GEO Mountains Workshop: Interdisciplinary Monitoring, Data, and Capacity Sharing across the Caucasus

Akaki Tsereteli Kutaisi State University, Kutaisi, Georgia

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Final Report (for Dissemination)

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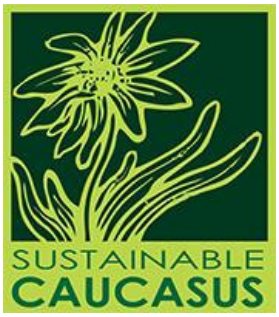

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1. Introduction & Workshop Aims

This workshop was one of a series of engagement undertaken by GEO Mountains in 2023 under the Adaptation at Altitude programme[1]. It took place at Akaki Tsereteli Kutaisi State University, Kutaisi, Georgia, within the context of the Caucasus Mountain Forum 2023. The event was co-convened by the Mountain Research Initiative (MRI) / GEO Mountains and UNEP/GRID-Geneva.

The workshop sought to bring together data providers and data users from a range of disciplines working across the Caucasus. More specifically, to complement other ongoing work (e.g. the Caucasus Environmental Outlook), the workshop focused on i) the coverage and availability of in situ data, ii) how exchanges opportunities for capacity sharing, and iii) potential data exploitation activities.

The programme and list of participants are provided below in Section 2 and Annex 3.

2. Previous Online Workshop & Consultation

The workshop built upon a previous online workshop[2], which was held on 30 September 2021. The virtual consultation that followed that meeting indicated that:

- Most respondents consider themselves either data users or both data users and providers, and most work with multiple different types of data (e.g. in situ and remotely-sensed) at regional scale;
- A high proportion of respondents are working on forward looking projections related to climate change;
- A range of approaches are currently employed in the region to discover potentially useful datasets, such as internet searches or reading journal articles or technical reports;
- Nearly half or respondents would not consider paying licence fees to obtain data;
- 35% of respondents experience significant difficulties in discovering, accessing, or using relevant data;
- A reasonable proportion of respondents experience moderate technical or computation challenges that limit their ability to exploit existing data;
- 45% of respondents suggested that closing the most critical data gaps would have major positive impacts on their work;
- Amongst the data providers, a majority (53%) already make their own data available for non-commercial purposes, and this is mostly done via institutional repositories;
- A large proportion of respondents identified “making the actual measurements” as the most problematic or challenging step in the data delivery pipeline;
- Inter-institutional competition and limited / time and funding were identified as the most important barriers to enhanced data sharing, and the potential for data to be misused was also highlighted as a concern of data providers;
- There is strong support for the concepts of Open Science and Open Data, including dedicated “data” publications; and,
- There is support for dedicated regional data portals.

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

[1] https://adaptationataltitude.org/
[2] https://www.geomountains.org/news-page-all/138-geo-mountains/2817-inter-and-transdisciplinary-mountain-data-in-the-caucasus-identifying-user-requirements-and-access-preferences

3. Workshop Programme and Key Points

Below, the workshop programme is presented and a few key points made regarding data availability, exchange, use, and outstanding challenges (as applicable) are listed beneath each item. For further details, please see the slides shared in Annex 1.

Session 1 (11:15 – 13:00):

11:15 – 11:20: **Welcome & Introduction to the MRI** – Dr. Carolina Adler (MRI)

11:20 – 11:35: **Introduction to GEO Mountains & Recent Activities** – Dr. James Thornton (MRI)

- James presented various recent GEO Mountains activities and outputs
- Particular attention was paid to a study that assessed the coverage of open in situ daily climate from across the world's mountains; according to this study, station density in the Caucasus is fairly high compared with other regions, although the highest elevations are still somewhat under sampled.
- GEO Mountains In Situ inventory was also presented. Based on this, there seem to be few research-oriented sites (e.g. infrastructure established by university groups / research programmes).
- A further GEO Mountains study suggests that increases in human population and urbanisation over a recent 40-year period have been rather modest.
- GEO Mountains *Mountains Uncovered*[3] series of fact booklets was also presented, and physical copies of the booklets corresponding to the region were made available for consultation.

11:35 – 11:50: **Operational hydrometeorological activities in Georgia's mountains** – Dr. Irakli Megrelidze (Deputy Head of Hydrometeorological Department, National Environmental Agency, Georgia)

- The department is responsible for a wide range of monitoring and services
- A considerable drop in the number of meteorological stations occurred in the years prior to 2000, although the number is starting to increase again now.
- One of the application areas is early warning systems, and in this respect current radar observation networks play an important role (e.g. for flash floods).
- Avalanches and periglacial hazards are important issues; an alarm system was installed at Devdoraki Glacier in 2016.
- Major enhancements to the infrastructure and underway and will continue in coming years thanks to a project from the Green Climate Fund that also involves UNEP.

11:50 – 12:05: **Introduction to the concept of "Mountain Observatories"** – Prof. Maria Shahgedanova (University of Reading) [online]

- The general concept of Mountain Observatories was introduced.
- Examples were given of other networks which align with such a vision, such as VAO[4].
- There is a well-functioning network in Central Asia, but sites which could be or become Mountain Observatories are less clear – although there are some possibilities.

[3] https://www.geomountains.org/resources/outreach
[4] https://www.vao.bayern.de/

- The MRI Mountain Observatories Working Group is willing to assist any efforts to develop such integrated, long-term, multi-method monitoring efforts.

12:05 – 13:00: **Discussion A**:

A facilitated discussion took place in plenary, guided by the following questions:

What can you say about measurement stations in your region? Are they numerous? Are they functional? Are their data freely accessible?

Based on the existing infrastructure and data (see e.g. the Caucasus GeoNode, GEO Mountains' Inventories and the Mountains Uncovered Series), how could the vision of a regional network of Mountain Observatories be (further) implemented in the region?

Where could these potential supersites cluster / be located? How can capacities be shared amongst different institutions / organisations conducting mountain monitoring in the region?

The following key points were raised by participants in response to these questions:

- Although the discussion was slightly curtailed due to time constraints, Georgia Hydromet mentioned that they do have a station at 3,600 m near Mount Kazbek, but note that site visits and maintenance at the site are challenging.
- The Georgian Hydromet service explained that are available free of charge to academic researchers, and that if the data are shared more widely, there could be a risk that some data may be misinterpreted; the general public rather want the services directly.
- Some hydromet data rescue / digitisation activates have been undertaken (e.g. with support from Norway), but the availability of the resultant data is still not guaranteed or fully evident in some cases.
- The Georgian Hydromet service has a collaboration with the Turkish State Meteorological Agency.
- The Azerbaijan Renewable Energy Agency also conducts some exchange on a regional level.

Session 2 (16:45 – 18:30):

16:45 – 17:00: **Working Group on Research of RA VI & the Research Board Task Team dedicated to data sharing with the research sector** – Prof. Adina-Eliza Croitoru (Research Board Management Group, World Meteorological Organization & Babes-Bolyai University)

- The WMO Research Board is seeking to take stock of research activities related to cryosphere changes and their societal impacts to try and identify opportunities to transfer infrastructure and methods from research to operations.
- WMO will support the free and open exchange of data related to the cryosphere and other Earth System domains, plan projects for integrated regional mountain monitoring and early warning centers, and continue advocacy for crucial satellite observations in mountain regions.
- Attention was drawn to the WMO Unified Data Policy.
- A key point is that research / academia requires more than only "core" (i.e. standard weather) data.

- Infrastructure for data sharing is provided by WIS 2.0[5] (see also[6].
- Various consultations with the research community are planned by WMO regarding data exchange.
- WMO Regional Association VI (Europe) has its own focus and plans, including developing a regional research plan.

17:00 – 17:25: **Technologies for data storage and exchange with a focus on in situ data** – Dr. Yaniss Guigoz (University of Geneva)

- The Spatial Data Infrastructure in Caucasus already contains a great deal of data (mostly spatially distributed)
- In situ data are important, but in some senses are more challenging to share; how can we integrate in situ data into an existing spatial data infrastructure?
- The GEO Mountains In Situ Infrastructure is a step towards the implementation of the FAIR principles, but further work is required.
- OGC has various standards, including SOS, but the uptake of this option has been limited.
- There is a general trend towards the use of APIs rather than web services, and in particular SensorThings, various examples of which were presented.

17:25 –18:25: **Discussion B:**

A second facilitated discussion took place in plenary, guided by the following questions:

How can we enhance data exchange and use between the research community, NHMs, and other stakeholders in the region?

How can we build stronger links between educational institutions and the monitoring community?

How can we expedite the transition from data to information in support of climate change adaptation policy?

The following key points were raised by participants in response to these questions:

- The Georgian Hydromet service hosts visits / internships from universities, which could be considered an example of good practice to be replicated more widely. This scheme works both to the benefit of the students and the agency.
- As a research community, we need to evaluate and decide whether to use SensorThings or WIS2. Small pilot projects should be conducted initially, following further discussions. (Note that WIS2 is primarily designed for “core” data, in WMO parlance, whilst much research data may be in the “recommended” category).
- Data availability remains a key impediment to delivering actionable information in many regards.
- Another major challenge is related to climate model outputs; the Caucasus region sits on the periphery of various domains which could affect the quality of the outputs. Moreover, the available in situ data from the different national monitoring agencies and research groups (if applicable) in the region has not yet been brought together to systematically evaluate historical model performance and potentially devise improved downscaling and bias correction techniques that are seamless across national

[5] https://community.wmo.int/en/activity-areas/wis
[6] https://docs.wis2box.wis.wmo.int/en/latest/

borders. Such data would be particularly valuable in addressing transboundary issues. This could represent a high-impact joint project that could be conducted collectively.
- Developing a transboundary hydrological budget for major catchments could be another high-impact collaborative project.
- MRI mentioned that in the IPCC AR6, regions that appear relatively data poor were identified, and in such cases it is imperative (including to address the decision reached at COP27) to establish whether they really are data poor, or rather whether there are sufficient data, but they are not accessible or in usable formats.

18:25 – 18:30: **Summary, Conclusions, and Next Steps** – James Thornton, Carolina Adler, & Yaniss Guigoz

Outlook and prospects from GEO Mountains to support the region and seek regional participation in inter-regional efforts.

4. Conclusions & Next Steps

In summary, the workshop was well attended by representatives from environmental monitoring national agencies and researchers from several countries. During the workshop, participants discussed the potential to establish multi-disciplinary Mountain Observatories (MOs) in the region. Although currently in situ observations are generally for operational purposes and are limited to specific themes (typically weather and climate), the potential could exist to develop an MO in the Kazbegi region, where there are already nearby stations as well as a GLORIA site[7]. Across the wider Caucasus region, according to the World Glacier Monitoring Service (WGMS)[8], there are 10 glaciers with at least some historical in situ glacier mass balance estimates, which – especially if still actively monitored – could also act as "nodes" for enhanced integrated monitoring.

In the afternoon, participants were informed of, and discussed, different options for increasing the exchange of data and capacities between the research and operational communities. For instance, participants learnt about the activities under WMO to engage more extensively with the research community and integrate their data into WMO systems (e.g. in the form of "recommended data" in WIS2.0). Alternative approaches such as the Open Geospatial Consortium (OCG) SensorThings API[9] were also presented.

In the final discussion, it was made clear that certain barriers with respect to in situ data accessibility remain to be overcome, but several ways forward were proposed. For instance, a pilot collaborative project could be developed in Phase 2 of Adaptation at Altitude to expose in situ data from a small number of stations whose data can be shared via SensorThings.

In addition, the need for improved (i.e. much higher resolution downscaled and bias corrected) climate change projections from the region, which sites at the extremities of existing regional climate model domains, was identified as a critical need. If such work could be conducted in a collaborative manner, such that in situ data from all countries in the region could be included, the resultant products would benefit a wide range of applications, both research and practical. These options will be explored thoroughly and potentially incorporated into GEO Mountains wok plan in the second phase of Adaptation at Altitude.

[7] http://www.pakbs.org/pjbot/PDFs/48(5)/16.pdf
[8] https://wgms.ch/data-exploration/
[9] https://www.ogc.org/standard/sensorthings/

In light of continued climate change and other pressures on the region's mountain environments, the urgency of many of these tasks was noted by participants.

In concluding the workshop, the organizers warmly thanked:

- The organisers of the Caucasus Mountain Forum, and especially Ana Ungiadze, for room preparation and technical support.
- All invited speakers for their excellent contributions.
- All participants for sharing their time and expertise.

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

Author and note taker: James Thornton

Annex 1. Link to Presentations

All presentations given during the workshop are saved in an online repository and publicly accessible here[10]. The recordings are available upon request (james.thornton@unibe.ch).

Annex 2. Lists of Registrants

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

First Name	Last Name	Affiliation	Country
Mamuka	Gvilava	GIS and RS Center GeoGraphic	Georgia
Francesca	Eccher	Libera università di Bolzano	Italy
Giorgi	Ghambashidze	Scientific-Research Centre of Agriculture	Georgia
Rana	Humbatova	Azerbaijan Renewable Energy Agency	Azerbaijan
Alexandrine	Massot	Mountain Research Initiative	Switzerland
Rana	Humbatova	Azerbaijan Renewable Energy Agency	Azerbaijan
Adina	Croitoru	Babes-Bolyai University/ World Meteorological Organization	Romania
Arsen	Nikoyan	Ministry of Environment	Armenia
Ani	Ghukasyan	Ministry of Enviornment	Armenia
Somnath	roy	IIGST	India
Tariq Ibrahim	Ujjan	PMD	Pakistan
Maika	Bilbao	Universidad Nacional de Cuyo	Argentina
Jonathan	Muñoz Pérez	ESA	France
TEMUR	GUGUSHVILI	International Black See University	Georgia
Gvantsa	Salukvadze	Tbilisi State University	Georgia
Leonid	Petrov	Lomonosov Moscow State University	Россия
Giorg	Zagareli	designtbilisi, MARD	Georgia
Dhanendra	Singh	Suresh Gyan Vihar university, Jaipur (India)	India
Wilson	Lechón	Universidad Central del Ecuador	Ecuador
Nandita	Paul	Presidency University Kolkata, MSc Student (Geography)	India
Viankcor Henry	Cashpa Carrion	Instituto Nacional de Investigación en Glaciares y Ecosistemas de Montaña	Perú
Izabella	Khanzratyan	Enterprise Incubator Foundation (workplace)	Armenia
Lavanya	Witharana	University of Gothenburg	Sweden
Nadya	Yanakieva	Space research and technology institute, Bulgarian academy of sciences	Bulgaria
Svetlana	Jumaeva	Swiss Agency for Development and Cooperation	Tajikistan

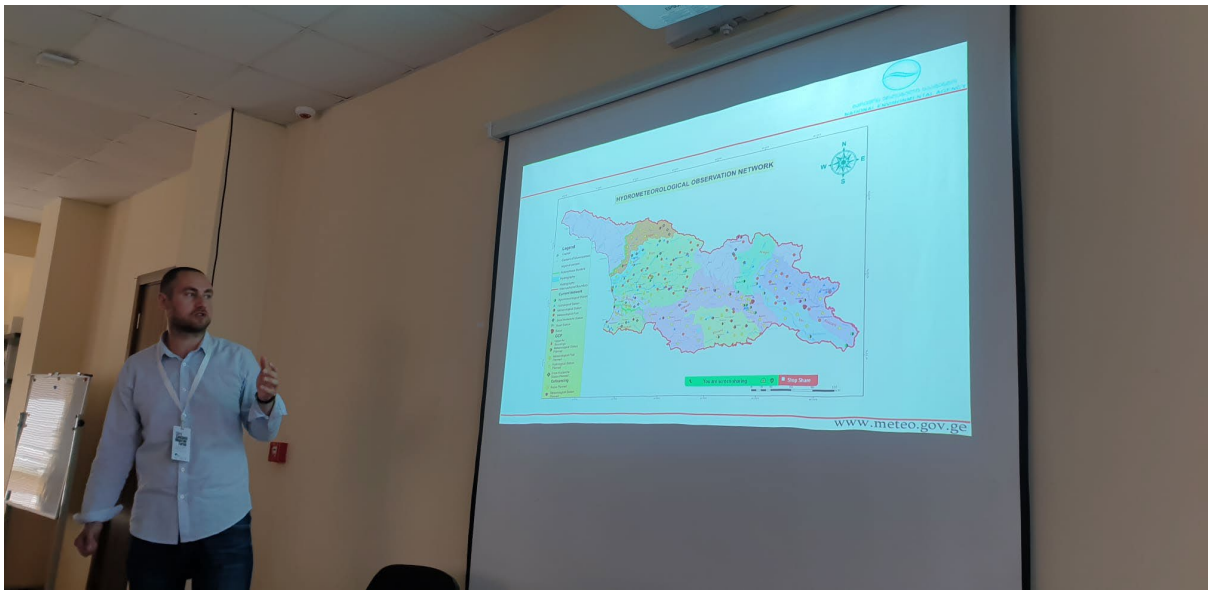
[10]https://drive.google.com/file/d/1ekWmHwuwtl2iHYjwdcwrdHeFkXrpc4bD/view?pli=1

Humbatov	Fuad	Ministry of Ecology and Natural Resources	Azerbaijan

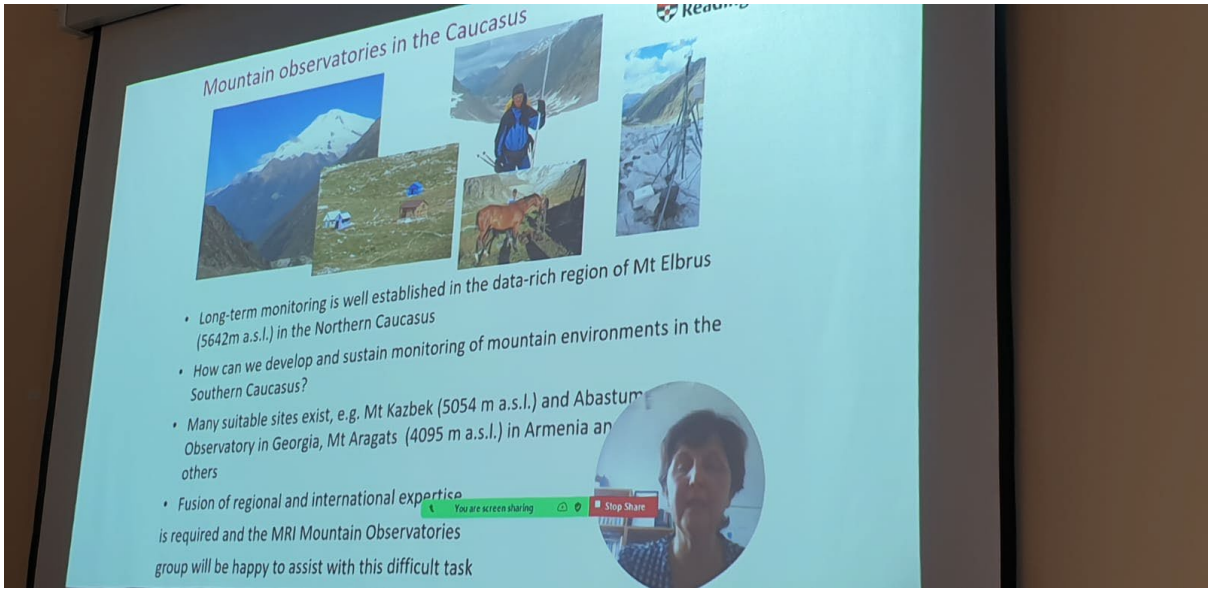
Annex 3. Photographs

Several photographs taken during the workshop are provided below.

Dr. James Thornton, MRI & GEO Mountains (Photo: © Carolina Adler / MRI).



Dr. Irakli Megrelidze, Hydrometeorological Department, National Environmental Agency, Georgia (Photo: © Carolina Adler / MRI).



Prof. Maria Shahgedanova, University of Reading & MRI Mountain Observatories Working Group (Photo: © Carolina Adler / MRI).

Prof. Adina Croitoru, Research Board Management Group, World Meteorological Organization & Babes-Bolyai University (Photo: © Carolina Adler / MRI).

Dr. Yaniss Guigoz, GRID-UNEP (Photo: © Carolina Adler / MRI).