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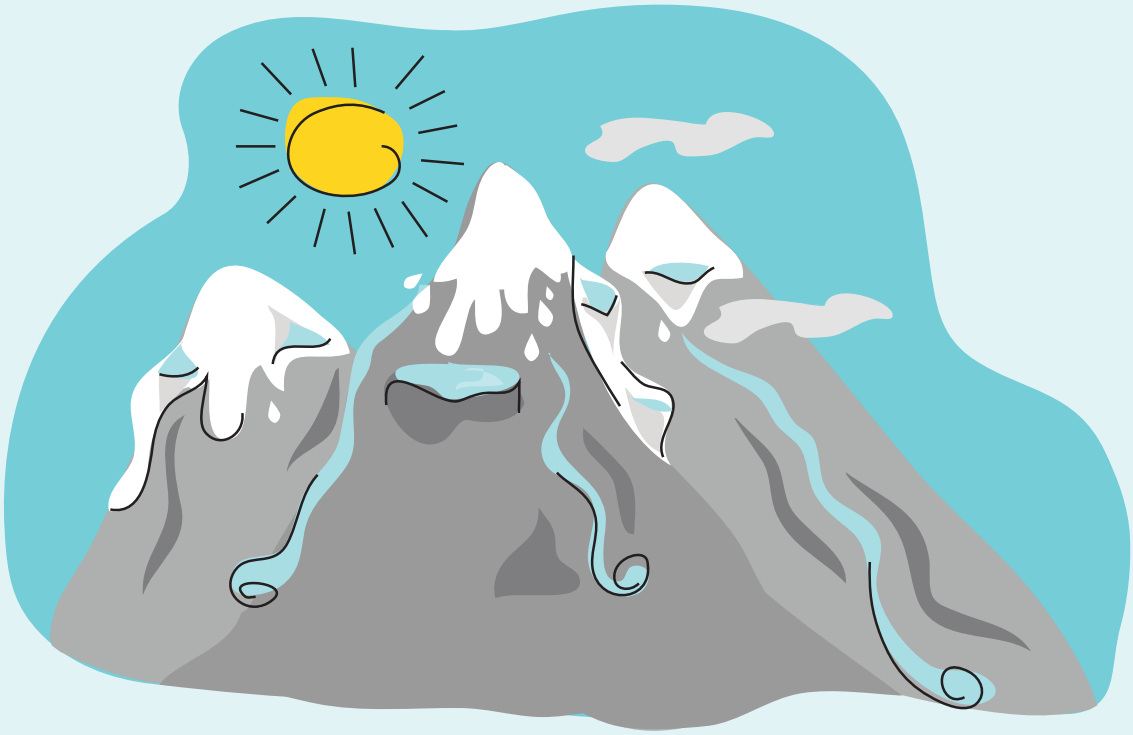
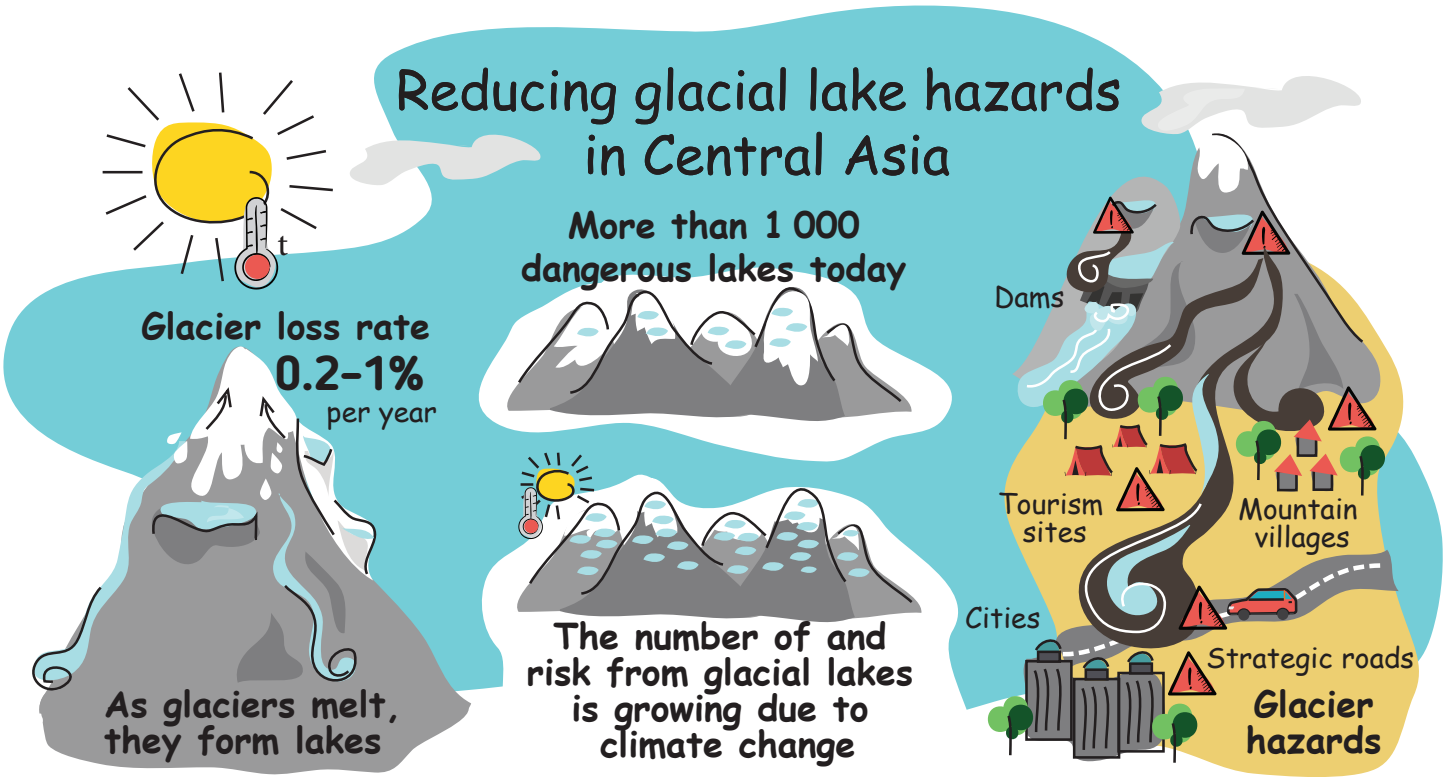
GLOFCA
GLACIER LAKE OUTBURST FLOODS IN CENTRAL ASIA



Reducing the vulnerability of the Central Asia populations from glacial lake outburst floods in a changing climate



Five glacial lakes at 3,300–3,400 meters above sea level in the upper Aksu River basin, Dzungarian Alatau, Kazakhstan. 2023. Photo: Bauyrzhan Abishev.

Why this project?

Central Asia's mountain regions are prone to natural disasters and are vulnerable to the impact of climate change. In these remote and often impoverished areas, women, children, and the elderly are hit particularly hard by the impacts of disasters and climate change as local response capacities are limited and men leave for work in cities and foreign countries. Large cities, such as Bishkek and Almaty, are not spared from the risk of glacial hazards. The protective Medeu dam built in the 1970s upstream of Almaty helped reduce the risk of massive glacial lake outburst floods (GLOFs). It remains a unique and expensive structure, and other sites at risk remain unprotected. Tourism and strategic infrastructure such as hydropower, mining sites, and roads can be damaged by such floods.

Most glaciers are found in very remote, desolate places, but the hazards that originate there can have a far-reaching impact. While avalanches of either snow or rock are typically very localized events, flash floods from the glacial lakes that form atop or near the glaciers can be both sudden and devastating for cities and villages below.

From the 1970s, accelerated glacier loss, at a rate 0.2–1% per year, resulted in a substantial reduction of the glacial cover and formation of glacial lakes. Global warming of 1.5–2°C may further decrease the glacial cover in Central Asia by an additional 30 to 60 per cent, but the danger of glacial lake outburst floods is not going away. On the contrary, the currently known 1,000 dangerous glacial lakes, including more than 100 in Kazakhstan, 350 in the Kyrgyz Republic, 330 in Tajikistan, and 270 potentially affecting Uzbekistan from within and beyond its borders, are likely to increase in number and their geographic spread in the future. Thousands of unknown glacial lakes may exist undetected, appear and disappear irregularly. Some potentially dangerous lakes are located outside of the national borders and necessitate cross-border cooperation on early warning, risk assessment, and partnerships between academia, hydrometeorological and disaster response agencies, and local communities in addressing risks.

Glacial lakes and GLOF risk areas

- Priority sites
- Glacial lakes and GLOF risk areas

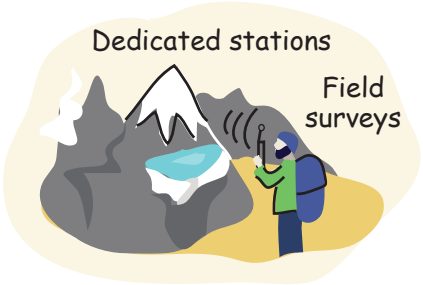
Project area

The project area covers vulnerable communities located across several mountain ranges in Central Asia. In Uzbekistan's Pskem River basin, the lakes Shavurkul and Ikhnach pose a potential risk to the downstream communities of Pskem and Tepar, both of which are covered by the project. In Kazakhstan, the towns of Esik and Talgar have previously been affected by devastating GLOFs. The project aims to reduce risks from potential future events. In the Kyrgyz Republic, the project focuses on two high-risk areas: the Ala-Archa River valley, one of the most mudflow-prone regions in the northern Tien Shan, and the Ton-Tosor River valley, home to up to 21 potentially hazardous lakes. Nearly 115,000 people in these regions are at risk from GLOFs. In Tajikistan, the project targets Saidoi Nasafi (Baralmos) Glacier in the Lakhsh district, where at least five glacial lake outburst events were recorded in 2023 alone, causing flooding and damaging the international motorway along the Surhob River. The project will implement targeted interventions at four pilot sites across seven high-risk locations, selected in consultation with governments and vulnerable communities. The total geographic area covered by the project is almost 350,000 km^2, twice the size of Tajikistan.

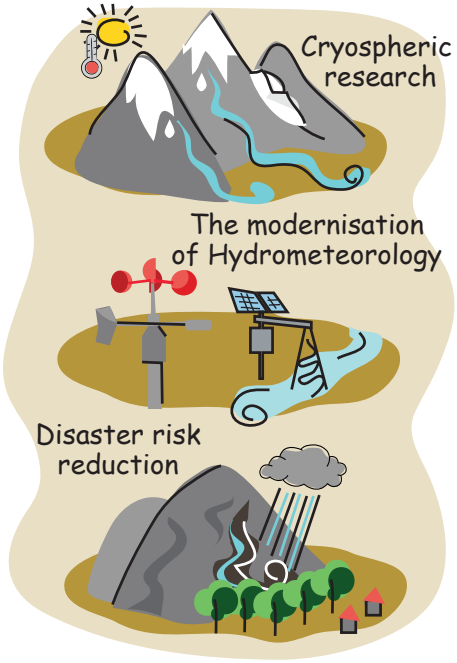
Key stakeholders and actions on risk reduction

National hydrometeorological services: monitoring

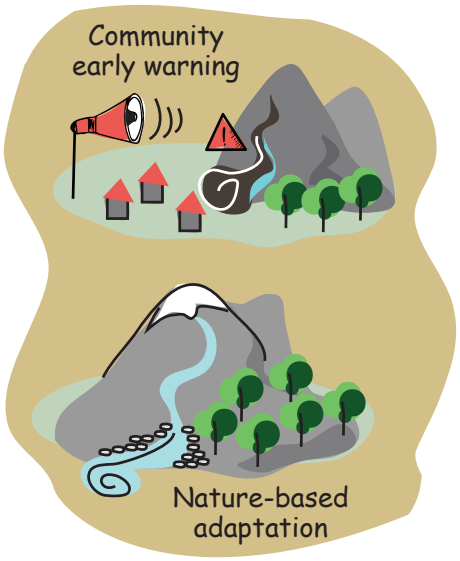
National science and research institutions



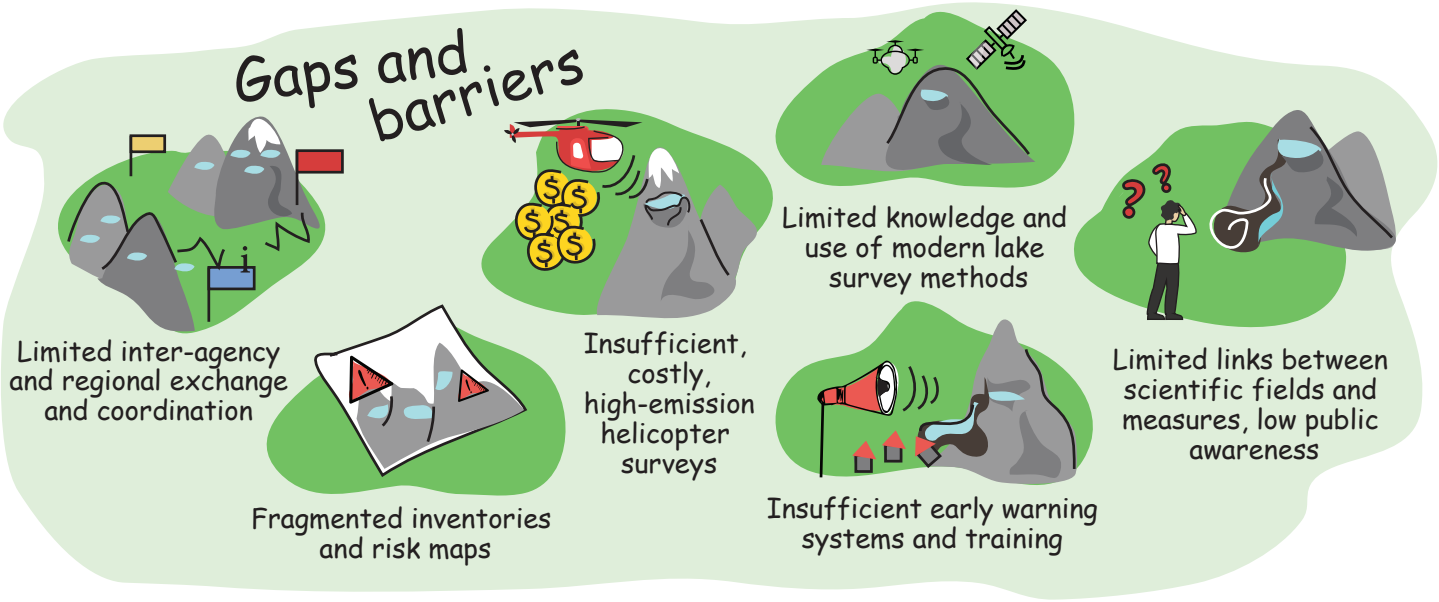
International projects
Local projects



Local projects



Gaps and barriers



Who is involved and what are the existing gaps?

National governments and international partners recognize the dangers from glacial lakes and support the monitoring and response measures. Projects on the modernization of hydrometeorological networks and disaster response capacities, as well as actions by humanitarian agencies and research organizations, contribute to risk reduction. However, disaster response mechanisms and policies are focused on response rather than prevention, communication, or early warning. Many communities remain under-equipped, untrained, and uninformed about nearby glacial hazards.

The UNESCO Regional Office in Almaty has long supported building the knowledge and capacities in Central Asian countries in water and glacier research and disaster risk reduction. Through training programs and summer schools, more than 260 young scientists were trained on glacier mass balance, mapping GLOFs, and related topics. UNESCO also helped establish the Central Asian Regional Glaciologiocal Centre in Almaty, a key platform for scientific cooperation in the region.

Nevertheless, there is still a lot of work to be done to consolidate the existing knowledge on glaciers, glacial lakes, and GLOF risks. Regional cooperation in the assessment and monitoring of transboundary GLOFs is limited. Interagency links and the capacities of the responsible organizations are weak, and the methods used for GLOF detection and monitoring are costly, inefficient, and high-GHG-emitting, such as helicopter surveys. Disaster-response authorities lack expertise to conduct a risk analysis of the communities affected by GLOFs or issue early warnings. And within the research community, there is very little cooperation. Local organizations have limited capacities to design and produce awareness-raising materials, including education materials for children and students or easy-to-understand maps and infographics for the affected communities.

About 250 representatives of local authorities, NGOs, and residents of twenty at-risk communities participated in the project's formulation and the respective consultations. The project's concept was designed and discussed at several national and regional meetings between 2015 and 2019 and then submitted for consideration and approval by the Adaptation Fund. The project is implemented by the UNESCO Regional Office in Almaty in close collaboration with the governmental agencies of Kazakhstan, the Kyrgyz Republic, Tajikistan, and Uzbekistan in partnership with the University of Zurich (Switzerland), and the participation of regional institutions. As the UN agency specializing in science, UNESCO is mandated to promote the use of natural and social sciences, education, and technology for disaster risk reduction. UNESCO is coordinating projects on monitoring glaciers, snow, and permafrost and assessing the impact of climate change on water resources.

1. Strengthening the national and regional capacity to monitor and assess glacial hazards

Hazard and risk assessment

Strategies and approaches to mapping and monitoring

Glacial lake inventory

Organizational capacity for mapping and monitoring

2. Vulnerability assessment, exposure and risk maps

Vulnerability assessment and risk exposure maps

Local risk reduction plans

Consideration of hazard maps in development plans

3. Design and launch of Early Warning Systems (EWS) and risk reduction measures

Evaluation of institutional responsibilities on early warning and disaster risk reduction

Design and implementation plans for site-specific early warning systems

4. Demonstration projects to introduce technologies and best practices on glacier lake early warning systems

Early warning systems in vulnerable communities installation and testing

Structural and nature-based adaptation measures

Training and simulation exercises for the population

Maintenance and financing strategy

5. Knowledge exchange, stakeholder engagement and communication

A user-friendly web site with risk maps, materials, reports

Education and training programmes

Dissemination of knowledge in Central Asia and beyond

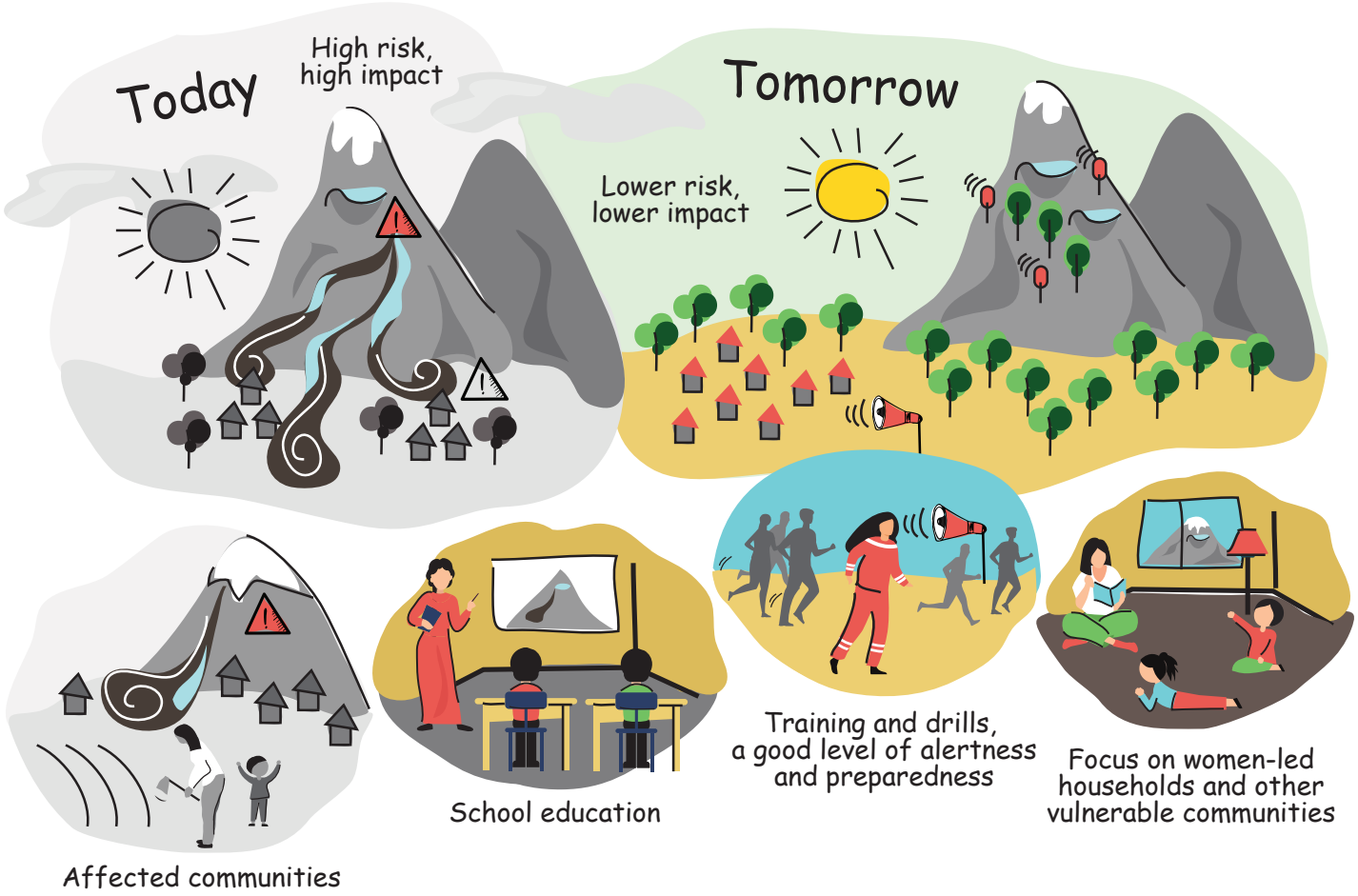
Project objective and components

The objective of the project is to strengthen adaptation to climate change by reducing the risks and vulnerabilities associated with glacial lake outburst floods in Central Asia's mountain regions. The project is funded by the Adaptation Fund ($6.5 million), covers four countries, and has a duration of five years. The project is funded by the Adaptation Fund ($6.5 million), covers four countries, and is planned for a duration of five years (2021–2026).

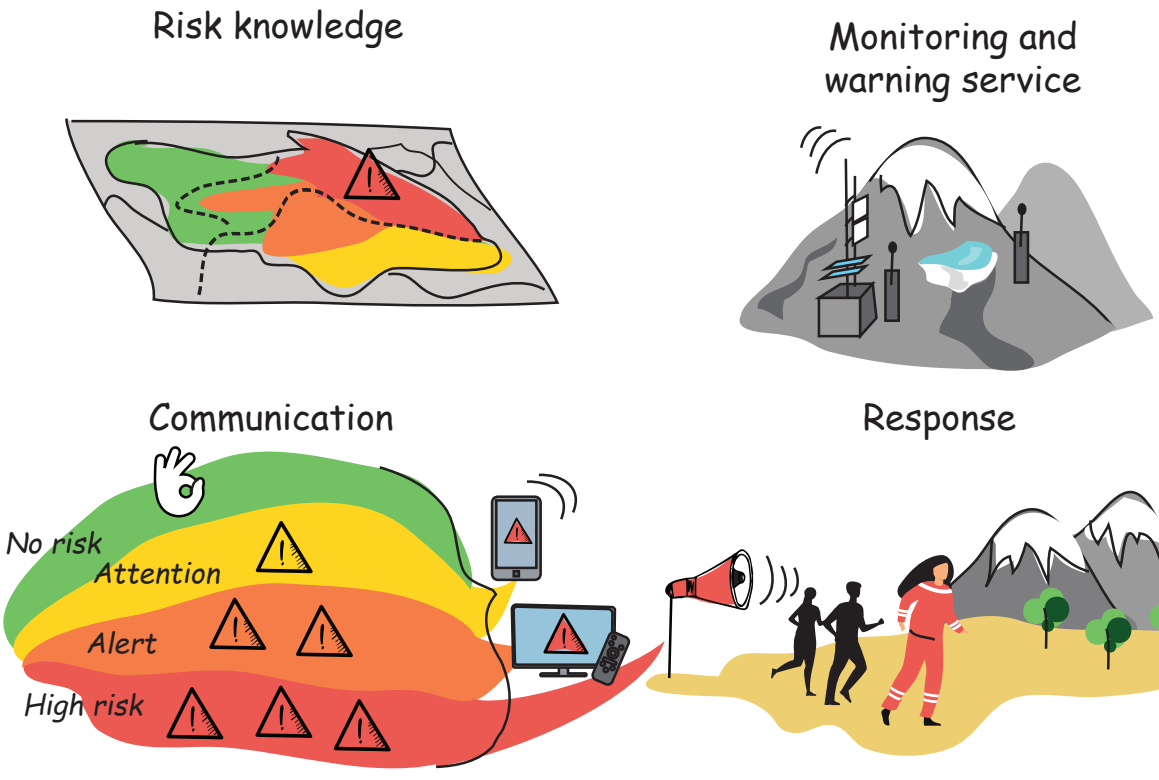
The project consists of five components. Component #1 strengthens national and regional capacities to monitor and assess GLOF hazards and supports decision-making with modern information, including a glacial lake inventory. At the same time, the organizational capacity for GLOF mapping and monitoring is enhanced. Component #2 supports national and regional policies and approaches toward the assessment of vulnerability to GLOF risks, adaptation measures, and plans for selected communities. Component #3 focuses on the design and implementation of monitoring and early warning systems in each country, along with complimentary risk reduction measures at the local level. Component #4 involves the demonstration of low-cost adaptation measures for the benefit of vulnerable communities and provides training and simulation exercises for local authorities and the general population. Component #5 supports knowledge exchange, stakeholder engagement, communication and education. A web-based knowledge management platform (www.glofca.org) has been established to provide access to key resources, including maps, infographics, outreach and training documentation, and other materials on GLOF risks and adaptation strategies.

Throughout the project cycle, regional workshops bring together stakeholders to exchange knowledge and experience between countries. A regional-scale hazard assessment serves to identify risks across all lakes and affected communities, supporting broader benefits from the project. The project also carries out community assessments, working with local authorities and community members, ensuring the meaningful participation of women. As a result of these assessments, GLOF risk areas are identified for each country, and risk reduction plans are designed in a participatory manner and mainstreamed into local development plans. Site-specific measures on risk reduction may include artificial lake lowering, armouring arms or channels, early warning stations and sirens, tree plantations to stabilize slopes and reduce erosion, deflection structures, evacuation and response drills, and the identification of evacuation routes and safe zones.

Focus on vulnerable communities. Connecting science and monitoring to villages.



Elements of the Early Warning Systems (EWS) for the Glacier Lake Outburst Floods (GLOFs)



The project brings together the science of glacial changes and GLOF risks, the design of locally tailored adaptation measures and the implementation of early warning systems for vulnerable communities. The early warning system utilizes ground-based sensors, satellite observations, and robust communication technology for the timely and reliable transfer of warnings to the authorities and local population. In addition to modern technology, it is important that local schools and community centres are actively engaged through learning exercises. The project promotes synergies with the ongoing modernization of hydrometeorological services and cryospheric monitoring. It aims to integrate GLOF risk considerations into land use planning, agriculture, and disaster management.

The project relies on national institutions, NGOs, and humanitarian agencies working locally. Experience in early warning and risk reduction from the Andes, Himalayas and the Alpes informs approaches in Central Asia through collaborations with the University of Zurich and the World Glacier Monitoring Service. Investments in the next generation of local scientists and practitioners and the involvement of school children in educational programmes support the project's sustainability. The project builds on existing institutions and maintains close collaboration with governments and the responsible authorities at all stages of implementation. The technical components of the early warning system will be tailored to local capacities, and ownership of the equipment will be transferred to the responsible national agencies.

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ADAPTATION FUND

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