

MRI Mountain Observatories Working Group & GEO Mountains Workshop in Central Asia

Almaty, Kazakhstan

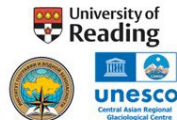
18–20 April 2023



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Introduction & Workshop Aims

Between the 18th and 20th April 2023, the Mountain Research Initiative (MRI), GEO Mountains, the University of Reading, the Central-Asian Regional Glaciological Center under the auspices of UNESCO (CARGC), and the Kazakhstan Institute of Geography and Water Security co-convened a workshop on the topic of “Mountain Observatories” at Hotel Almaty, Almaty, Kazakhstan.

The workshop was the inaugural meeting of the Central Asia Mountain Observatories Network (CAMON). It was also the first in a series of regional workshops that GEO Mountains are undertaking in 2023 under the Adaptation at Altitude Programme. The topic of “Mountain Observatories” is a common theme that will feature prominently in each of these workshops. The CAMON workshop was an ideal starting point for this series of meetings because although the network was formally announced in 2023, there is a long history of collaboration between its members. CAMON consists of four established observatories (Tuyuksu in Kazakhstan, Chon-Kyzyl-Suu and Ala-Archa in Kyrgyzstan, and Pskem in Uzbekistan) and two emerging observatories (Varzob and Khorog in Tajikistan). The former were established in the 1950s as glaciological stations to provide data on glacier mass balance informing water resource management in this arid region. All observatories have evolved to include a wider range of observations and participated in many joint regional and international projects.

Participants were drawn from several Central Asian countries, and represented a combination of research institutions / mountain observatories, national hydrological and meteorological services (NHMSs), and educational institutions. In total, there were 43 in person participants. In addition, 62 unique participants joined online for at least part of the workshop.

The aims of the workshop were as follows:

- To provide a platform to share experience, knowledge, and capacities across CAMON;
- To build, or further develop, personal connections
- To discuss and co-identify joint projects, in particular those related to “new” monitoring and research directions for CAMON sites (e.g. enhanced focus in biotic monitoring);
- To discuss potential movement towards greater standardisation across CAMON sites (e.g. in terms of variables measured, equipment, protocols, and/or data processing and storage);
- To identify opportunities for enhanced data exchange between individual CAMON sites, as well as between CAMON (or CAMON sites) and NHMSs and the World Meteorological Organization (WMO) system;
- To identify opportunities for teaching, training, and Early Career Researchers’ projects to be more fully integrated with CAMON, and;
- More generally, to develop a stronger identity and “combined voice” extending across individual countries and disciplines, which in the longer term could help attract additional research funding and enhance CAMON’s influence and potential advocacy efforts in relation to sound environmental management and sustainable mountain development in the region.

Previous Online Workshop & Consultation

The workshop built upon a previous online workshop and associated consultation, which was held in October 2021. During that meeting, it was established that:

- The region has good data coverage for glaciology, hydrology, and meteorology, but lacks socio-economic, ecological, and biological data;
- Despite extensive monitoring in the 1950s-1980s, much data has yet to be digitized;
- The 1990s-2000s suffered from interruptions in data collection; and,

- In terms of mountain ranges, the Northern and Central Tien Shan have better data coverage than that of the Pamir and Pamir-Alay.

Some of the CAMON sites were also briefly introduced, including the established Tuyuksu Mountain Observatory (Kazakhstan), the Chon Kyzyl Suu Mountain Observatory and the Ala-Archa region (both in Kyrgyzstan), and the Pskem Observatory (Uzbekistan)

Participants noted the challenge of sustaining data flow over time and among researchers, institutions, state agencies, and local governments, as well as the importance of connecting short-term research projects to long-term monitoring programs (and find funding mechanisms to enable such transitions). While data availability varies across countries and disciplines, digitizing analog historical data is a pressing regional issue. Additionally, it was noted that users of data sometimes struggle to discover and use available data due to paywalls, language barriers, or lack of standardization.

The workshop also was an opportunity to address responses gathered via a survey conducted following the online consultation held in 2021. The main points arising from the associated individual surveys were:

- Most respondents were based in Kazakhstan, working in a university / research setting, and considered themselves to both data users and data providers;
- Dominant disciplines were hydrology, meteorology and climate science, natural hazards / Disaster Risk Reductions (DRR), and the cryosphere;
- Most respondents work across spatial scales and on multiple time horizons;
- A relatively high proportion of respondents indicated that they currently experience difficulties in discovering, accessing, or using necessary data;
- Long-term meteorological/climatic, hydrological, snow, and high quality remote/satellite data were identified as being the main specific lacking datasets;
- Documentation and metadata provision were considered reasonable, with technical or computational constraints to data exploitation also not being a major concern;
- KazHydroMet data quality and metadata was cited as a specific example of good practice, although other respondents struggled to cite any example of good practice;
- Most respondents suggest that they endeavour to make their data freely available, primarily via dedicated geospatial portals (although this desire may not always be followed through), with the most prominent motivations for sharing being to provide as a service to the community and “quid pro quo”;
- Making the actual measurements (including data processing) was clearly identified as the most problematic component of the data lifecycle;
- Limited time / funding and (inter-)institutional competition emerged as the most common perceived barriers to more routine / extensive data exchange;
- Most respondents were in favour of Open Data and Open Science, and publishing datasets in dedicated journals;
- The development of a dedicated regional data portal was considered important; and,
- Financial or funding issues, the complex geopolitical situation, insufficient expertise for obtaining in situ data, poor quality (or complete absence) of metadata for the in situ data sets, and poor availability of social data were listed as major barriers that must still be tackled.

This situation therefore represented the point of departure for the 2023 workshop.

Workshop Programme

On Day 1, the morning was spent setting the scene, with a series of presentations from the conference organizers. This session included words of welcome on behalf of the MRI and CARGC, a presentation on the scope and recent activities of GEO Mountains, and an introduction to the general concept of Mountain Observatories. An example of existing pan-CAMON monitoring and

research – quantifying water sources using isotopic analysis – was then presented. In the afternoon, a series of presentations were given that provide an overview of the monitoring that has been, and continues to be, undertaken at CAMON sites. Taken together, these presentations demonstrate the considerable depth and breadth of CAMON’s existing monitoring work. Day 1 closed with a series of presentations spanning various topics – including atmospheric measurements, cryospheric measurements, and data sharing – from experts representing several international organizations with considerable experience working in the region. Overall, Day 1 was focused on the physical sciences (e.g. climate, the cryosphere, and the hydrosphere).

On the morning of Day 2, attention turned to the state of biodiversity monitoring in the mountains of Central Asia, with presentations being followed by discussion on the topic. Overall, there was clear appetite to expand the scope of monitoring at CAMON sites to include aspects related to biodiversity and ecology, where possible. In the afternoon, participants had the opportunity to join a short field trip into the surrounding mountains, although this was slightly curtailed due to adverse weather in the previous days leading to high avalanche risk. The field trip was followed by a hosted workshop dinner at the hotel.

Day 3 began with presentations and associated discussions regarding links that either already exist, or could be developed, between CAMON members and educational institutions offering courses related to mountain systems across several Central Asian countries. Again, CAMON members and university representatives alike showed a high degree of interest in establishing these connections. Discussion then turned to considering some of the societal aspects of mountain systems, which are currently under-monitored at CAMON sites and by the other monitoring agencies represented at the workshop. It was agreed that the lack of socio-economic monitoring and research is a weakness of CAMON which needs to be addressed. Participants were given the opportunity to identify socio-economic themes or aspects that they considered especially important for characterizing, understanding, and ultimately better predicting global change and its impacts in the mountains of Central Asia, thereby providing a contribution from this group to an ongoing task under GEO Mountains that is looking to identify and characterize ESVs in mountains (Task Group 2.3). It is proposed that, following further refinement, selected societal variables corresponding to these variables could be prioritized for monitoring across the “data rich regions” that comprise CAMON sites. The workshop concluded with discussions towards the formalization of CAMON as a network, and how the collaborations established or strengthened can be taken forwards.

The full programme is provided below:

Tuesday 18th

9:00 – 10:00: Introduction

Prof. **Takir Ospanovich Balykbayev** (Head, CARGC) and Prof. **Igor Severskiy** (Director of Research, CARGC): Welcome

Dr. Carolina Adler (MRI, Switzerland): The Mountain Research Initiative (MRI)

10:00 – 10:40: Dr. **James Thornton** (MRI, Switzerland): An introduction to GEO Mountains and its Ongoing Activities Questions and Answers

10:40 – 11:00: BREAK

11:00 – 11:20: Prof. **Maria Shahgedanova** (University of Reading, UK): The general concept of Mountain Observatories and the MRI’s MOs Working Group, as applicable in Central Asia

11:20 – 11:50: Ms. **Zarina Saidaliyeva** (University of Reading, UK): CAMON together: Quantifying sources of water in Central Asia using isotopic analysis

Questions and Answers

12:00 – 13:00: LUNCH

13:00 – 15:00: Presentations from CAMON Members on their sites; The Status Quo

- a) Mr. **Vasily Kapitsa** (Kazakhstan Institute of Geography and Water Security): The Tuyuksu Mountain Observatory, Kazakhstan
- b) Prof. **Rysbek Satylkanov** (Tien Shan High Mountain Scientific Centre, National Academy of Sciences of the Kyrgyz Republic): The Chon-Kyzyl-Suu Observatory, Kyrgyzstan
- c) Dr. **Ryskul Usubaliev** (Central Asian Institute of Applied Geosciences): Monitoring activities at the Central Asian Institute of Applied Geosciences, Kyrgyzstan
- d) Dr. **Maxim Petrov** (Institute of Geology and Geophysics, Uzbekistan): The Pskem Mountain Observatory, Uzbekistan
- e) Prof. **Abdulhamid Kayumov** (Center for Research of Glaciers of the Academy of Sciences of the Republic of Tajikistan): Re-instating mountain monitoring in Tajikistan
- f) Dr. **Arnaud Caiserman** (Mountain Society Research Institute, University of Central Asia): The emerging Khorog mountain observatory in the Pamir, Tajikistan

15:00 – 15:30: Existing strengths and needs of CAMON, challenges and opportunities (e.g. joint monitoring projects), including project ideas for the GEO Mountains funding call (Discussion: All)

15:30 – 16:00: BREAK

16:00 – 16:30: Dr. Joel **Caduff-Fiddes** (SLF, Switzerland; online). Current state of cryosphere monitoring in Central Asia and CROMO-ADAPT updates

16:30 – 17:00: Dr. **Martin Steinbacher** (Swiss Federal Laboratory for Material Science and Technology, Switzerland; online). Air quality and aerosol monitoring in the mountains of Central Asia under the WMO's Global Atmosphere Watch (GAW) programme

17:00 – 17:30: Dr. **Miriam Jackson** (ICIMOD, Nepal; online). On collaboration across HMA between CAMON and ICIMOD

17:30 – 18:00: Mr. **Hassan Haddouch** (WMO, Switzerland; online). Sharing real-time weather data via the WMO system

18:00 – 18:30: Towards greater exchange between WMO, National Hydrometeorological Services, and CAMON researchers regarding monitoring activities, data, and knowledge (Discussion: **All**)

Wednesday 19th

9:00-10:00: Biotic monitoring in Central Asia

9:00 – 9:30 Dr. **Kymbat Osmonbaeva** (Tian Shan Highland Research Centre of the Institute of Water Problems and Hydropower of the National Academy of Sciences of the Kyrgyz Republic): An example of long-term biota monitoring: the natural regeneration of the coniferous forests in the Chon-Kyzyl-Suu basin

9:30 – 10:00: Dr. **Dmitry Milko** (Institute of Biology, National Academy of Sciences of the Republic of Kyrgyzstan): State and problems of biota monitoring in the Kyrgyz Republic: A “bottom-up” view from a local biodiversity expert

10:00 – 10:40: Dr. **Harald Pauli** (Austrian Academy of Sciences & BOKU Vienna; online). Global plant diversity monitoring on alpine mountain tops: Advances and difficulties in establishing GLORIA observation sites in Asia

10:40 – 11:00: Dr. **Adilet Usupbaev** (Institute of Biology, National Academy of Sciences of the Republic of Kyrgyzstan): GLORIA in Kyrgyzstan

11:00 – 11:30: BREAK

11:30 – 12:30: Expanding CAMON's (disciplinary) scope to include vegetation / biodiversity monitoring (All)

12:30 – 17:30: LUNCH and Excursion

19:30: Workshop DINNER

Thursday 20th

9:00 – 10:00: Opportunities for integrating ECRs in CAMON's activities.

9:00 – 9:15: Dr. **Kogutenko** (Kazakh-German University): Mountain Studies at the Kazakh-German University: Best practices and potential links with Mountain Observatories

9:15 – 9:30: Dr. **Orunbaev** (American University of Central Asia): Mountain Studies at the American University of Central Asia

9:30 – 10:00: Discussion (All)

10:00 – 10:30: BREAK

10:30 – 12:30: Opportunities for sharing capacities across CAMON

Work in groups and brief verbal reports (All)

12:30 – 13:30: Lunch

13:30 – 14:00: Dr. **Thornton** / Dr. **Adler**: Defining Essential Societal Variables for applications in (global) mountains

14:00 – 15:30: Work in groups and brief verbal reports on expansion of socio-economic monitoring (All)

15:30 – 16:00: Prof. **Shahgedanova**: Summary and ways forward

16:00 – 16:30: Signing of Memorandum of Understanding between the CAMON Observatories

Simultaneous Russian–English interpretation was provided throughout. The slides from all presentations given during the workshop have been shared with the participants and can be

provided to other parties upon request. The recordings of the workshop can also be made available upon request.

Main Outcomes & Next Steps

The workshop involved several phases of discussion, followed by plenary reporting. The main outcomes of these discussions are presented in turn below.

Discussion 1: Opportunities for CAMON

One group suggested that it could be sensible to continue to further develop work on water quality, isotopes, and hydrochemistry within the network. This would exploit the experience and existing work of current successful collaborations, such as Central Asia Research and Adaptation Water Network (CARAWAN) initiated in 2019. This group also suggested that expansion of the network's monitoring activities into aspects related to biodiversity could represent an important opportunity. It was suggested that globally standard methodologies should be applied, or where necessary developed. A final suggestion was the development of a dedicated geospatial portal to host / serve various data collected by the network.

A second group produced a list of several possible research opportunities that could be conducted at network level, which included an investigation into the association between synoptic meteorological conditions and river discharge, additional work on hazards such as mudflows and avalanches, enhancing snow depth and density measurements, and exploring links between vegetation growth and catchment moisture conditions.

A third group envisaged transects of stations across which various air quality measurements are made, monitoring activities specifically aiming to track climate-related changes in vegetation patterns (e.g. expansion of the treeline), and more generally establishing more rigorous procedures for coordination and control across the network's activities.

A fourth group proposed digitization and compilation of existing analogue data archives, investigations into changes in soil quality, conducting geochemical analysis on glacial moraines (e.g. for dating purposes), and exploring changes in groundwater and surface water quality.

A final group proposed that a common data format be used for certain variables, and that the measurement instruments used at CAMON sites gradually become more standardised over time. They additionally proposed the use of dust meters to measure atmospheric transport of dust particles and deposition at CAMON sites.

Discussion 2: Towards greater exchange between CAMON, WMO, & NHMSs on monitoring, data, & knowledge

A first group suggested that the WMO data infrastructure be exploited for sharing data. They also suggested that all NHMSs with an existing agreement with the WMO should also update their lists of (internal) organizations which will share data in this way, for instance to ensure that the various agencies responsible for environmental monitoring within a given country are all included. It was further suggested that the NHMS provide open access to primary data on their websites (or at least a monthly "permit" for data use). The group noted that UzHydroMet do provide open access to data for scientific research on request; however, this is only in analog format and is not available to non-residents. The group finally noted that Annual Hydrological Bulletins reporting hydrological measurements at daily time step (or as performed) were published in all post-Soviet countries until the mid-1990s, and are still produced in some countries. However, these documents and the data they contain are not currently available to all.

A second group reported that 1. Official meteorological and hydrological data published by Kazhydromet is freely available. This group again emphasised that the development of a regional

geodata portal that brings together various data from CAMON sites and the wider region could be extremely beneficial.

A third group suggested that it is imperative that data that currently exist only in analogue form are digitized, and that this cannot be done without dedicated funding / a project.

A fourth group communicated that whilst some data of Kyrgyzhydromet are available, they have to be purchased. The Tien Shan Centre indicated that they are ready to share data, on the provision of “equal exchange”. More generally, it was suggested that data exchange within the network at least should be enhanced, and that the draft MoU would ideally contain text in relation to this.

The fifth group suggested that it would be beneficial if the WMO could promote openness of national datasets, if it lies within its remit. They also noted that enhanced training and skills are required to facilitate the collection and sharing of high-quality data, for example related to working with the instruments, data handling skills, and developing young technicians / researchers. This group also recommended the creation or compilation of a dataset that could be published in a scientific “data journal”.

Discussion 3: Expanding CAMON’s scope to include more vegetation / biodiversity monitoring

Participants proposed numerous ideas in relation to increasing CAMON’s scope to incorporate more biotic and ecological monitoring. For example, it was suggested that the carbon sequestration of mountain forests in Kazakhstan (and potentially eventually across the entire region) should be estimated. It was also suggested that four GLORIA sites that had previously been surveyed could be revisited to establish biotic shifts over a six-year period. It was emphasized that data exchange between observatories is necessary to generate “4D maps”. With respect to establishing new biotic monitoring (e.g. new GLORIA sites), some preliminary work may be required to identify priority sites. Phenology, forest extent change, lichen monitoring, and carbon exchange were all identified as potentially interesting and important themes that could be pursued. Methodologically, it was suggested that remote sensing methods be applied in addition to in situ ones. One data output could be new or imported maps of vegetation distributions. It could be worth forming a sub-group of CAMON including all those interested in biodiversity and ecology monitoring. Overall, it emerged from the discussion that first we must priorities developing inventories of existing datasets (metadata). Then, where required, the actual datasets should be digitized. Then, they should be exchanged to the fullest extent possible.

Discussion 4: Opportunities for integrating education activities and ECRs in CAMON’s activities

Numerous ways in which stronger links and exchange could be developed between CAMON, NHMNs, educational institutions, and ECRs were explored. For example, it was suggested that summer schools could be jointly advertised that are developed by, and open to applicants from, multiple universities from across the region. It was suggested that data generated by CAMON should be available for university teaching and for undergraduate and MSc dissertations. In order to overcome certain restrictions, NHMSs could provide data for use in student projects under a special license. Students should have opportunity to conduct fieldwork at the CAMON sites over summer, however, internships could be offered that last a longer period than the traditional two-month period (July and August) including the research centres running CAMON sites. Supervision of MSc dissertations by CAMON research staff would be an efficient way to improve the quality of dissertations while providing low-cost labour to the observatories. The need for stronger and wider training in hydrological modelling and access to data required to run hydrological models were highlighted as a priority in reports from several groups. In general, there was considerable enthusiasm from all parties in developing stronger links with mountain education activities. Numerous other suggestions are included in the Discussion Outputs (see Annex 4).

Discussion 5: Needs and opportunities for sharing capacities across CAMON

In this part of the workshop, observatories were asked what capacities they could share with others in the network, as well as those capacities that they required or would like to obtain (either from other network members or, else, the international community). Some identified needs included enhanced remote sensing data processing and GIS skills, access to high resolution satellite images for relevant periods, more modern equipment for monitoring glaciers, snow, glacier lakes, and permafrost, more automatic weather stations, access to expertise to establish more GLORIA sites, and exchanges to learn how to apply isotopic methods. Some, but not all, of these requirements could potentially be met on a fair basis by developing exchange and coordination mechanisms within CAMON. Technical support of the contemporary equipment may be challenging and not all observatories have continuous access to technical expertise. Sharing expertise across the network is important.

Discussion 6: Identifying priority topics for enhanced socio-economic monitoring in and around CAMON sites

Finally, participants were asked to identify their priorities in terms of socio-economic topics or processes from a set of pre-defined suggestions offered by the GEO Mountains Task Group on ESVs as a starting point.

One group suggested that in their opinion, demographic aspects such as population density, composition, and household composition are key, since the number and distribution of people within a given area are strong determinants of vulnerability and exposure as components of risk. Likewise demographic characteristics such as the proportion of pregnant women, the elderly, small children, and those with physical limitations can be important with respect to extreme events. Livelihoods was also identified as a key theme, with corresponding variables or indicators being related to crop types, livestock numbers, and other employment statistics. Access to water could also be considered an important social aspect, along with any protections in place against natural hazards. Social structure was likewise deemed important, since in many regions economic and educational inequality can be pronounced, and again links with Disaster Risk Reduction (DRR) efforts. The group also shared some feedback from local residents that was gained during previous work, which suggested that livestock density (in terms of soil trampling) and heath status are key.

A second group identified human population density dynamics, especially in low and mid elevation belts, as being highly interesting. Inefficient use of natural resources., e.g. fertile soil, along with information on nutrition sources such as pastures were highlighted; in many regions, pastures represent a limited resource and cattle breeding lays the foundation of economic and food security. Information of forest ecosystem services were also mentioned. It was also suggested to focus on access to and efficient use of water resources; CAMON can say something about the future supply, but also needs to think about the demand and associated political situations. Gender equality and prospects for climate-driven or influenced migration was also considered important by this group. Crucially, these data should not only be historic, but should also incorporate future projections and scenarios.

A final group again considered population dynamics, the age distribution, and vital statistics (e.g. mortality and birth rates) to be important. They suggested that it could be interesting to compare such population statistics before and after disasters. The group also indicated that collecting more information on climate change adaptation measures could be useful, including energy generation strategies. More generally, they suggested that understanding an economy's principal sectors, as well as the degree of internet coverage, is important. Again, water access and use was emphasized, as was education levels (e.g. data on schools), alongside information on waste management systems. Finally, data on natural hazards protection schemes and levels of formal

education were considered important in the context of supporting sustainable mountain development against the background of climate change.

Workshop conclusions

Prof. Shahgedanova drew the following conclusions and closing remarks:

- Many thanks to everyone for their contributions over the last three days, as well as their efforts to develop and sustain the mountain observatories over a much longer period
- The last three days have clearly demonstrated that CAMON is a functioning network which has been working for a long time (e.g. elements of the network have existed for 50 years, and some joint projects have been running for multiple years)
- The network thus has very strong foundations and is in a strong position to expand its capacities further.
- Indeed, despite many problems, it is clearly already comparable with the most advanced networks of mountain observatories in other countries, such as the United States, and that we have numerous shared interests and aims
- We are also very grateful to the ECRs who attended the meeting and expressed interest in joining the wider activities.
- We should endeavor to develop stronger links with our biologist colleagues, since the biosphere represents one of the largest gaps in mountain monitoring across the region
- For instance, this could be achieved by converting glaciological monitoring stations into fully fledged multi-disciplinary observatories.
- Unfortunately, social aspects have never traditionally been at the center of our scientific research, and there is a strong lack of experts working on this topic; we therefore need to add a stronger social sciences and humanities component to all our research.
- Some of our needs can be addressed within CAMON. For example, we can share lab equipment such that water isotope analyses can be done in regional centers (rather than the samples being sent to the UK or other places abroad for analysis).
- Still, there are some areas, like obtaining sufficient funding and becoming part of established networks such as GLORIA, in which external support is required.
- The MRI can help identify these potential funding sources and make links with external experts.
- Further discussions are still required on the specific details of who wants to share what (data, capacities, etc.) with whom, which can be topics to explore in future.
- It was agreed that CAMON should develop a web presence. In the first instance, this can be a simple web-page hosted at GEO Mountains (as a GEO Mountains Community Project) that provides a short overview of the sites (e.g. their locations, aims, operating organizations). In addition to this, to the greatest extent possible, CAMON sites (and indeed any other monitoring locations in the region) should submit their key metadata information to GEO Mountains so that they can all appear in the next release of the GEO Mountains In Situ Inventory. (GEO Mountains staff can provide assistance in this task).
- A logo could help the network develop a strong visual identity.

It was agreed that it could be useful to create a CAMON mailing list for more efficient communication among CAMON contact points. In addition, after lengthy discussions, it was agreed that CAMON would submit at least one proposal to GEO Mountains' "Data Projects" small grants call on topics such as biotic monitoring / assessing the scope of potential collaboration with GLORIA, and efforts to develop inventories of existing datasets.

The meeting then culminated with CAMON members signing a Memorandum of Understanding (MoU). Whilst this is not a legally-binding document, the fact that it was signed again confirms that CAMON is a serious network. A version of the original document that has been translated into English is appended to this report.

While concluding the workshop, the organizers warmly thanked:

- All the staff of Hotel Almaty, including the caterers;
- The technical staff, for setting up and running the audio-visual equipment that permitted online participation;
- The interpreter, Siarhei Miadzvetski (TMT Eurasia Consulting) for enabling such effective dialogue between the participants;
- The staff of CARGC who contributed to the workshop, especially Dr. Alexandr Yegorov, for outstanding logistical support as well as to Irena and Olga for on-site support;
- Zarina Saidaliyeva (University of Reading, UK) for extremely valuable assistance with notetaking (in addition to contributing extensively to the scientific content of the programme); and,
- The Swiss Agency of Development and Cooperation (SDC), whose financial support enabled several participants' travel expenses to be covered.

Before leaving, participants were invited to complete a short feedback survey.

Authors: James Thornton & Maria Shahgedanova

Note takers: Zarina Saidaliyeva & James Thornton

Annex 1. Link to Presentations

All presentations given during the workshop are publicly accessible [here](#).

Annex 2. Lists of Attendance

The full list of workshop registrants / applications is provided below. Please also note that it is possible that other participants not listed above joined the meeting.

First Name	Last Name	Affiliation	Country
MURODJON	ABDURAKHMANOV	National university of Uzbekistan	UZBEKISTAN
Bulent	Acma	Anadolu University	Turkey
Tamara	Akhmedova	Scientific Research Hydrometeorological Institute, Uzhydromet	Uzbekistan
Uran	Akhmetov	International Institute of Mountains	Kyrgyz Republic
Raushan	Amanzholova	Kazakh-British Technical University	Kazakhstan
Riza Annisa	Anggraeni	ASEAN Foundation	INDONESIA
Kassymzhan	Assimov	K_assimov@kbtu.kz	Kazakhstan
Zakir	Baig	Institute of Space Technology	Pakistan
Erdenee	Batzorig	Mongolian remote sensing society	Mongolia
Temirbek	Bobushev	Kyrgyz Economic University, Professor, Bishkek	Kyrgyz Republic
Yuliya	BORISSOVA	Center for Natural Resources and Sustainability, Kazakh German University	Kazakhstan
Arnaud	Caiserman	University of Central Asia	Tajikistan
Bobur	Choriyev	Termiz state university.	Uzbekistan
Soumik	Das	Jawaharlal Nehru University	India

Tanmay	Dhar	Uttaranchal University	India
Joerg Andreas	Dinkelaker	Kazatu	Kazakhstan
Denis	Dirin	University of Tyumen, Institute of Earth Sciences, Head of the Department of Physical Geography and Ecology	Russian Federatuon
Baktybek	Duisebek	Kazakh-British technical university	Kazakhstan
Davron	Eshmuratov	Research Institute of Hydrometeorology, Uzhydromet, Uzbekistan	Ўзбекистан
Tirthankar	Ghosh	Indian Institute of Technology Bombay	India
Karamat	Hnfi	Karakoram international University	Pakistan
Gregory	Insarov	Institute of Geography of the Russian Academy of Sciences	Russia
Salauat	Kalabaev	National university of Uzbekistan	Uzbekistan
Vassiliy	Kapitsa	Central Asian Regional Glaciological Centre	Kazakhstan
Nikolay	Kassatkin	Central Asian Regional Glaciological Centre as a category 2 Centre under the auspices of UNESCO	Kazakhstan
Abdulhamid	Kayumov	State Scientific Institution "Center for the research of Glaciers of the National Academy of Sciences of Tajikistan"	Tajikistan
Gulnoza	Khamdamova	Hydrometeorological Service Agency under the Ministry of Natural Resources	Uzbekistan
abdul	khan	u.p. irrigation and water resources development department, lucknow, india	india
Alisher	Khudoyberdiev	National University of Uzbekistan	Uzbekistan
Larissa	Kogutenko	Kazakh-German University	Kazakhstan
Alexandr	Kokarev	Central Asian Regional Glaciological Centre under the auspices of UNESCO	Kazakhstan
Maira	Kussainova	Kazakh National Agrarian Research University	Kazakhstan
Liudmila	Lebedeva	Melnikov Permafrost Institute	Russia
Lyazzat	Makhmudova	Kaznaru, Department "water resources and melioration"	Kazakhstan
Assyl	Makyzhanova	Satbayev University	Қазақстан
Gavkhar	Mamadjanova	University of Reading	United Kingdom
Adkham	Mamaraimov	University of Potsdam and GFZ, Germany	Germany
Sagynbek	Orunbaev	American University of Central Asia	Kyrgyzstan
Ali	Rehmat	Hussaini Organization for Local Development HOLD	Pakistan
Olga	Romanova	Kazakh-German University	Kazakhstan
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Najibullah	Sadid	University of Stuttgart	Germany
Gulshat	Sagatdinova	Institute of Ionosphere	Kazakhstan
safiullah	sahil	Kazakh-German-University.	Kazakhstan
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Akgulim	Sailaubek	Institute of Geography And Water Security	Kazakhstan
Tomas	Saks	University of Fribourg	Switzerland
Hansha	Sanjyal	Global South Initiative	Nepal
Vishwambhar Prasad	Sati	Mizoram University, Aizawl	India

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Igor	Severskiy	Central Asian Regional Glaciological Centre under the auspice of UNESCO	Казахстан
Sarkorbek	Suvonqulov	Institute of Geology and Geophysics named after X.M.Abdullaev	Uzbekistan
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Em	Timur	Kazakh-British Technical University	Kazakhstan
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Zokhid	usarov	Hydrometeorology Scientific Research Institute	Uzbekistan
Vadim	Yapiyev	Nazarbayev University, School of Mining and GeoSciences	Kazakhstan
Darkhon	Yarashev	SCIENTIFIC RESEARCH INSTITUTE OF HYDROMETEOROLOGY OF UZBEKISTAN	Uzbekistan
Darkhon	Yarashev	SCIENTIFIC RESEARCH INSTITUTE OF HYDROMETEOROLOGY OF UZBEKISTAN	Uzbekistan
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Мария	Ананичева	Институт географии РАН	Россия
Аслам	Кадамов	Университет Центральной Азии, Институт Изучение Горных Регионов	Tajikistan
Виктория	Крылова	Казахстанско-Немецкий университет в г. Алматы	Казахстан
Зульфия	Куранбаева	Научно-исследовательский гидрометеорологический институт	Узбекистан
Азамат	Мадибеков	АО "Институт географии и водной безопасности"	Казахстан
Адилет	Макешов	ТШВНЦ при ИВПиГЭ НАН КР	Кыргызтан
Петров	Максим	Институт Геологии и Геофизики при ГОСКОМГЕОЛОГИИ РУз, Центр	Узбекистан
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Annex 3. Photographs

A number of photographs taken during the workshop are available [here](#).

Annex 4. Discussion outputs

A number of photographs of the flipcharts that were used to summarize the discussions are available [here](#).