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

Reducing glacial lake hazards in Central Asia
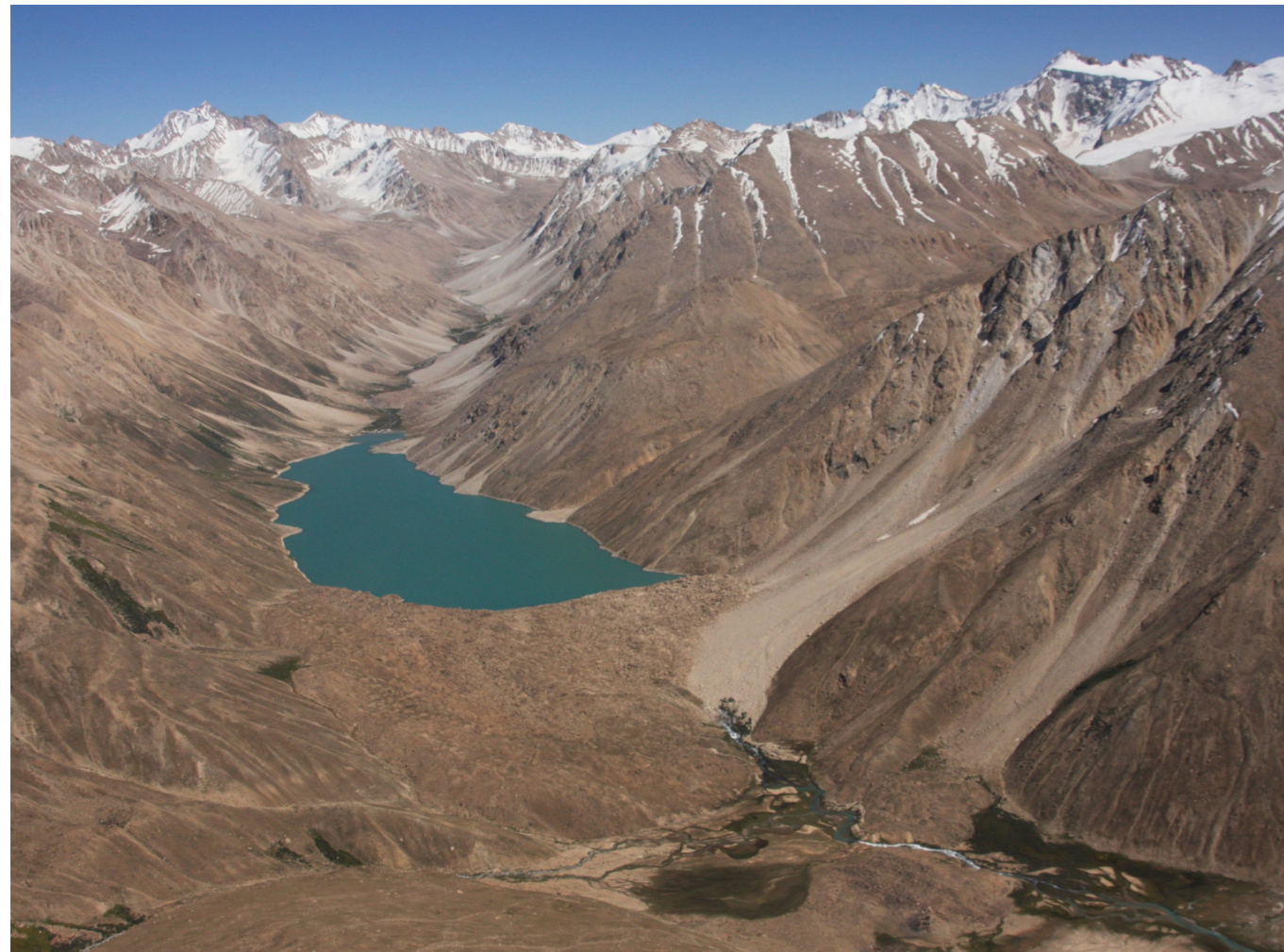
Glacier loss rate **0.2–1%** per year

As glaciers melt, they form lakes

More than 1 000 dangerous lakes today

The number of and risk from glacial lakes is growing due to climate change

Dams

Tourism sites

Cities

Mountain villages

Strategic roads

Glacier hazards

Potentially dangerous high-mountain lake in the Pamirs, Tajikistan. Photo: Martin Mergili.

Why this project?
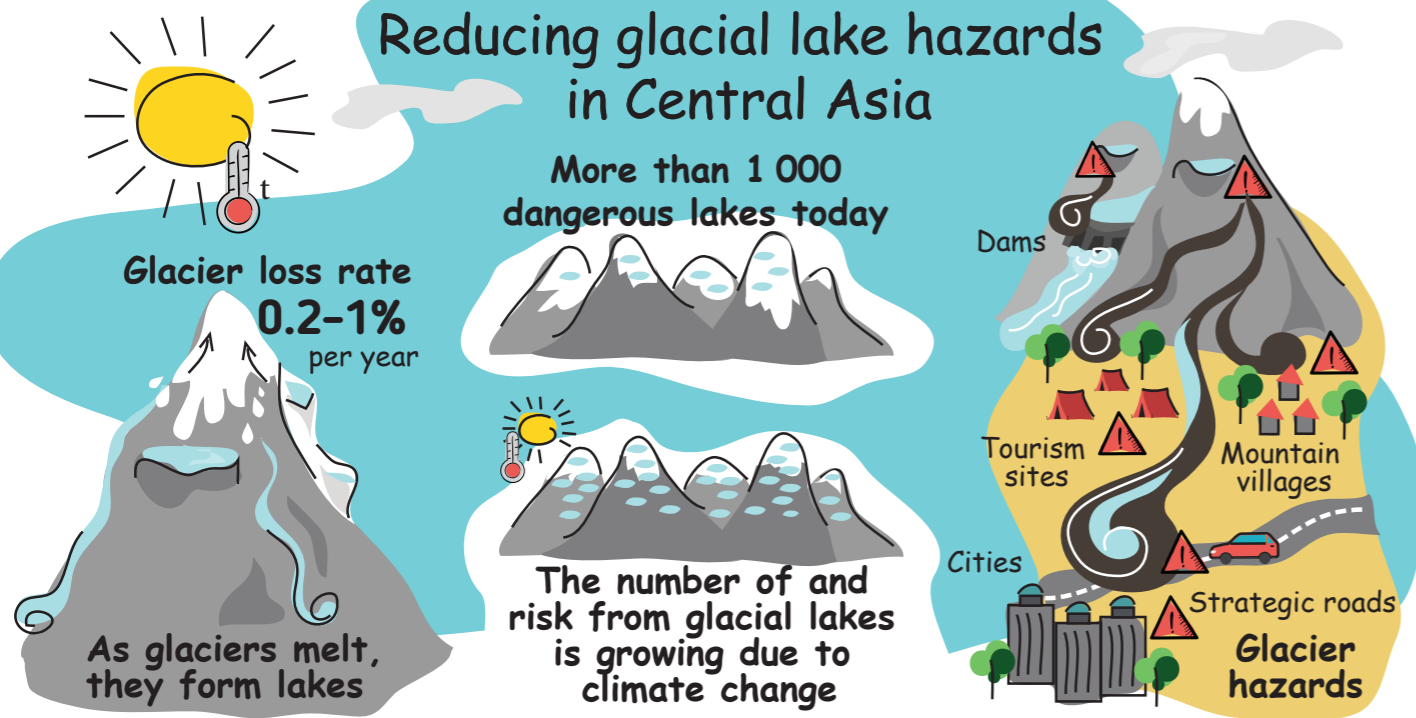
Central Asia's mountain regions are prone to natural disasters and are vulnerable to the impact of climate change. In these remote and often impoverished areas, women, children and the elderly are hit particularly hard by the impacts of disasters and climate change as local response capacities are limited 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 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, flashfloods 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 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 Kyrgyzstan, 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

Kazakhstan

Talgar ■ Esik
Almaty □ ■ Talgar Peak
▲ 4979

Bishkek □

Shymkent □

▪ 7439
Jengish Chokusu

Aksu ▪

Pskem ■
Tepar ■

□ Tashkent

Namangan

Kyrgyzstan

Uzbekistan

Samarkand □

7134
⚑ Lenin Peak

China

7495 ▲
Ismoil Somoni Peak

Dushanbe Tajikistan

■ Varshez

Muztag
▲ 7282

Afghanistan

Pakistan

8611 ▲
K2

Project area

The project area covers vulnerable communities located across several mountain ranges in Central Asia. In Tajikistan, the project focuses on 8 villages in the Shugnon district, in the middle of Pamir Mountains. Two glacial lakes upstream of the villages pose a significant risk of total destruction to 670 households. In Uzbekistan's Pskem River basin, two lakes — Shavurkul and Ikhnach — pose a potential risk to the downstream communities of Pskem and Tepar, which will be covered by the project. In Kazakhstan, the towns of Esik and Talgar were affected by the devastating glacial lake outburst floods in the past and the project will seek to reduce risks from the likely future floods. The project's sites in Kyrgyzstan are being re-defined. Provisionally, these include populated areas prone to the glacial lake floods of the Ala-Too Range. Nearly 90 thousand people live in the affected communities, half of whom are women. The specific project interventions at four pilot sites will cover 7–9 locations selected through consultations with the governments and vulnerable communities, where GLOFs pose a high risk. The total geographic area covered by the project is almost 350 000 km², twice the size of Tajikistan.

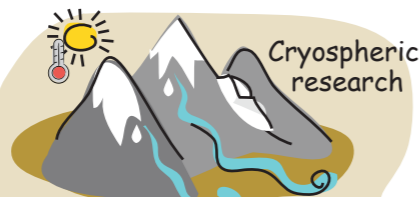# Key stakeholders and actions on risk reduction

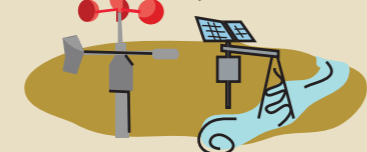**National hydrometeorological services: monitoring**

Field surveys

National science and research institutions

Dedicated stations
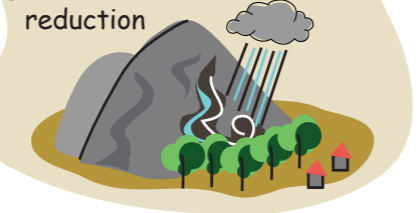
Field surveys
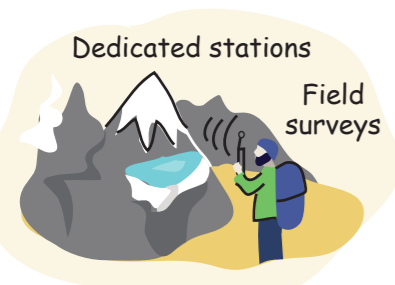
International projects
Local projects

Cryospheric research

The modernisation of Hydrometeorology
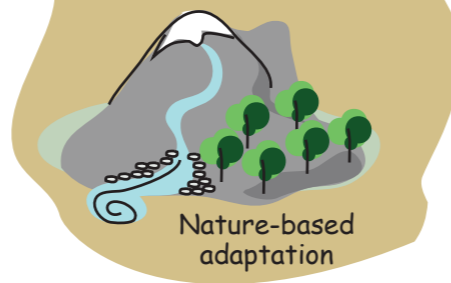
Disaster risk reduction

Local projects
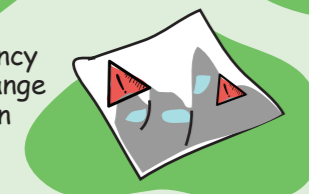
Community early warning

Nature-based adaptation

Gaps and barriers

Limited inter-agency and regional exchange and coordination

Fragmented inventories and risk maps

Insufficient, costly, high-emission helicopter surveys

Limited knowledge and use of modern lake survey methods

Insufficient early warning systems and training

Limited links between scientific fields and measures, low public awareness

Who is involved and what are the existing gaps?

National governments and international partners recognise the dangers from glacial lakes and support the monitoring and response measures. Projects on the modernisation of hydrometeorological networks and disaster response capacities, as well as actions by humanitarian agencies and research organisations 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 Almaty office has helped to build knowledge and capacities in Central Asian countries in water and glacier research and in disaster risk reduction through training 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 Asia Regional Glaciological Centre based in Almaty.

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 non-existent. Interagency links and the capacities of the responsible organisations 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 organisations 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 of the Adaptation Fund. The project is implemented by the UNESCO Office in Almaty in close collaboration with the governmental agencies of Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan in partnership with the University of Zurich (Switzerland), and the participation of regional institutions. As the UN agency specialising 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

Atlas of glacial lakes

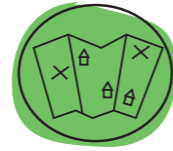Organizational capacity for mapping and monitoring

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
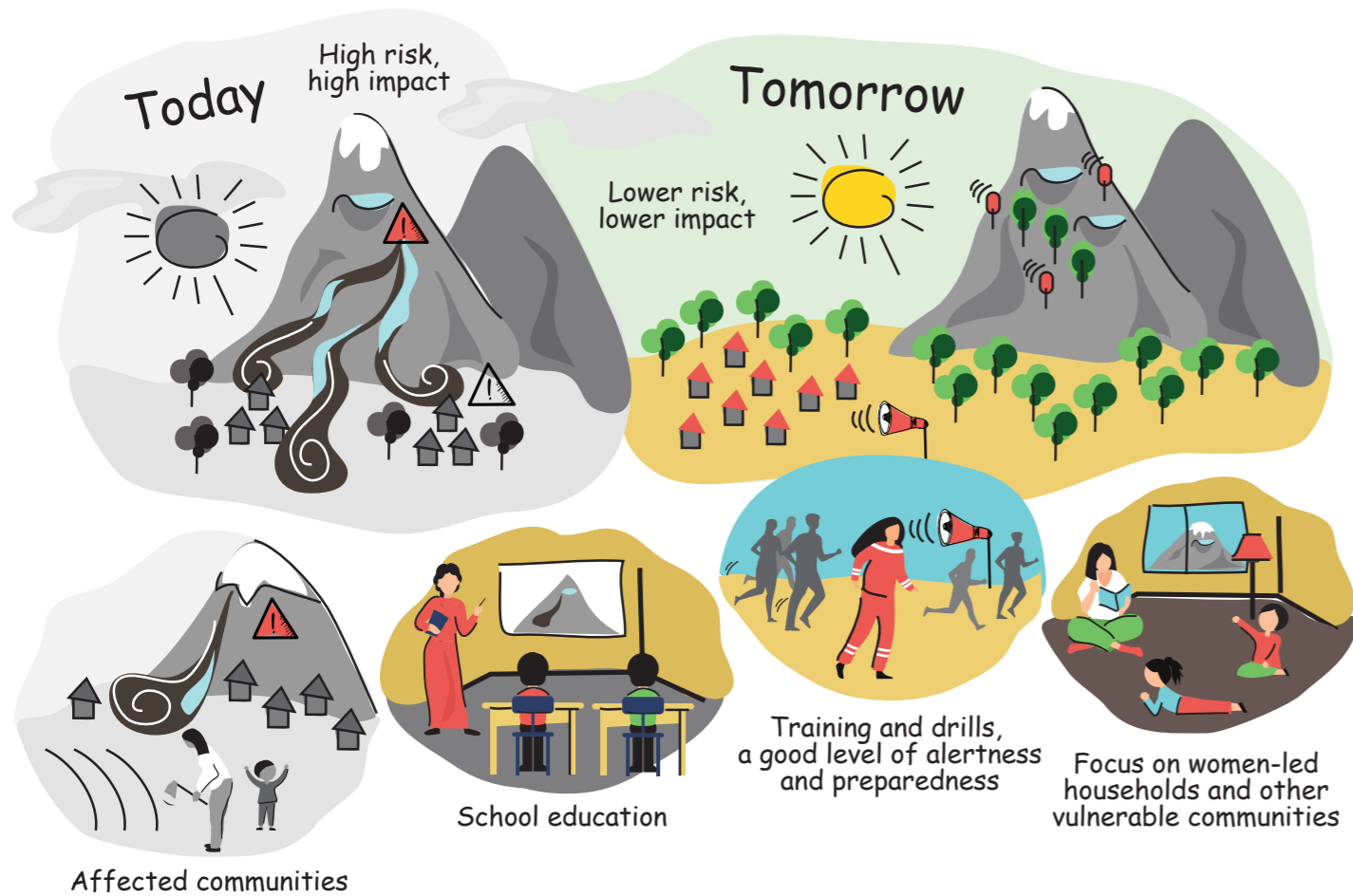
Project objective and components

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 consists of five components. Component #1 contributes to strengthening national and regional capacities to monitor and assess GLOF hazards and support decision making with modern information, including an atlas of glacial lakes. At the same time, the organisational capacity for GLOF mapping and monitoring will be strengthened. 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 contributes to the design and implementation of early warning systems — at least one per country — and 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. It will also establish a web-based platform for GLOF risks, knowledge materials — maps, infographics and outreach and training documentation — and adaptation measures and strategies.

Regional workshops will facilitate the exchange of knowledge and experience between countries. A hazard assessment for all lakes and affected communities will be conducted at the regional scale, so that the wider area benefits from the project. The project will also conduct community assessments, working with local authorities and community members, including the meaningful participation of women. As a result of these assessments, GLOF risk areas will be identified for each country and risk reduction plans 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 stabilise slopes and reduce erosion, deflection structures, evacuation and response drills and the identification of evacuation routes and safe zones.
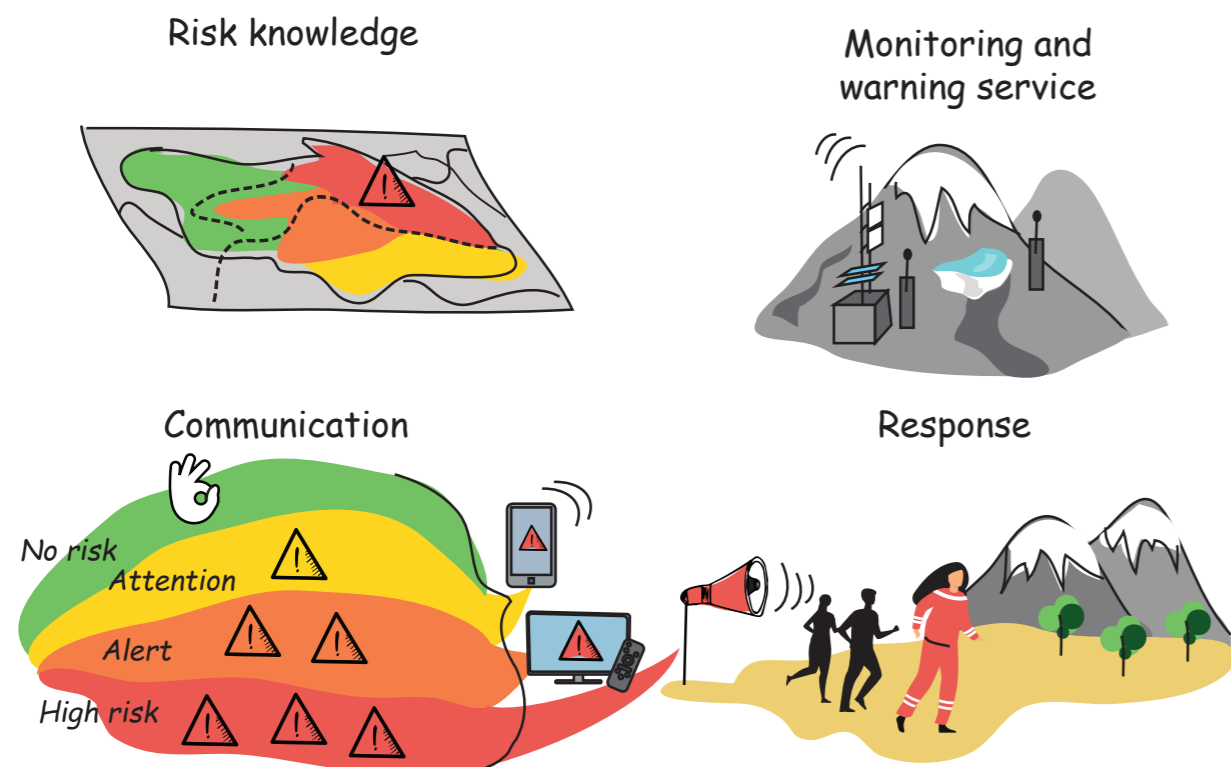
Focus on vulnerable communities.
Connecting science and monitoring to villages.

Today

High risk, high impact

Tomorrow

Lower risk, lower impact

School education

Training and drills, a good level of alertness and preparedness

Focus on women-led households and other vulnerable communities

Affected communities

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

Risk knowledge

Monitoring and warning service

Communication

No risk
Attention
Alert
High risk

Response

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 utilises 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 modernisation 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 on early warning and risk reduction from the Andes, Himalayas and the Alps will be brought to Central Asia through the University of Zurich and partnerships with the World Glacier Monitoring Service. Investments in the next generation of local scientists and practitioners and the involvement of school children in educational programmes will contribute to the project's sustainability. The project builds on existing institutions and will closely collaborate 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.