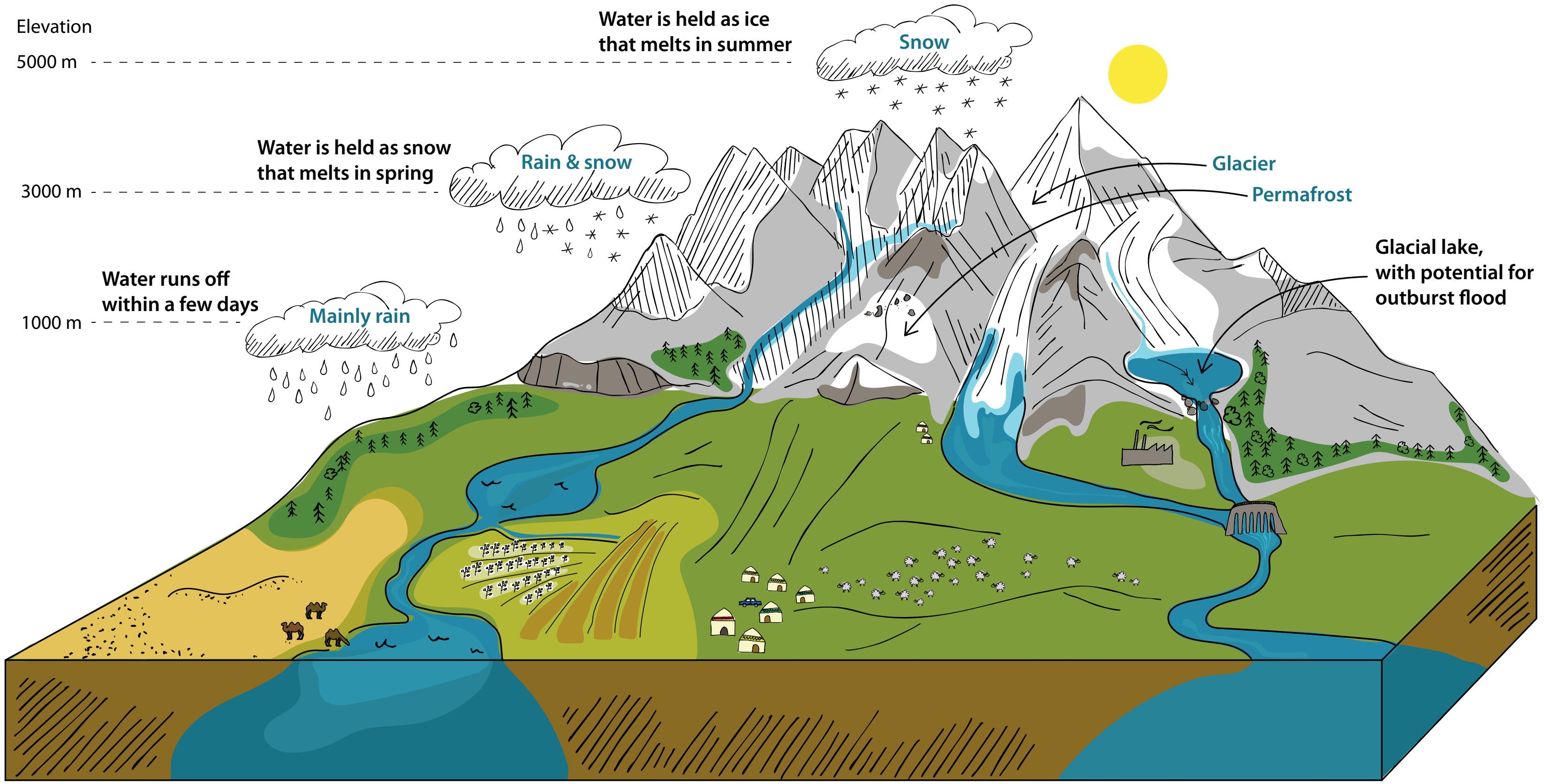
Climate-Cryosphere-Water Nexus
Central Asia Outlook

Vital roles of mountains, snow and glaciers



Blue Peace Central Asia

This summary has been prepared under request of the Climate Change and Environment (CC&E) Network of the Swiss Agency for Development and Cooperation (SDC)

Introduction

The three components of the cryosphere – glaciers, snow and permafrost – are all affected by climate change. Mountain communities face growing risks to infrastructure, while downstream communities face disruptions in their water supply and risks of food and energy insecurity as a consequence. In Central Asia, the cryosphere-related changes in water resources will be strongest in the second half of the century, as glaciers shrink and the extent and duration of snow declines considerably toward the end of the century (IPCC 2014).

Temperature increases in Central Asia are projected to exceed the global climate policy target, and combined with cryosphere-related changes may seriously affect water and other natural resources as well as weather-dependent sectors such as public health, hydropower and agriculture. The socioeconomic implications of the projected climate and cryosphere changes are not well understood, but lives and livelihoods clearly hang in the balance, and the region needs to strengthen its climate and glacier monitoring and assessment and take diverse adaptation measures to respond to the risks.

Regional demand for water resources

Fresh water was once a relatively secure resource, but economic development and expanding population are resulting in growing demand for water resources for food and power production, and for industrial and municipal uses. The competing demands for water resources between sectors and countries are expected to grow.

Cooperation or conflict

In the Soviet era, in exchange for fossil fuel and power supply during the winter months, the upstream countries of Tajikistan and Kyrgyzstan – major glacial centers and key sources of water resources for Central Asia – provided the downstream countries of Kazakhstan, Turkmenistan and Uzbekistan with a reliable source of water for reliable irrigation in the summer.

After independence, the water-for-energy exchange system collapsed, and the upstream countries changed the operations of their dams to produce more hydropower in winter to ensure their energy security, thereby changing the dynamics of seasonal water distribution and availability to downstream countries (Bernauer et al. 2012, International Crisis Group 2014). More water was coming to downstream areas in winter, when it was not really needed and caused flooding, while less water was available in summer, when agriculture needs it most. In periods of droughts, the water deficit in summer was particularly damaging, and local people suffered losses. Recently Uzbekistan and Tajikistan have signaled their willingness to find solutions to the recurring interstate water disputes through dialogue, and other countries have intensified bilateral and regional cooperation.

Glaciers of Central Asia are essentially natural reservoirs that accumulate and store water from winter and spring precipitation and release it in summer, when rainfall is low and water demand is high. In the face of ongoing climate change, the challenges related to water management may recur and persist. Adaptation to the new climate and water realities is central to the region's prospects for avoiding conflicts over scarce resources.

Climate change in the region

Temperature and precipitation

In Central Asia, temperatures have increased steadily over the last 50 years, with more pronounced warming over the winter months, and in the valleys and lowlands (Unger-Shayesteh et al. 2013). Compared to the climatic conditions in the 1950-1980 period, temperatures are projected to rise by 2.5°C-6.5°C towards the end of the century. The exact outcome depends on the global greenhouse gases emission pathways, which range from robust mitigation reducing emissions almost to zero to a relaxed attitude leading to rapid and steady climate warming (Reyer et al. 2017).

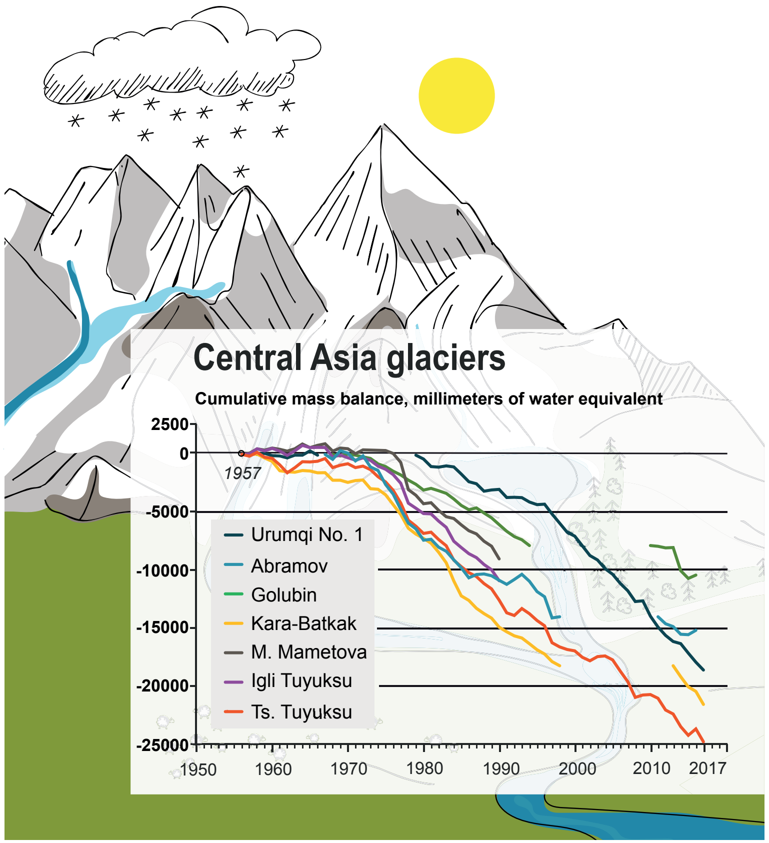
Changes in precipitation in Central Asia vary by topography and locality, but the lack of consistent monitoring limits the analysis. Projections suggest that south-west areas of the region may become drier, while north-east regions and the neighboring western China hinterlands may become wetter.

Glaciers, snow and permafrost

Climate warming accelerates the melting of snow, glaciers and permafrost, affecting the overall water balance. Higher temperatures reduce snow cover and depth, shorten the duration of cover, and shift the distribution of areas with permanent snow and frozen soil and rocks to higher altitudes.

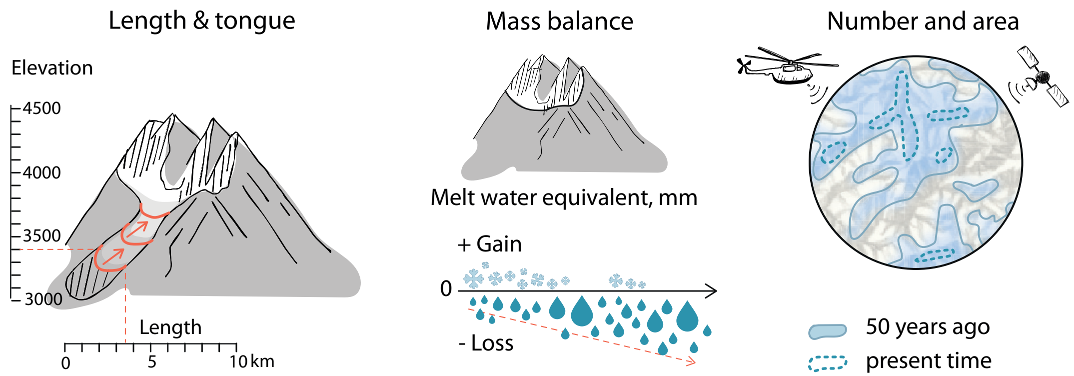
The glaciers in Central Asia are retreating at different rates in different areas. The shrinkage is most pronounced in the Tien Shan and at lower elevations of the Pamir-Alai Mountains. Many small glaciers have already disappeared.

Glacier mass balance measurements show losses close to 30 per cent since the 1960s, with an accelerated glacier mass loss since 2000 similar to many other regions worldwide. In the Tien Shan mountains, for instance, about 3000 km² of glacier area was lost during this period. The future melting of glaciers in Central Asia will vary by altitude, but more than 50 per cent of the current glacier mass is expected to be lost by the end of the century (Luz et al. 2013, Sorg et al. 2014, Huss & Hock 2015). With such substantial reductions in glacier cover and ice reserves, and changes in snow and rainfall pattern, river flow variability may increase and seasonal water flow may change.



Source: World Glacier Monitoring Centre (2018)

The changes in glaciers are captured by measures of size and mass balance.



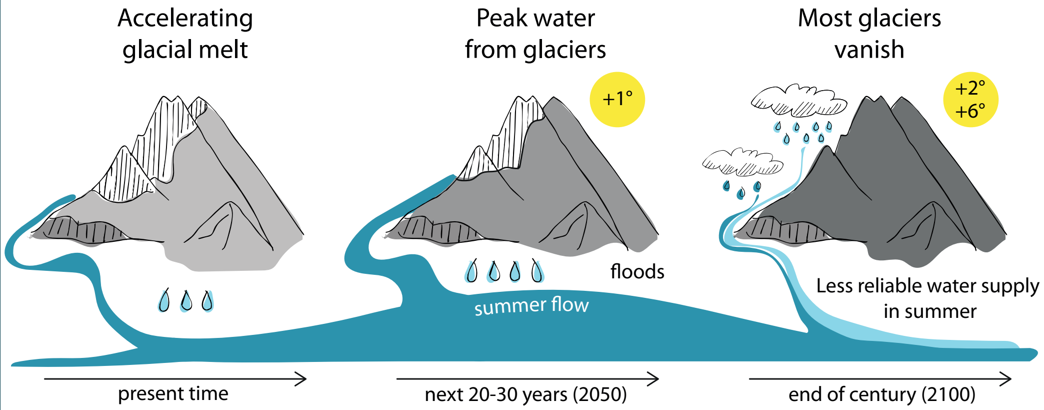
Water availability

Glaciers and seasonal snow pack of the Tien Shan and Pamir mountains provide about half of the stream flow to the Amu Darya and Syr Darya rivers, and the year-to-year amount of fresh water may vary with climatic conditions. The volume, depth and extent of snow determines the timing of the snow melt contribution to river flow.

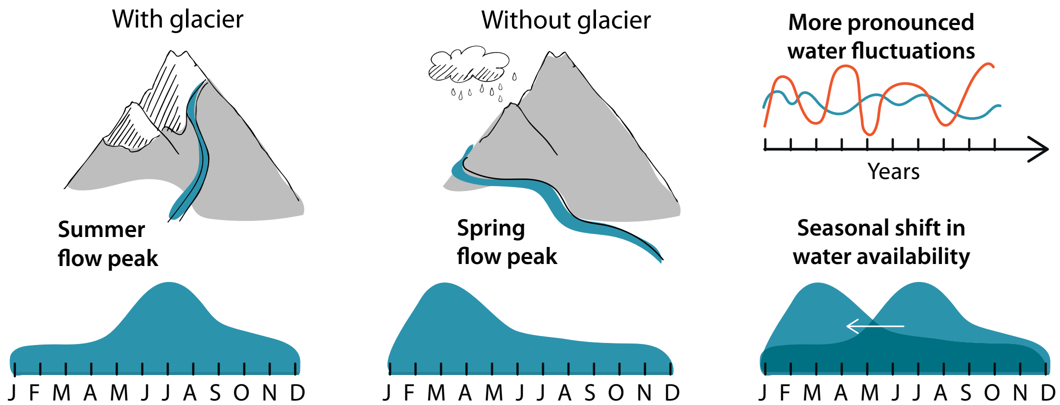
As the climate warms and the glaciers shrink, annual run-off, and especially the glacial melt contribution to the river flow, will initially increase, then peak and subsequently decline. Increased water evaporation from soils and plants in a warmer climate will exacerbate this decline. Widespread permafrost thawing and the appearance of glacier lakes increase the risk of rock instability and failure, and present threats to downstream communities and critical infrastructure, such as roads and mines. Sound water resources planning and effective risk management will depend on an understanding and consideration of these dynamics.

Central Asia run-off projections until about 2030 show no major expected changes, but a number of studies agree that changes in glacier and snow melt will result in a shift of seasonal water peak from summer to spring, with locally different peaks for individual catchments. The annual peak water is expected around 2050, and by the end of the century, run-off is likely to decline in all Central Asia river basins (Sorg et al. 2014, Reyer et al. 2017, Huss & Hock 2018).

Water flow increases with glacial melting, then declines when the glaciers are gone.



As glaciers retreat, the water flow peak shifts from summer to spring.

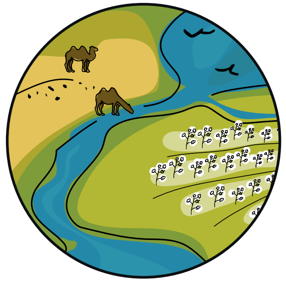


The changes in the mountains carry risks all the way to the lowlands.

Floods, flash floods and inundations

Slope instability and slides

Downstream water shortages and diminished water quality



Overall, Central Asia is considered a global hotspot region with respect to impacts of climate change on the mountain cryosphere and downstream societies, most notably for water resources and risks from natural hazards. While cryosphere related changes in water resources will be less strong in the next one to two decades, major changes are expected later in the century as glaciers become increasingly smaller and snow extent and duration decrease. A particular concern is the combination of the cryosphere-related changes with higher frequency of droughts in some regions of Central Asia and a widespread increase of extremely hot periods.

While in-depth understanding of the socio-economic impacts of climate and cryosphere changes is still incomplete and should be addressed in the region, the direction of changes is robust. Flexibility in river basin management plans with consideration of climate impacts and risk reduction measures become very important. Intensifying local adaptation efforts will be a key to avoiding climate risks that go beyond critical levels, as will the co-ordination of cross-border adaptation efforts.

Scientific evidence for the region comes with considerable uncertainties due to a lack of long-term, uninterrupted monitoring of the climate and the cryosphere (Unger-Shayesteh et al. 2013). Without a strong data basis, future trends that might support decision-making will be difficult to assess. Actions are being undertaken to fulfill the observational gaps of the last 30 years and to support new generations of hydrometeorologists, climate and glacier scientists and water planners (Hoelzle et al. 2017). The international community is working together with national and regional institutions and research centers to reestablish and modernize glacier and hydrometeorology observation networks and build local capacity. Broader support and information exchange is needed.

Rivers of Central Asia

Glaciers and water sources

Glacial source / source
Town or city
Major city
Lake
Reservoir

River mainly fed by glacial and snow melt
River mainly fed by snow and rain
Canal ●●●● Collector
Inland river delta

Climate change impacts on glaciers and water

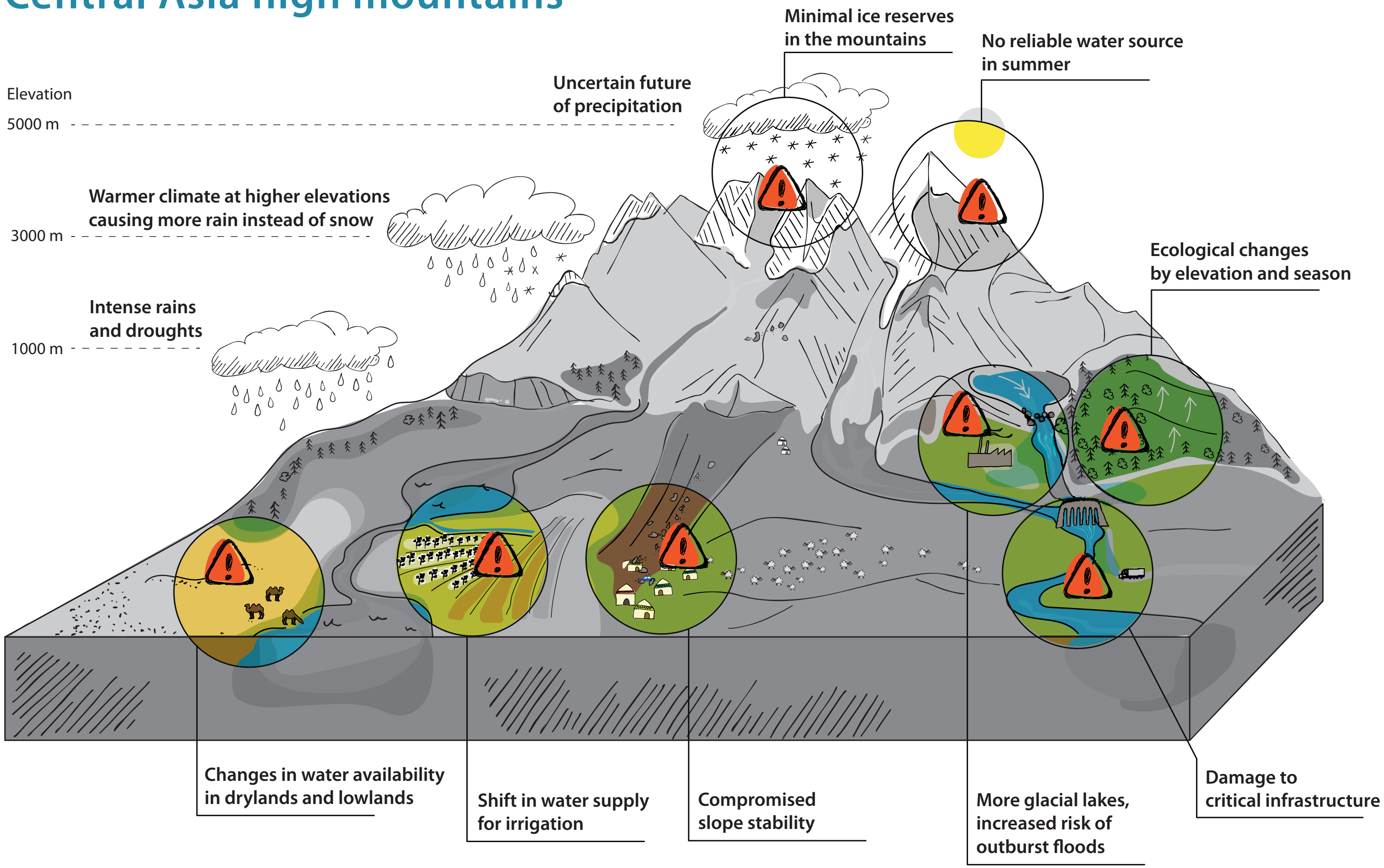
Glacial lake outburst flood risk, changes in rock and slope stability
Water deficit risk

Major river systems

Amu Darya
Syr Darya
Tarim
Ili
Chu
Talas


Central Asia
Water resource formation and use
Average water withdrawal (km³/year)
Average flow (km³/year)
70
30
10
5
Mountain regions above 2000 metres
Irrigated lands
Drainage water and irrigation run-off
Re-use of drainage
Main glacier areas
River basin outline
Country boundary
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
KYRGYZSTAN
TAJIKISTAN
AFGHANISTAN
CHINA
PAKISTAN
IRAN
Aralsk
Northern Aral Sea
Eastern Aral Sea
Western Aral Sea
Aral Kum Desert
Muynak
(38)
5
Lake Balkhash
Ili delta 4
Ili
CHN 4
Khorgos
12
16
Kapchagay Res.
KAZ 2.2
KAZ (other rivers) 1.5
Almaty
Chu
KAZ 1.3
KAZ 0.6
Talas
Taraz
1.5
4.8
KYR 3.3
Bishkek
Issyk-Kul
Akshirak
Enilchek
Tien-Shan
Aksu
Naryn
KAZ 10
Syr Darya
1
Shymkent
KYR 0.9
Chirchik-Charvak
Ahangaran
Tashkent
9
(37)
15
UZB 10
KYR 3
Kara Darya
4
Osh
TJK 2
2
Rivers of Ferghana Valley: 8
UZB 10
Aydar Lake
KYR 0.1
Kashgar
Yarkant
Sarygamysh Lake
Karakalpakstan 7.9
Prospective Collector
Tashauz 6.5
Horezm 4.4 (UZB)
Dashoguz Collector
Lebap 3.9
Golden Age Lake (under construction)
UZB 5.3
Zaravshan
Bukhara
Samarkand
5.3
Amu-Bukhara 5.2
Kashkadarya
1.2
0.3
Kafarnigan
Fedchenko
Dushanbe
Vaksh
Pamir
Great Turkmen Collector
Surhandarya
Karshi 4.2
Sherabad
UZB 1.4
TJK 6.6
0.6
Panj
1.5
Ashgabat
High water losses along Karakum Canal
Atrek
1.5
0.98
Karakum Canal 11
Amu Darya
0.2
4.8
0.5
5.5
20
33
Other rivers: 6.2
Kokcha
Murgab
Tejen
Mashad
Kunduz
Hari Rud
Kabul
Islamabad
Indus
0
250 km
Map produced by Zoï Environment Network, June 2018
Source: water flow and water use data www.cawater-info.net

Climate change impacts on Central Asia high mountains



Contributors

Veruska Muccione (University of Zurich),
Christian Huggel (University of Zurich),
Nadine Salzmann (University of Zurich and University of Fribourg),
Joel Fiddes (University of Oslo and Swiss Institute for Snow and Avalanche research SLF),
Samuel Nussbaumer (University of Zurich & University of Fribourg),
Viktor Novikov, Geoff Hughes (Zoï Environment Network)

Visuals

Carolyne Daniel
Matthias Beilstein

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Swiss Agency for Development and Cooperation SDC

University of Zurich[UZH]

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