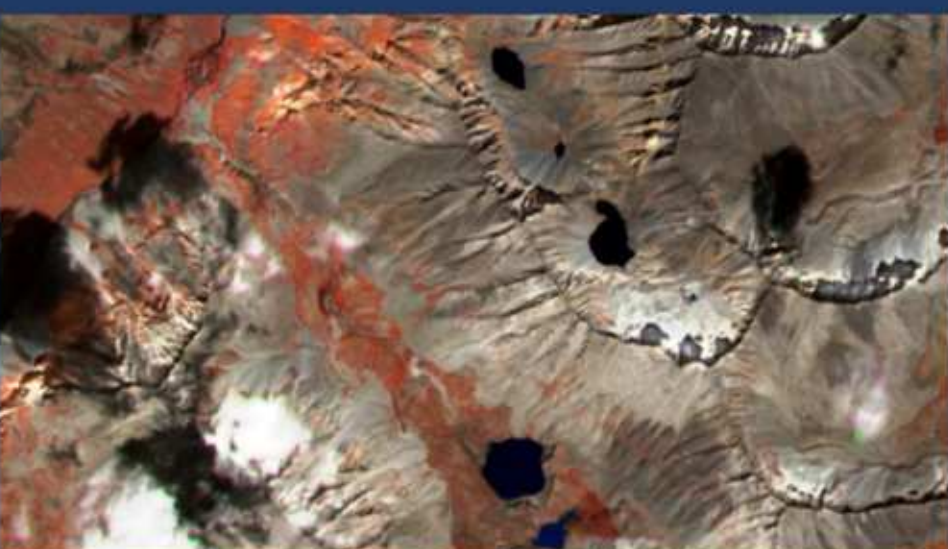
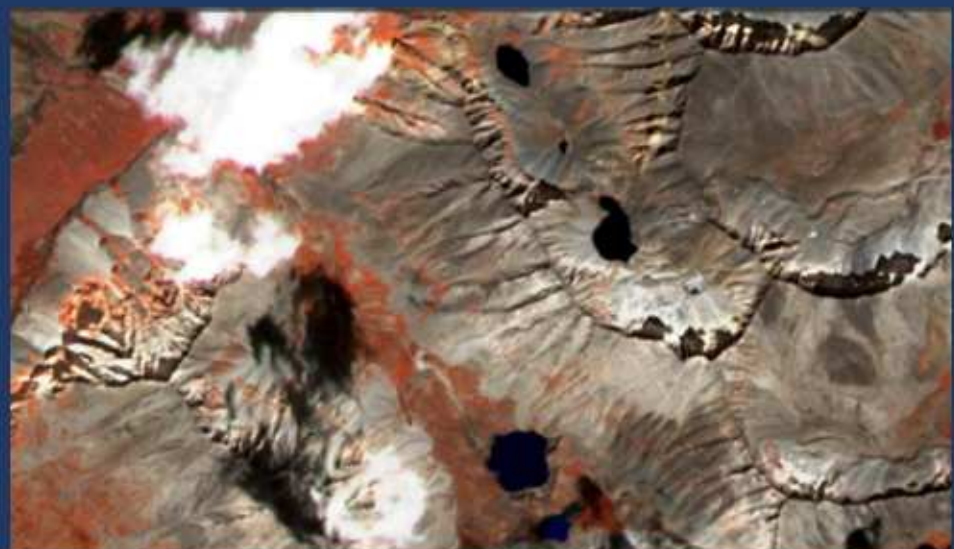
2023



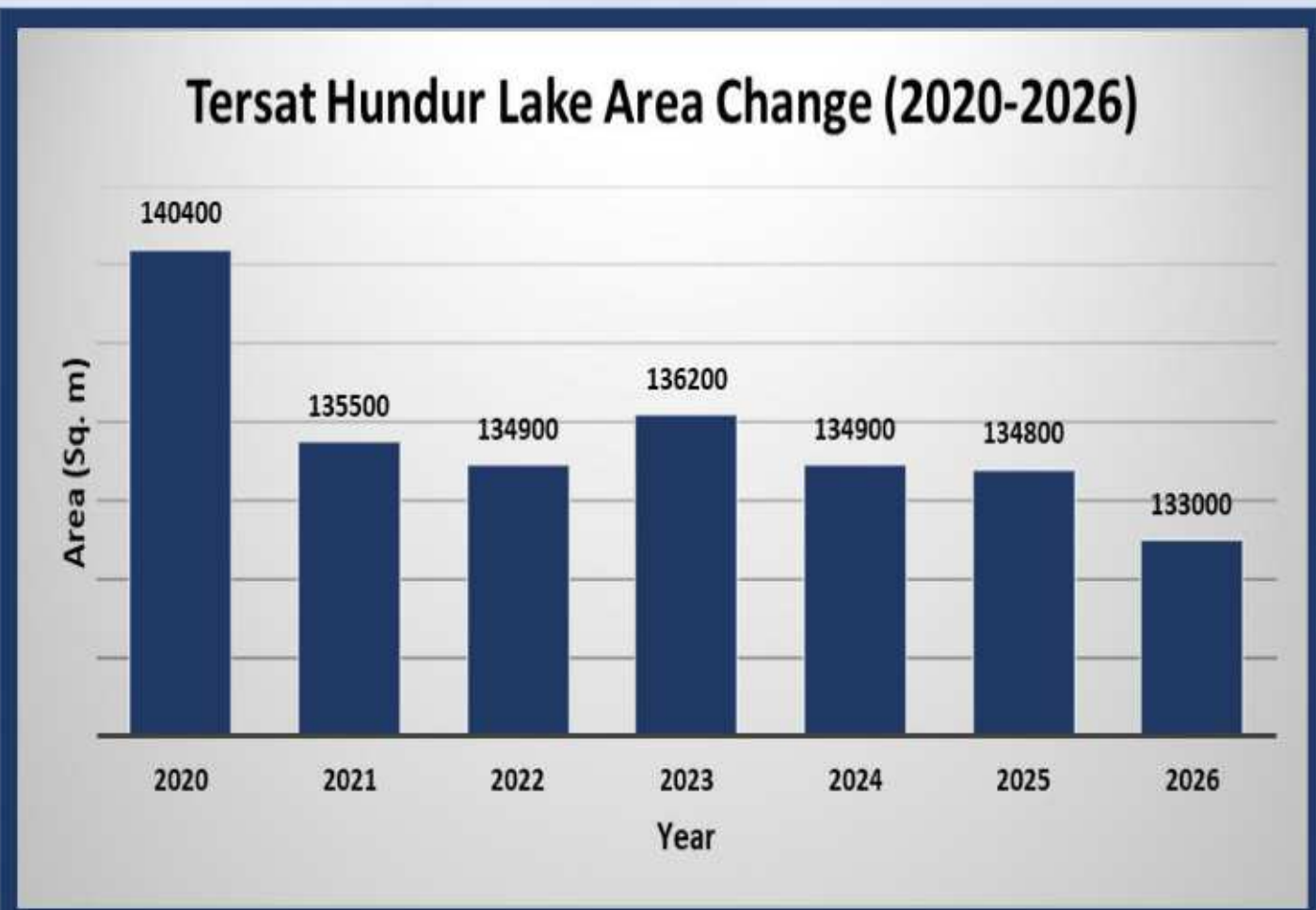
2024

2025

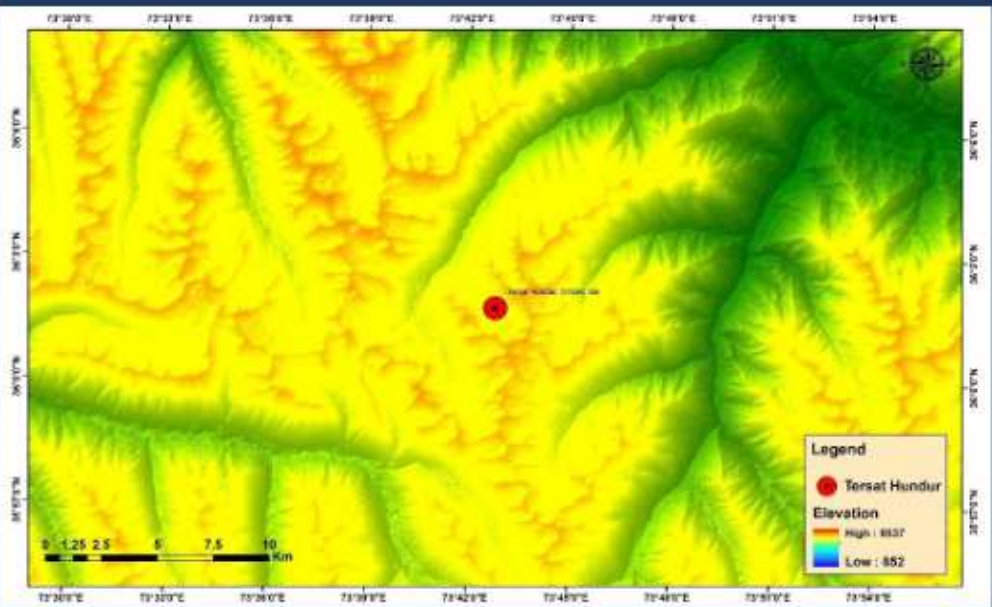
2026



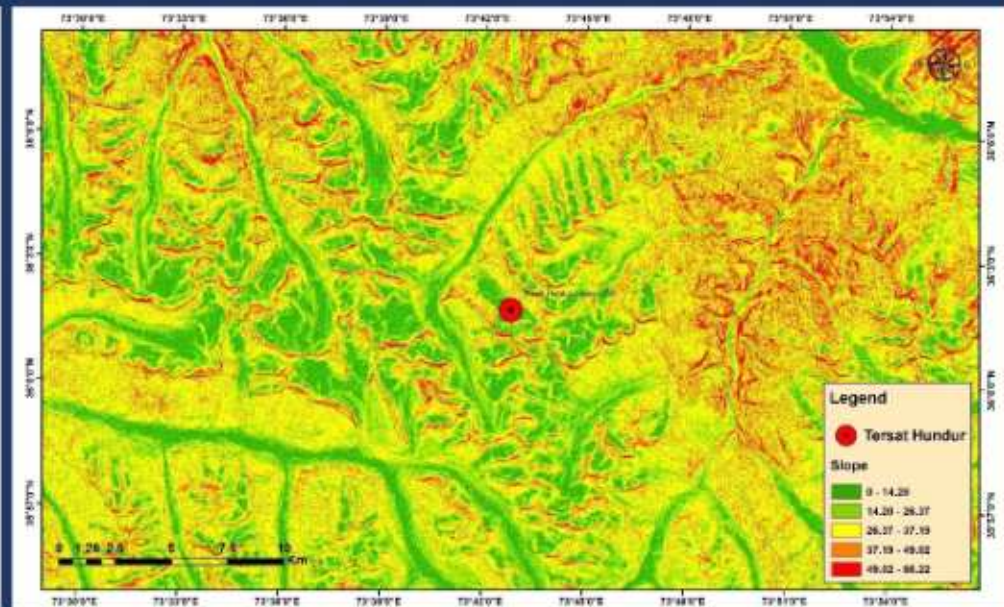
Geospatial Features



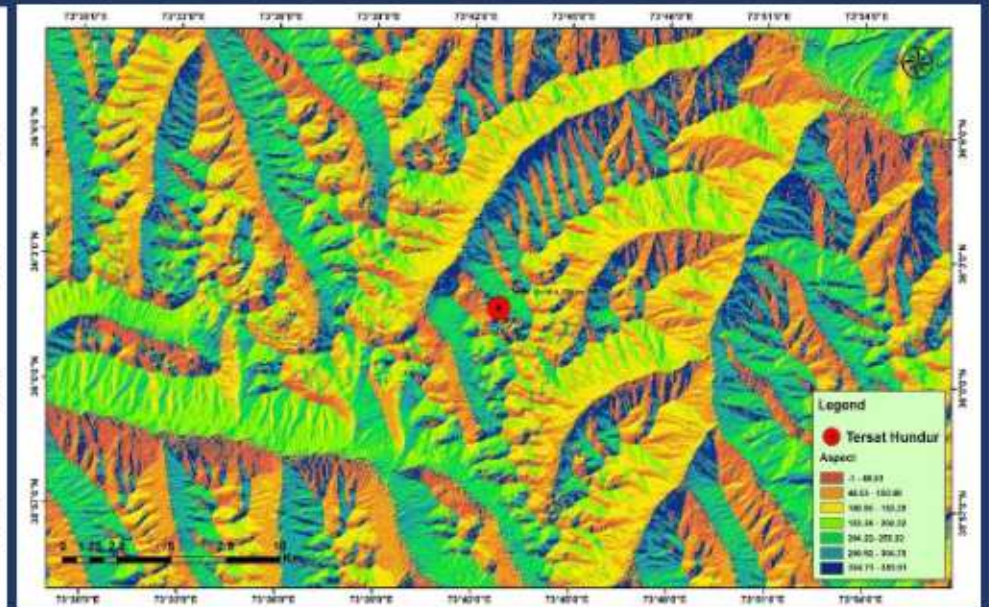
Elevation



Slope



Aspect



Thalu Glacier

Thalu 1 and Thalu 2 are two high-altitude glacial lakes associated with the Thalo glacierised landscape along the remote trekking route connecting Kumrat Valley in Upper Dir with the Chitral side through Thalo Pass. The lakes occur above the forested lower reaches of Kumrat, within a rugged alpine environment of glaciers, moraines, snowfields and steep mountain slopes. Route accounts identify Thalu 1 as Kak Sar and Thalu 2 as Kol Sar, although local names and spellings vary between trekking sources.

The surrounding terrain represents a transition from the forested Kumrat Valley to the high alpine and glaciated landscape around Thalo Gol and Thalo Pass. The Thalo Glacier is a substantial glacier of the Hindu Kush region, with historical geographical observations reporting an area of approximately 17 km² and a length of about 8.5 km, although these are historical values and should not be interpreted as its current extent. More recent mountaineering observations confirm extensive glacier terrain above Thalo Gol and describe access from Kumrat through Thalo Pass to the Thalo Zom Glacier.

The lakes are situated in a cold alpine to glacial climate, where winter snowfall and persistent snow and ice provide the principal water source. During summer, snow and glacier melt contribute to lake inflow and downstream drainage. Their hydrological conditions are therefore closely linked to seasonal temperature, snow accumulation and glacier ablation. The high elevation and proximity to active glacier and moraine terrain make lake morphology and water levels potentially variable between seasons and years.

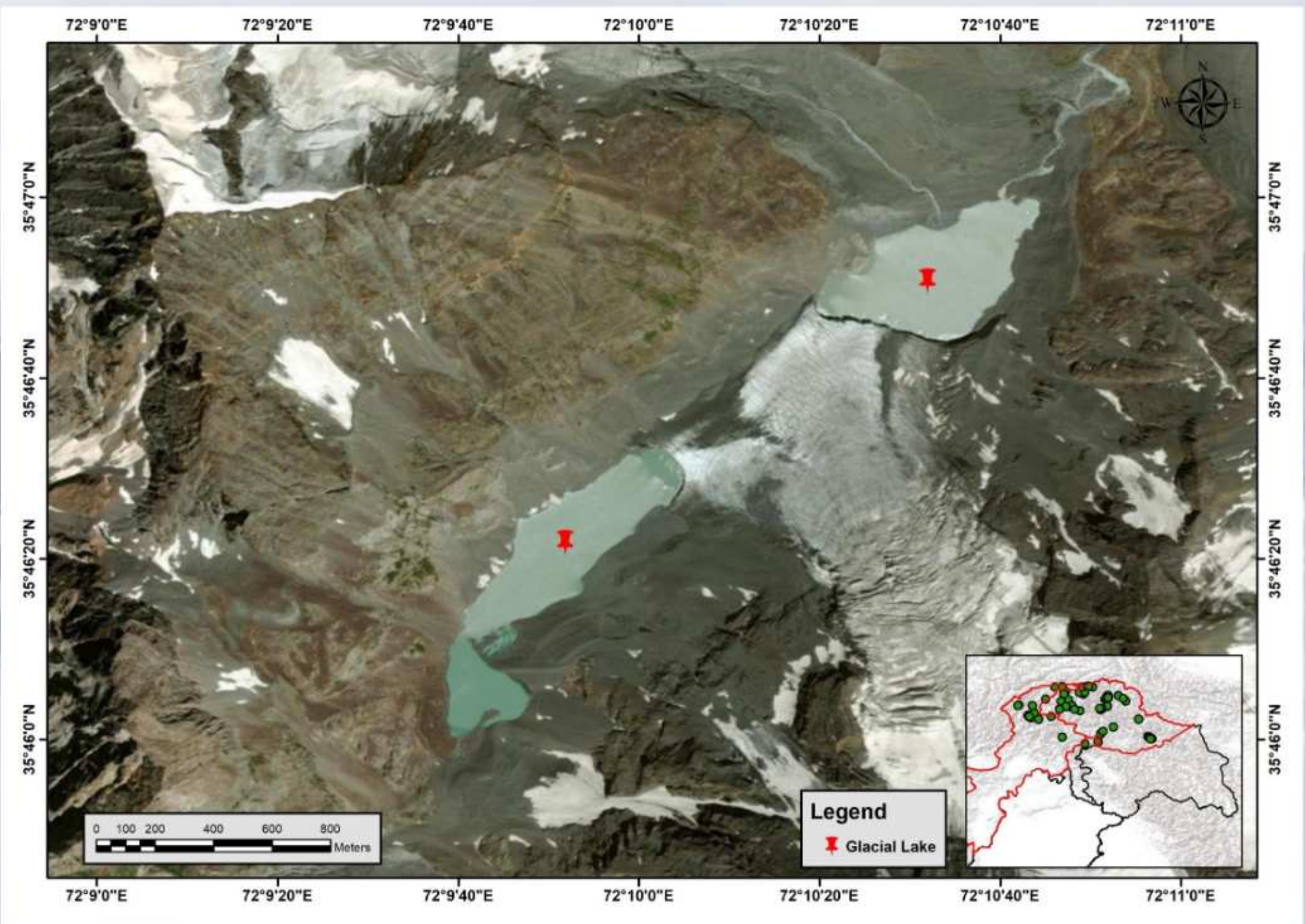
Geomorphologically, Thalu 1 and Thalu 2 represent small alpine glacial/proglacial water bodies within an actively glaciated landscape, surrounded by moraines, exposed bedrock, snowfields and debris-covered terrain. The lakes are part of a broader chain of water bodies encountered along the Thalo–Bashkargol trekking corridor; field accounts describe several glacial lakes before and after Thalo Pass.

The principal hazards are rapid lake-level changes, glacier-related flooding, temporary drainage blockage, debris flows, landslides and sudden outburst-type flooding. The confined terrain downstream can increase the propagation potential of sudden releases. Importantly, NDMA has explicitly identified “Thalu 1 & 2” among vulnerable glacial-lake locations during periods of elevated GLOF risk. In its June 2025 warning, NDMA highlighted the combined influence of persistent high temperatures, intensified monsoon currents and westerly disturbances on GLOF potential in these locations.

The lakes therefore have significance beyond their scenic and trekking value. Their position within a glacierised catchment makes them useful indicators of cryospheric change, seasonal meltwater variability and emerging high-altitude flood risk.



Thalo I & II Glacial Lake, Upper Chitral, Khyber Pakhtunkhwa



Parameter	Description
Geographic Setting	Thalu I & II are high-altitude glacial lakes in the Thalo glacierised area, Kumrat Valley, Upper Dir, Khyber
Central Coordinates	35° 46' 18.04" N, 72° 9' 51.88" E & 35° 46' 46.02" N, 72° 10' 27.20" E
Topography	Thalu I Glacial lake elevation: 4330 m.a.s.l Thalu II Glacial lake elevation: 4297 m.a.s.l
Hydrology	Primarily snow- and glaciermelt-fed, with seasonal meltwater controlling lake levels and downstream drainage during summer.
Climate	Cold alpine climate, with substantial winter snowfall and short summers. Summer warming drives snow and glacier melt.
Geomorphology	Glacial/proglacial lakes within an actively glaciated landscape, associated with moraines, glacier ice, snowfields and glacio-fluvial deposits.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

2021

2022

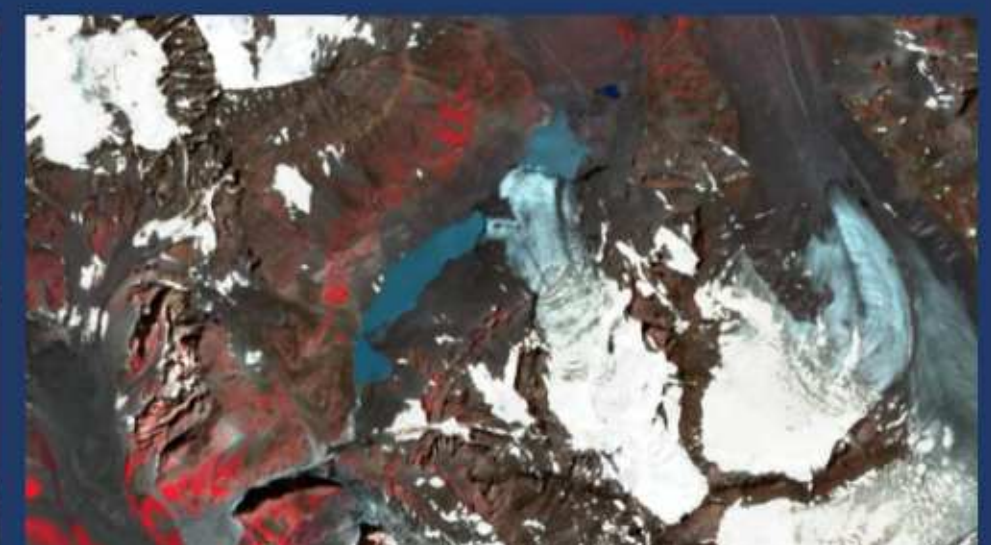
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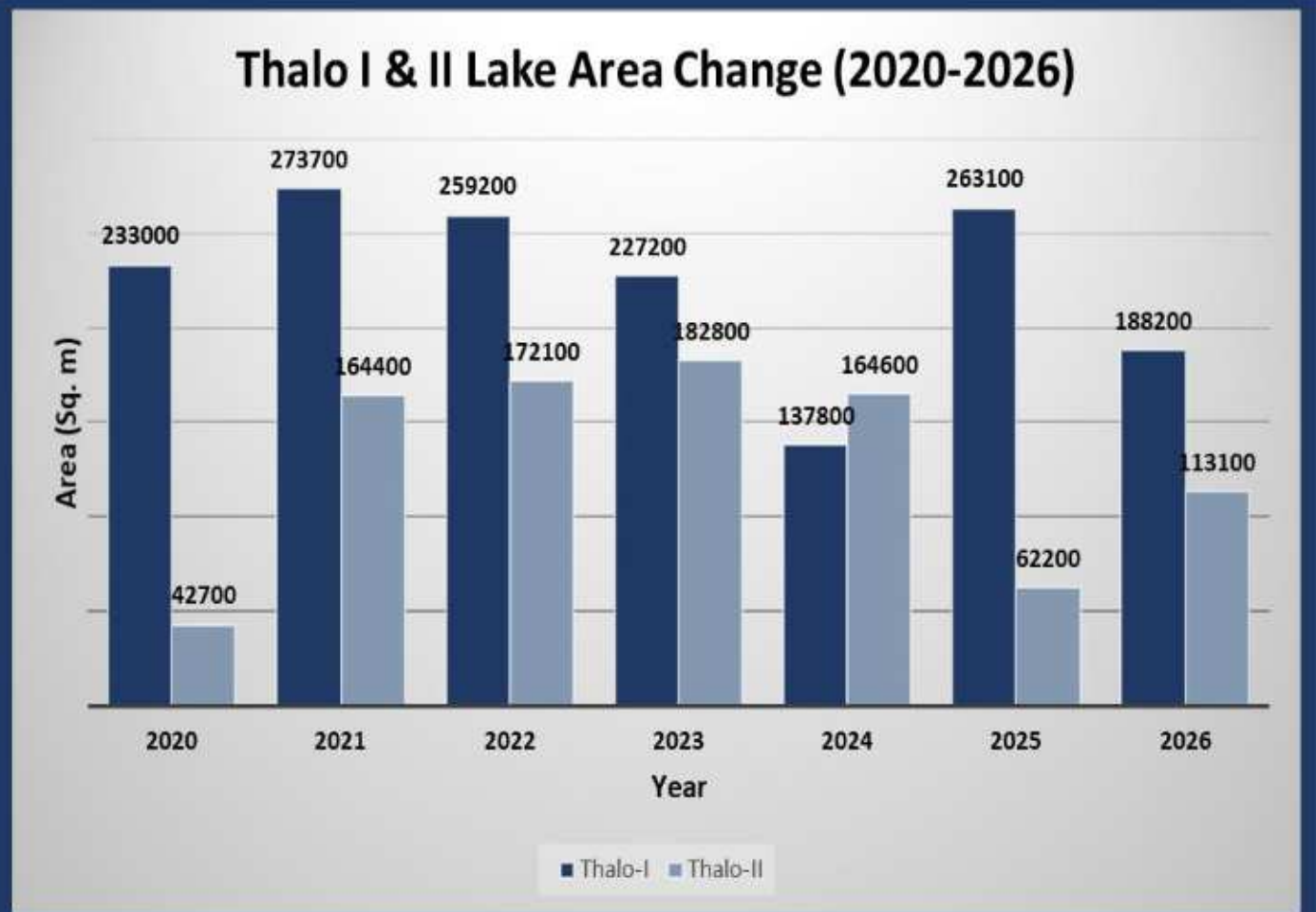
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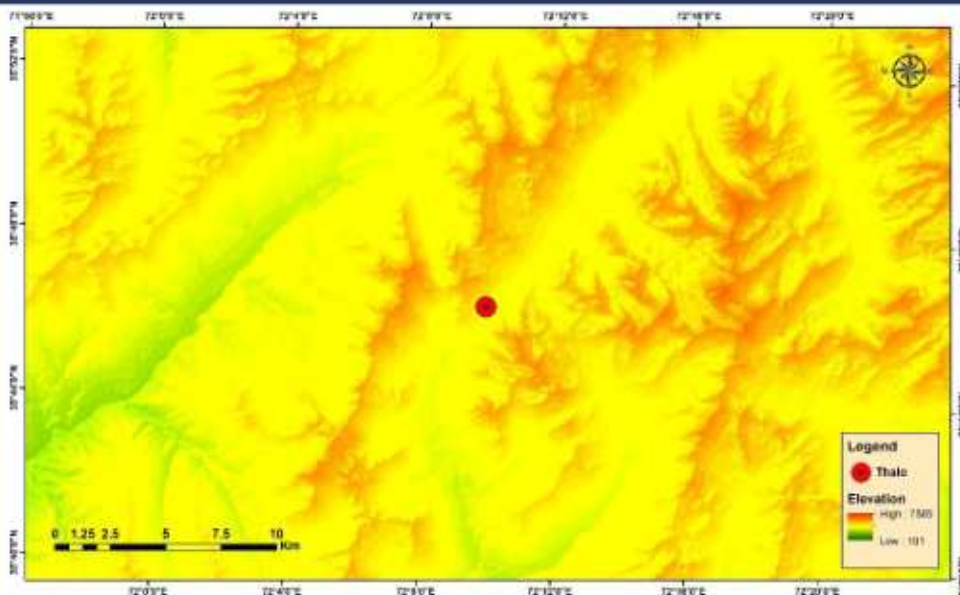
2026



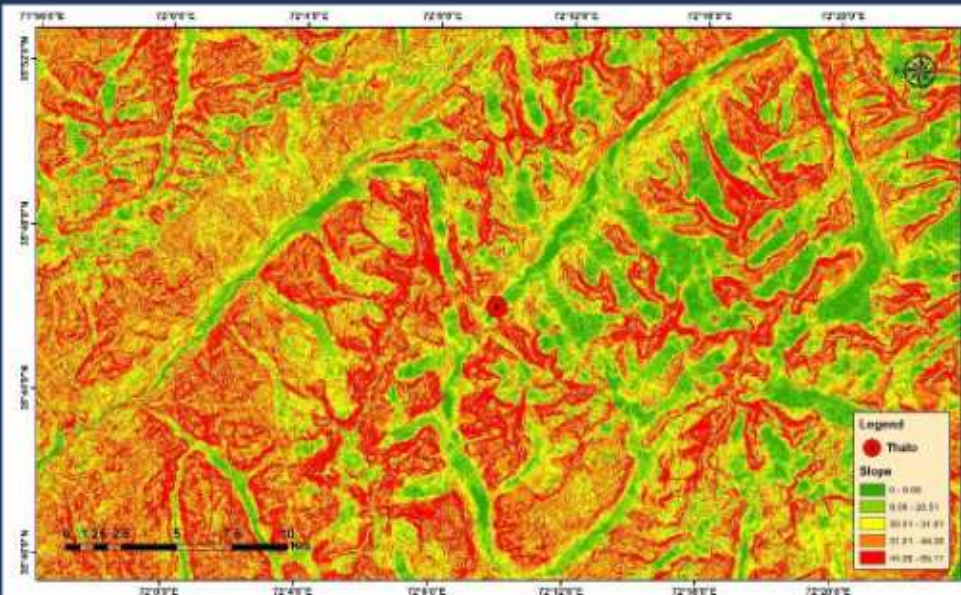
Geospatial Features



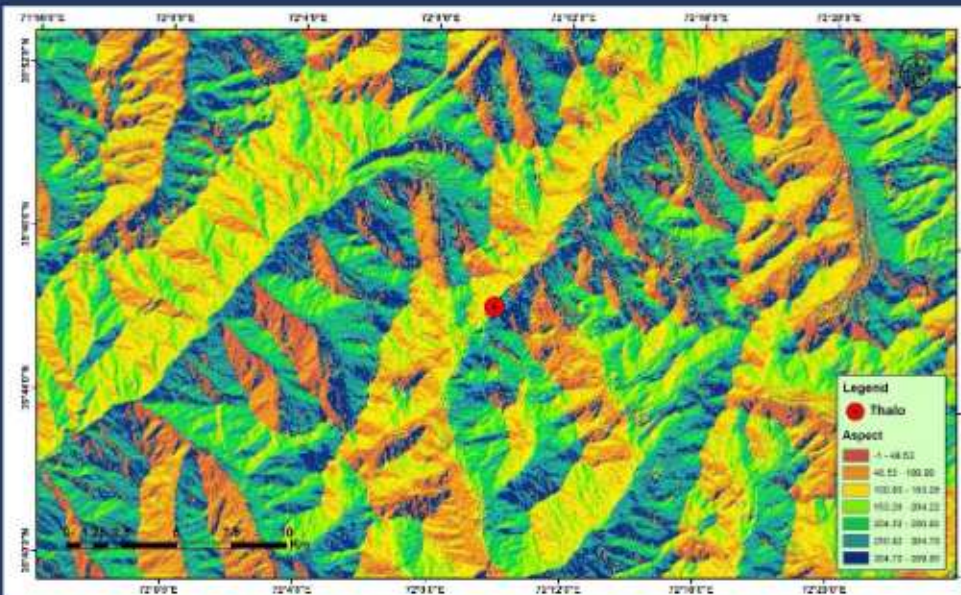
Elevation



Slope



Aspect



Ultr Glacier

Ultr Glacier is a prominent glacier of the Hunza Valley, Gilgit-Baltistan, located in the northwestern Karakoram within the Upper Indus Basin. It occupies the steep, high-altitude terrain above the Ultr–Bualtar catchment and Karimabad, with sharp ridges, exposed rock, debris-covered ice and active glacier-fed drainage. Its close proximity to settlements and cultivated areas makes it particularly important for water resources and hazard assessment.

The glacier is sustained mainly by winter snowfall and high-altitude snow accumulation, while summer temperatures drive seasonal snow and ice melt. Meltwater contributes to local streams and supports downstream water availability. The glacier's behaviour is influenced by the complex climatic and topographic conditions of the Karakoram, where individual glaciers can show contrasting patterns of advance, stability and retreat.

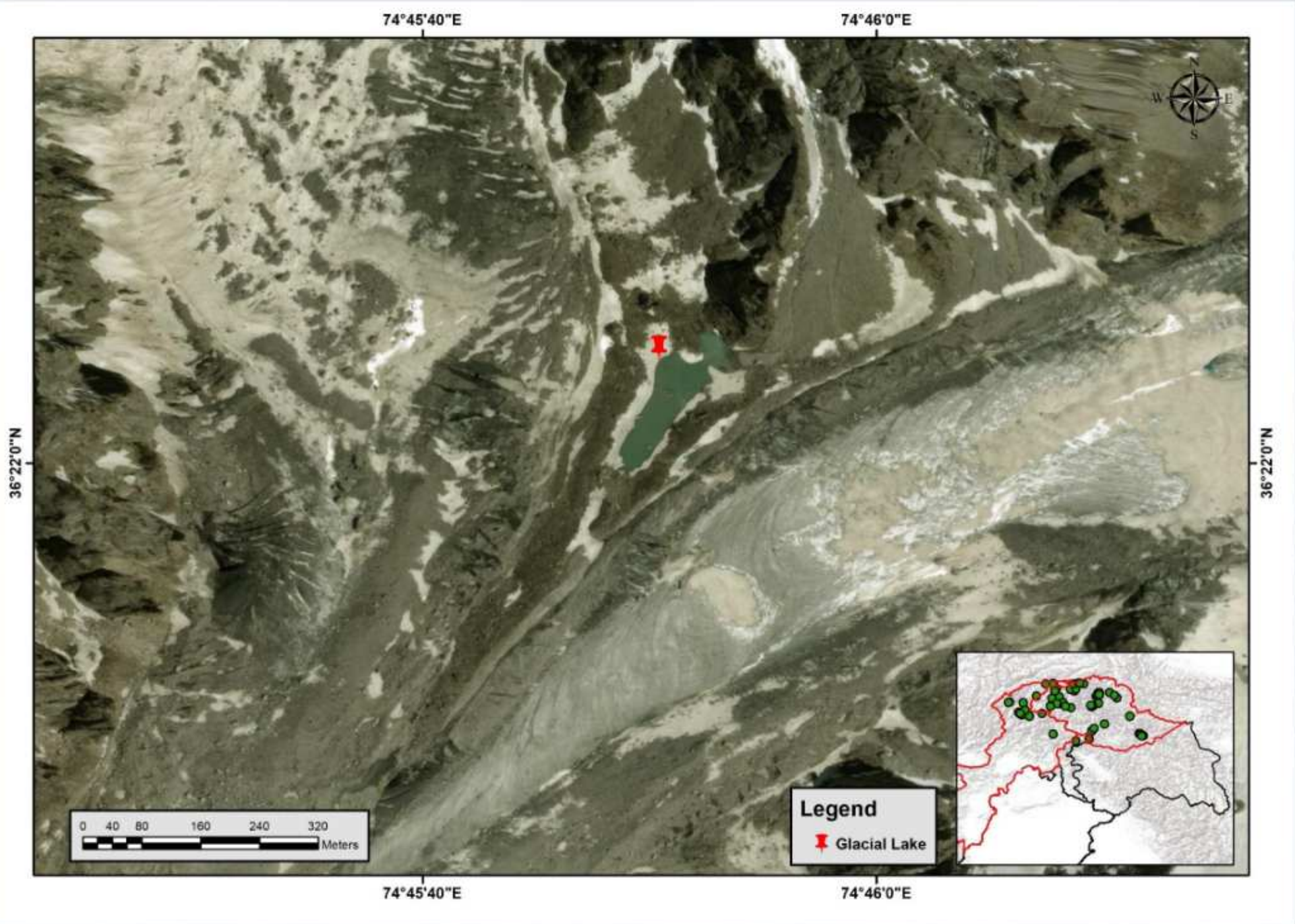
Ultr Glacier and its surrounding slopes are geomorphologically active, with icefall, rockfall, debris transport, moraine development and meltwater erosion. These processes can produce sudden increases in sediment and water discharge, particularly during periods of intense warming or rainfall.

The 2026 cryospheric context remains significant, with continued monitoring of glacier changes across the Hunza Basin showing substantial spatial variability in glacier behaviour. Ultr should therefore be assessed using its own multi-temporal satellite record rather than applying a uniform retreat trend to the entire basin.

Potential hazards include flash floods, debris flows, rockfalls, landslides and sudden increases in glacier-fed discharge. Given the glacier's proximity to populated and cultivated areas, changes in meltwater channels and surrounding slopes require particular attention.



Ultar Glacial Lake, Hunza, Gilgit Baltistan



Parameter	Description
Geographic Setting	Ultar Glacier, Hunza Valley, Gilgit-Baltistan, in the northwestern Karakoram and Upper Indus Basin, above the Ultar-Bualtar catchment and Karimabad.
Central Coordinates	36° 22' 0.28" N, 74° 45' 49.63" E
Topography	Glacial lake elevation: 4689 m.a.s.l
Hydrology	Snow- and glaciermelt-fed, with summer ablation providing seasonal runoff to the local drainage system and supporting downstream water use.
Climate	Cold, high-altitude Karakoram climate, with substantial winter snow accumulation and strong summer melt; glacier response is controlled by both temperature and precipitation.
Geomorphology	Active glacial environment characterized by icefalls, moraines, debris transport, rockfall and meltwater erosion.
Primary Hazards	Glacial Lake Outburst Floods (GLOFs), flash floods, debris flows, landslides, moraine dam failures, and channel aggradation.

Spatio-Temporal Analysis

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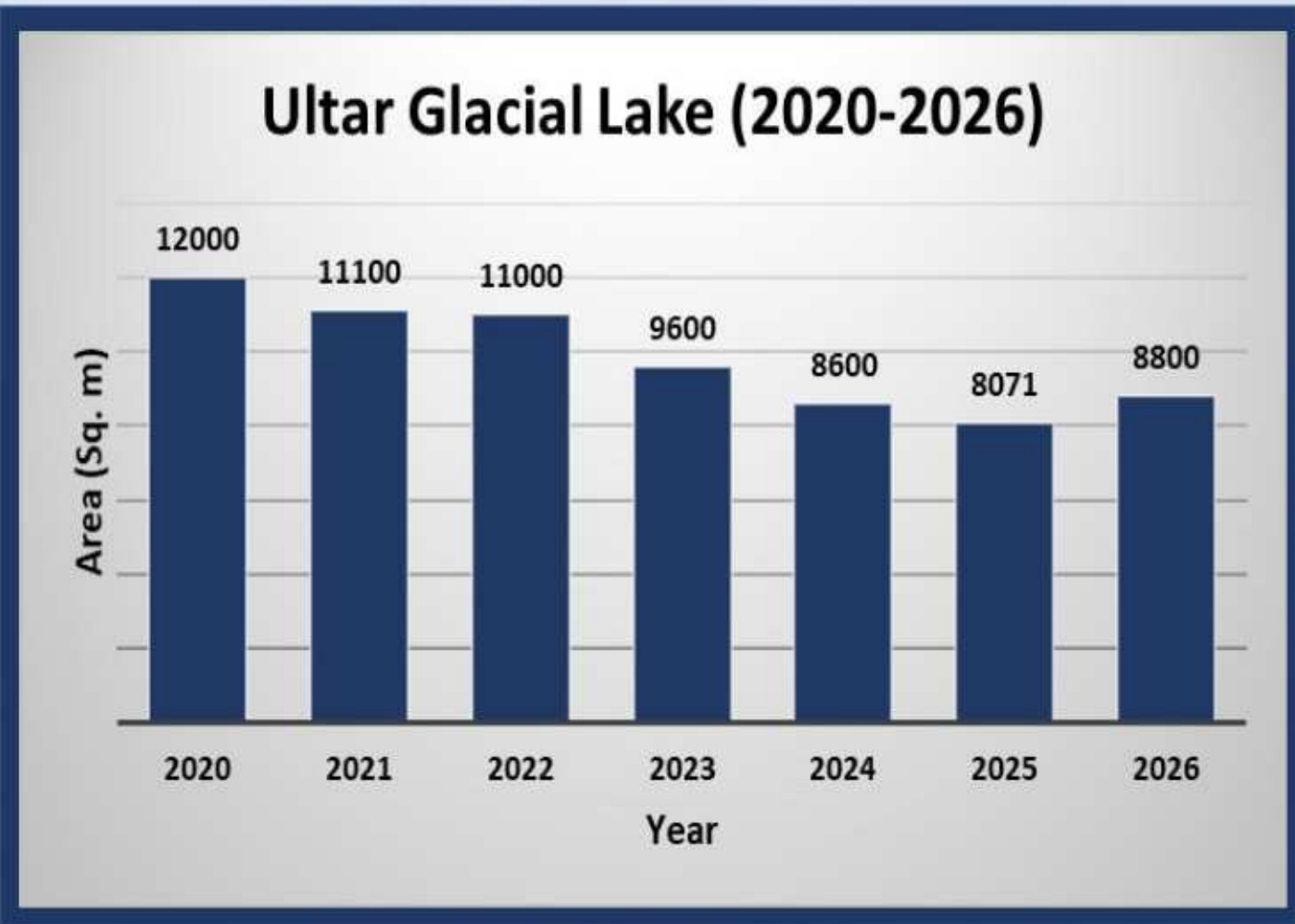
2025



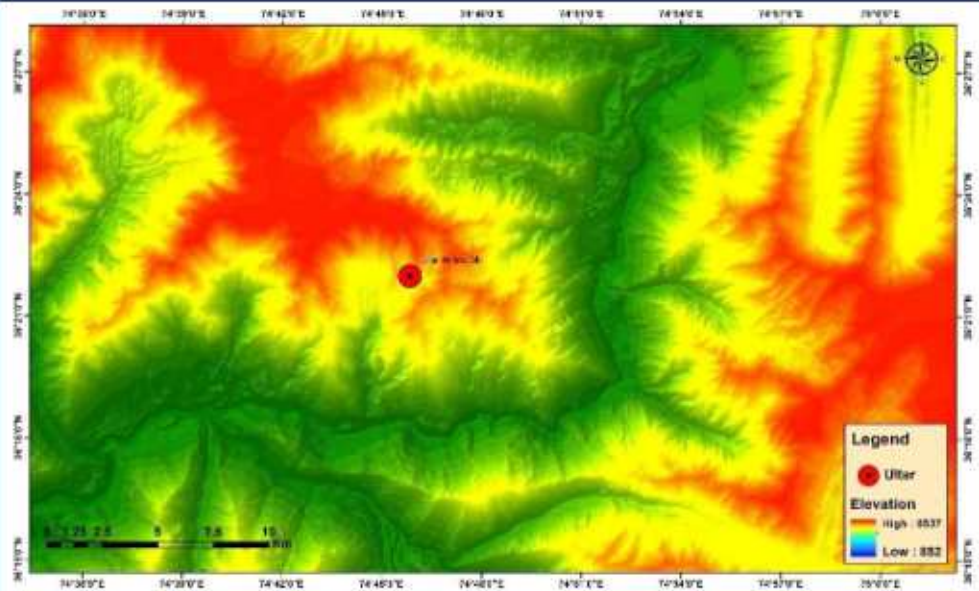
2026



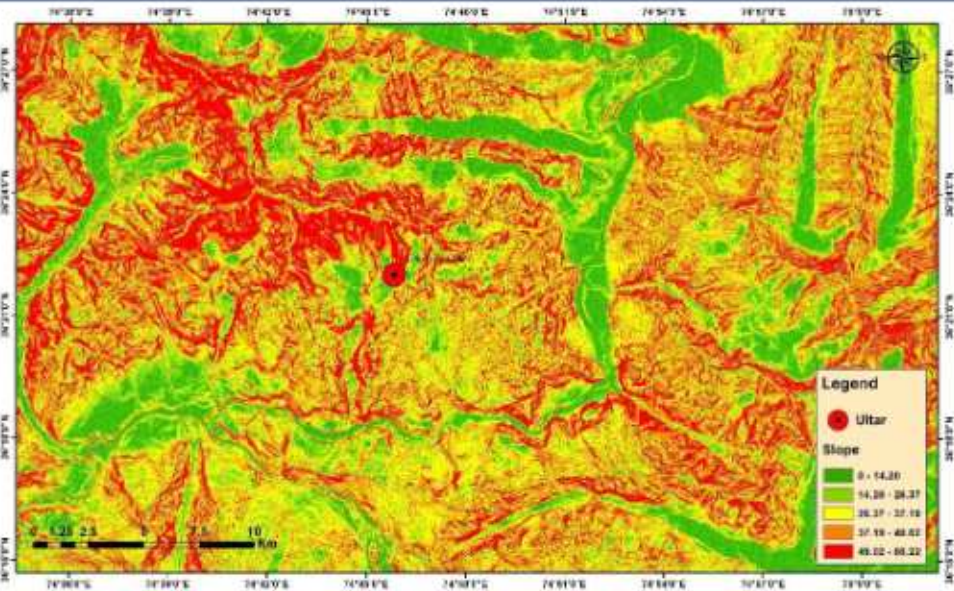
Geospatial Features



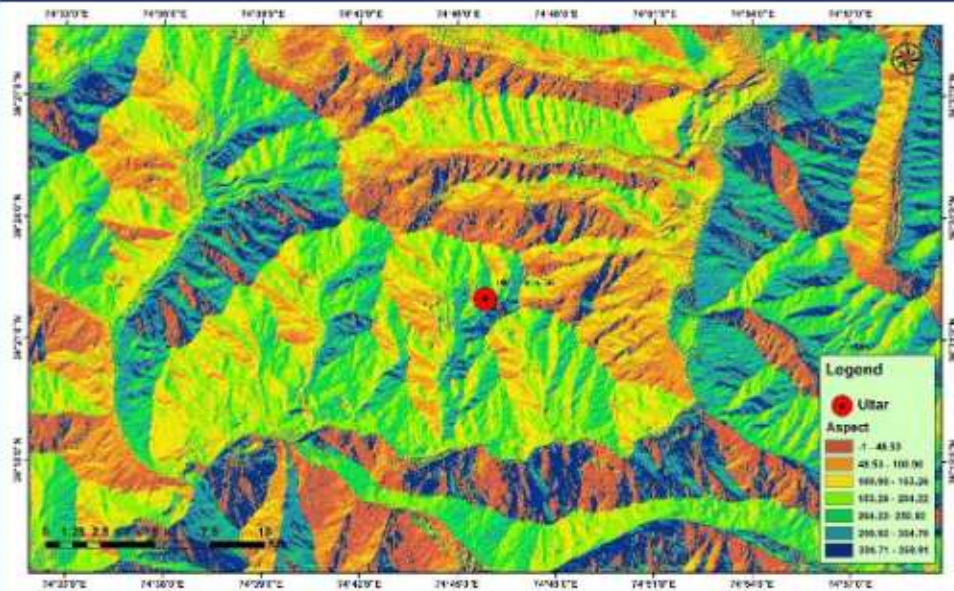
Elevation



Slope



Aspect



Mitigation Measures for GLOF Risk Management in Pakistan

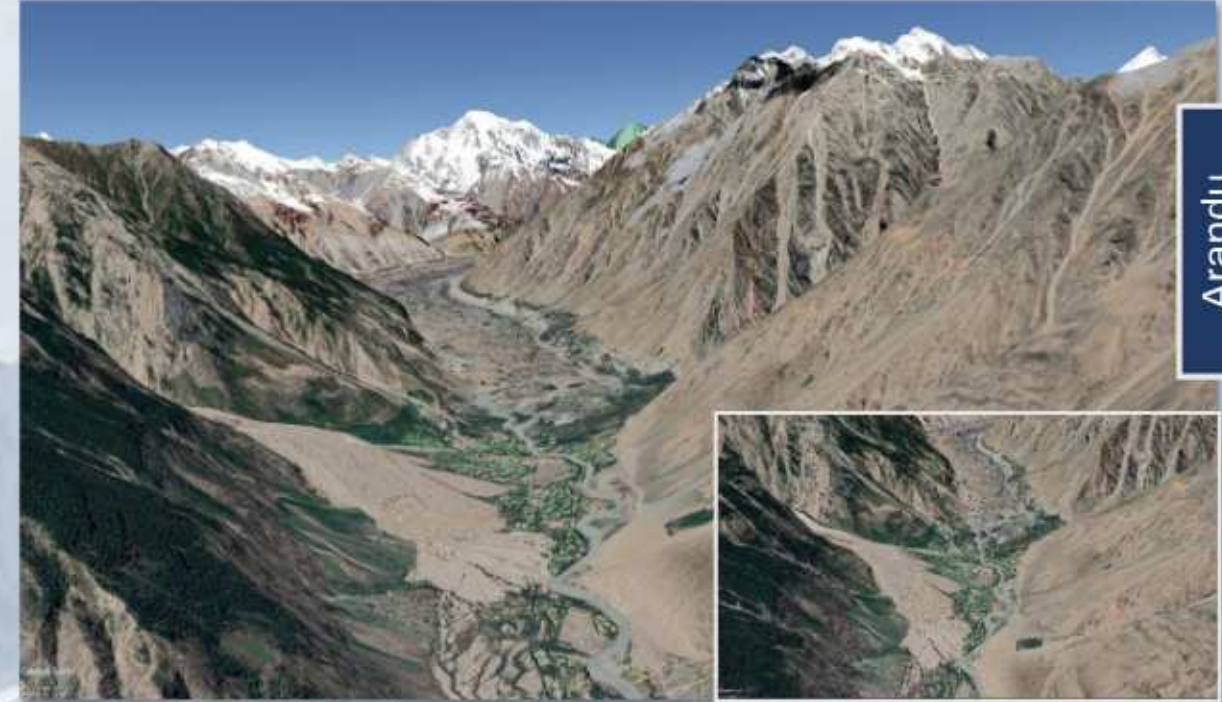
1 CONTROLLED LAKE LOWERING   POTENTIAL FOR PAKISTAN Highly effective for rapidly growing lakes. Reduces water pressure on moraine dams and lowers the chance of catastrophic outburst.  POTENTIAL SITES Shisper, Badswat, Gulkin, Hassanabad, Passu, Khurdopin, Karambar, Batura, Thally Bar  BENEFITS Immediate risk reduction, protects downstream communities, roads, hydropower and agriculture.	2 ARTIFICIAL DRAINAGE TUNNELS   POTENTIAL FOR PAKISTAN Suitable for very large and stable moraine dams threatening high-value assets. High cost and technical complexity.  POTENTIAL SITES Large lakes near CPEC route, major hydropower projects and major settlements (e.g., Batura, Thoftanda, North Khurdopin)  BENEFITS Permanent solution for long-term risk reduction in very high-risk lakes.	3 SPILLWAY EXCAVATION   POTENTIAL FOR PAKISTAN Very effective for regulating lake levels, especially during heavy rainfall or rapid snowmelt.  POTENTIAL SITES Hunza, Nagar, Ghizer, Upper Chitral, Swat, Astore, Diamer – where moraine dams can be safely excavated.  BENEFITS Long-term control of lake level, prevents overtopping and sudden breaching.	4 SIPHON SYSTEMS   POTENTIAL FOR PAKISTAN Rapidly deployable, low-cost method for temporary or seasonal lake level reduction.  POTENTIAL SITES Seasonally high-risk lakes monitored under NDMA GLOF programme (e.g., Gulkin, Daral, Barpu, Phundar, Punda, Kiwai)  BENEFITS Easy installation, flexible, useful in remote locations without heavy equipment.	5 MORaine DAM REINFORCEMENT   POTENTIAL FOR PAKISTAN Can improve stability of weak moraine dams using riprap, gabions, geotextiles and drainage improvements.  POTENTIAL SITES Lakes with weak/erodible moraine dams after detailed geotechnical investigations.  BENEFITS Increases dam stability, reduces seepage and chance of sudden breach.
6 CHECK DAMS DOWNSTREAM   POTENTIAL FOR PAKISTAN Highly suitable in steep tributaries to reduce flow velocity, trap sediments and protect communities, bridges and irrigation systems.  POTENTIAL AREAS Tributaries of Hunza, Gilgit, Shigar, Shyok, Swat, Chitral, Panjkora and Indus headwaters.  BENEFITS Reduces debris flow intensity, protects infrastructure and farmland.	7 RIVER TRAINING WORKS   POTENTIAL FOR PAKISTAN Essential for stabilizing riverbanks, guiding flow and preventing erosion in populated valleys.  POTENTIAL AREAS Hunza, Chitral, Swat, Astore, Diamer, Neelum, Kaghan and all major Indus/Jhelum tributaries.  BENEFITS Protects settlements, roads, bridges, agricultural land and hydropower assets.	8 DEBRIS BARRIERS   POTENTIAL FOR PAKISTAN Effective in narrow valleys where debris flows and rockfalls threaten roads and settlements.  POTENTIAL LOCATIONS Along Karakoram Highway, Babusar Road, Chitral valleys, Swat Valley, hydropower access roads and settlements.  BENEFITS Traps debris and boulders, reduces damage to infrastructure and saves lives.	9 SLOPE STABILIZATION   POTENTIAL FOR PAKISTAN Critical in Pakistan as many GLOF events are triggered/amplified by landslides and slope failures.  POTENTIAL AREAS Hunza, Nagar, Chitral, Kohistan, Diamer, Swat, Kaghan, Neelum and landslide-prone valleys.  BENEFITS Reduces landslide risk, protects communities, roads and monitoring infrastructure.	10 AVALANCHE PROTECTION STRUCTURES   POTENTIAL FOR PAKISTAN Useful in avalanche-prone high-altitude areas to protect infrastructure, monitoring stations and access roads.  POTENTIAL AREAS Upper Chitral, Broghil, Shimshal, Khunjerab Pass, Deosai, high Karakoram valleys.  BENEFITS Reduces avalanche impact on roads, bridges, settlements and monitoring systems.
KEY CONSIDERATIONS FOR PAKISTAN  Site-specific assessments are essential for each lake and valley.  Integrate engineering measures with early warning systems and monitoring networks.  Prioritize high-risk lakes threatening lives, infrastructure and economic assets.  Community involvement, maintenance and capacity building are critical. A COMBINATION OF ENGINEERING MEASURES, MONITORING AND COMMUNITY PREPAREDNESS WILL SIGNIFICANTLY REDUCE GLOF RISK IN PAKISTAN. 				

GLOF Monitoring Stations Selected Valleys

Arkari Gol



Arandu



Badswat

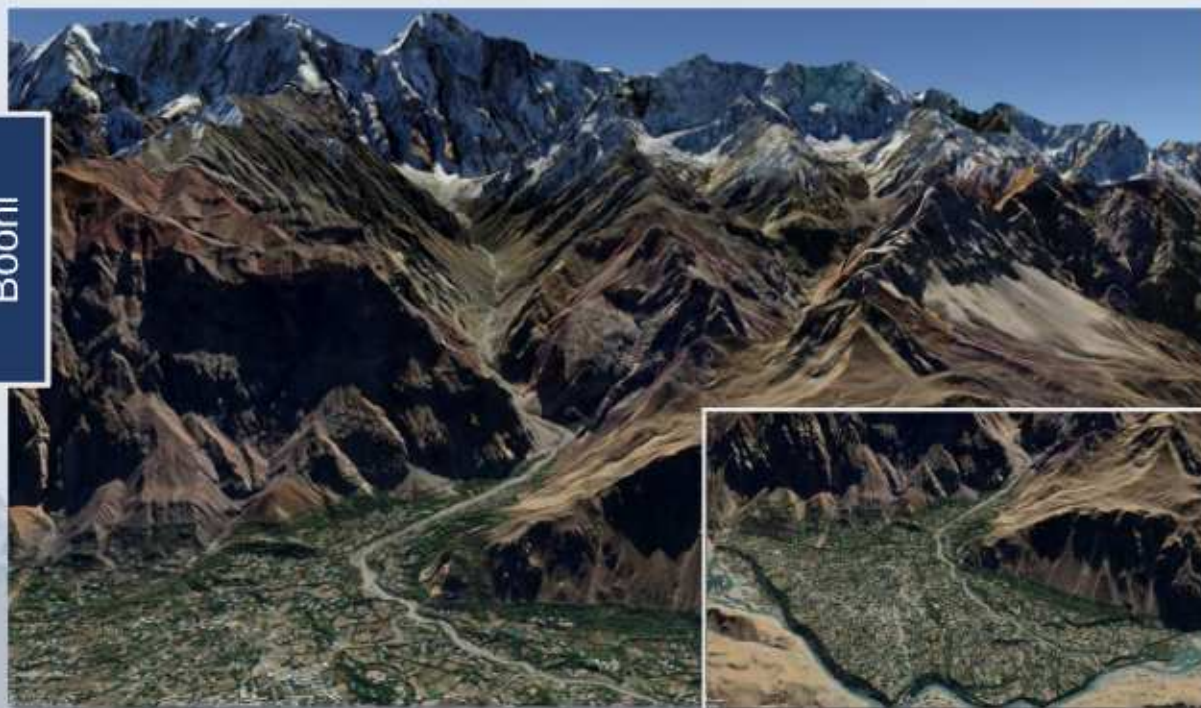


Barah



GLOF Monitoring Stations Selected Valleys

Booni



Darkut



Gabral



Ghandus



GLOF Monitoring Stations Selected Valleys

Ghulkin



Haramosh



Hisper



Hopper



GLOF Monitoring Stations Selected Valleys



GLOF Monitoring Stations Selected Valleys

Matiltan



Paliyat



Reshun



Rupal



GLOF Monitoring Stations Selected Valleys

SHIGAR



Shimshal



Shishper



Sosat





Technical Early Warning
National Emergencies Operation Center (NEOC)
National Disaster Management Authority (NDMA), Pakistan