GEO Mountains Workshop: Interdisciplinary Monitoring, Data & Capacity Sharing across the Hindu Kush Himalaya

ICIMOD, Kathmandu, Nepal

6-8 November 2023

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1. Introduction & Workshop Aims

The workshop was part of a series of regional engagements undertaken in 2023-24 by the Mountain Research Initiative (MRI) in its role co-leading the Global Network on Observation and Information in Mountain Environments (GEO Mountains) under the Adaptation at Altitude programme (A@A). The workshop for the Hindu Kush Himalaya (HKH) region took place from Monday 6 to Wednesday 8 November 2023, and was co-convened by the International Centre for Integrated Mountain Development (ICIMOD), the Himalayan University Consortium (HUC), and the World Meteorological Organization (WMO).

The workshop was hosted by ICIMOD in Lalitpur, Kathmandu, Nepal. It sought to bring together data providers and data users from a range of disciplines working across the HKH. More specifically, through a series of invited presentation and group discussion activities, the workshop sought to:

- Identify examples of good practice, challenges, and solutions / opportunities regarding mountain monitoring, data exchange, and capacity sharing;
- Enhance the sharing of data, capacities, and training resources between monitoring authorities (e.g. National Hydrological and Meteorological Services; NHMSs) and researchers, as well as identify opportunities for students / Early Career Researchers (ECRs) to (further) engage in mountain monitoring;
- Explore opportunities to enhance the thematic scope of existing monitoring efforts & better integrate biophysical and socio-economic data obtained using different approaches;
- Identify priority variables for monitoring, understanding, and predicting the socio-economic dimensions of mountain systems across the region under global change; and,
- Propose future projects with the potential for high scientific, practical, and/or policy impact which could be conducted collaboratively by some of the workshop participants going forwards.

The workshop was attended by researchers, representatives of national environmental monitoring agencies, and other local institutions. In total, 82 participants attended the workshop, of whom 62 attended in person and 20 online. Participants came from across the region, including Nepal, Pakistan, India, Bhutan, Bangladesh, and China. In addition, researchers working in the region or in a co-convening role from France, Italy, Romania, the UK, Switzerland, and Germany were in attendance. For the full list of in person attendees, see Annex 2.

This report presents the workshop proceedings and summarises the key points, outcomes, and recommendations that arose from the discussions.

2. Previous Online Workshop & Consultation (2022)

The event built upon a previous online workshop held in June 2022. The outcomes of the virtual consultation following that engagement included the following points:

- Respondents were mainly affiliated with the research sector and government agencies, and spanned a wide range of disciplines;
- Most respondents work using combinations of different types of data, although a reasonable proportion also reported primary reliance on in situ data;
- An equal proportion of respondents identified themselves as “data providers” and both “data providers and data users”;
- A reasonable proportion of respondents reported that they would “sometimes” consider paying licence data fees, although fewer said they would “never” do so;
- Nearly half of respondents indicated that they “frequently” or “sometimes” experience difficulties in discovering, accessing, and using data;
- Nearly half of respondents indicated that technical or computational constraints sometimes limit their ability to extract value from available data;
- A majority of respondents indicated that addressing the most critical data gaps would “significantly” or “somewhat” improve the efficiency and impact of their work;
- Over half of respondents make their own data freely available to others;
- Institutional repositories clearly dominated as a preferred means of data sharing, while a dedicated regional inventory / data portal was deemed to be highly important;
- “Service to the community” followed by “altruism” (*quid pro quo*) were listed as the most important motivations for data sharing;
- In order of perceived importance, “limited time / funding”, “(inter-)institutional competition”, “limited technical capacities”, and “IT constraints” (e.g. large file sizes) were identified as being the most important current barriers to more extensive and routine data exchange;
- Respondents exhibited strong support for the principles of Open Data / Open Science, with almost all indicating that this is either “extremely” or “somewhat” important for the advancement of their discipline, and related policy and practice; and;
- Respondents suggested that “Combining multiple types of data”, “extending existing in situ observatories and establishing new ones to ultimately develop a network of Mountain Observatories with common standards”, and “exploiting the potential of high-resolution satellite Earth Observation data products” were the strategies with the most potential to improve the availability and usability of climate and climate impact-related data across the region’s mountains.

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

3. Workshop Programme & Key Points

In this section, the workshop programme is presented. Beneath each item, a few key points made by the presenters or during the discussions regarding data availability, exchange, use, and outstanding challenges (as applicable) are stated. For further details regarding the presentations given, please see the slides which were presented (the link is provided in Annex 1).

Day 1

Monday 6 November

09:00 – 09:30: Arrival & Registration

09:30 – 09:45: Welcome – Carolina Adler (Executive Director, MRI; virtual) & Pema Gyamtsho (Director General, ICIMOD)

Dr. Thornton introduced himself, welcomed the Director General of ICIMOD and all participants, provided some information on the context of the workshop (the A@A programme), and thanked ICIMOD staff (especially Sudip Pradhan and Rajesh Shrestha) for their excellent collaboration in the event's preparation.

A pre-recorded message of welcome from Dr. Adler, MRI Executive Director, was then played. Next, Dr. Gyamtsho (ICIMOD Director General) gave some words of welcome and opening remarks on behalf of ICIMOD. In light of the vulnerability of the HKH and the broader geopolitical situation, Dr. Gyamtsho's address highlighted the importance of monitoring and the need to exchange the associated data in an open yet sensitive fashion.

A group photograph was taken.

09:45 – 10:05: **Workshop Objectives, Participants' Expectations & Overview of GEO Mountains – James Thornton (MRI)**

Dr. Thornton summarised the objectives that GEO Mountains' hoped to achieve during the workshop (see the link to the slides in Annex 1). All participants were invited to share their own expectations of the workshop and any more general initial ideas related, which were then collated (see Annex 4). Dr. Thornton then proceeded to give a brief introduction to GEO Mountains' and its key activities and outputs over the last few years (e.g. the development of data portals, hosting other workshops, and generation of policy-relevant outputs).

Participants were encouraged to contribute metadata on monitoring sites they operate (or are aware of), and/or any gridded datasets they have developed or feel could be useful to the wider mountain community, to GEO Mountains' In Situ and General Inventories, respectively. A policy brief that was developed on "Mountain Observations" and the *Mountains Uncovered* Series – which provides intercomparable, multi-thematic information on 100 global mountain ranges – were also mentioned; both resources are available via the GEO Mountains website.

10:05 – 10:20: Introduction to the general concept of "Mountain Observatories" – Maria Shahgedanova (University of Reading & MRI; pre-recorded)

Prof. Shahgedanova highlighted the general lack of in situ data in mountain environments and the need to better understand interactions between biophysical processes and societies – both in the mountains themselves and in adjacent lowlands.

In this context, the Mountain Observatories Working Group aims to establish regional and eventually global networks of long-term, multi- and inter-disciplinary, multi-method, and multi-

scale mountain monitoring “hubs” or “super-sites” (Shahgedanova et al., 2021). The types of data / specific variables that such sites would ideally monitor were presented.

Then, some examples of existing sites that largely meet the definition of “Mountain Observatories” were drawn from Central Asia. Indeed, several of these sites (and their operating institutions) have already been consolidated into a formalised network – the Central Asia Mountain Observatories Network (CAMON). Participants involved in such sites were warmly invited to join the working group.

10:20 – 10:40: Introductory presentation from ICIMOD: Regional Database & Information Services – Sudip Pradhan (ICIMOD)

Mr. Pradhan presented several of ICIMOD’s past and ongoing ICIMOD initiatives, programmes, and systems related to data and information sharing, including the Regional Database System (RDS) – a data regional data portal for the HKH – and SERVIR – which seeks to exploit Earth Observation (EO) and geospatial technologies to address critical challenges. According to ICIMOD’s policies, all data disseminated via these platforms are freely downloadable.

The Forest Fire Detection and Monitoring System in Nepal, which has recently been extended to include Bhutan, and the Regional Land Cover Monitoring System were amongst the services presented. Drought monitoring and early warning systems are also in place (please see the slides for further details).

10:40 – 11:00: **BREAK**

11:00 – 12:00: Invited presentations on existing mountain observatories / experimental basins / local networks (I)

Syed Hammad Ali – Glacier Monitoring Research Centre (GMRC), Pakistan Water and Power Development Authority (WAPDA) (online)

Dr. Ali’s presentation focused on the Upper Indus Basin (UIB), which contains over 7,000 glaciers. The WAPDA’s mission is to manage Pakistan’s water resources for irrigation, energy, and flood control. The organisation is responsible for hydro-meteorological monitoring, including the maintenance of a network of stations in the remote UIB. The data from these stations are transmitted to a central node (using the Meteor Burst Communication System; MBCS) and contribute to river flow forecasting. Further details were then given on the organisation’s monitoring network, including the variables monitored. Some of the associated data were also illustrated.

Tao Che, Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS) – Observations of Hydrological, Ecological & Environmental Processes in the Heihe River Basin

Prof. Che’s presentation focused on the Heihe River Basin, which is located in north-eastern China. The team are currently checking the various stations that are present to ensure that the data returned are of high quality. Two field campaigns per year are typically conducted, during which instruments are calibrated. The importance of integrated, multi-scale monitoring – including using both in situ and remote sensing methods – to help inform broad-scale studies on the future evolution and security of water resources derived from the Himalayas / Third Pole was also highlighted.

Sonam Lhamo, Bhutan National Centre for Hydrology and Meteorology – Status of Cryosphere Monitoring in Bhutan

Dr. Lhamo explained the high importance of the cryosphere to freshwater regimes in Bhutan, including with regards to water supply, energy generation, and extreme events. Three specific glaciers are currently monitored intensively: Gangju La, Thana, and Shodug. Current limitations in the monitoring programme are related to aspects such as permafrost, black carbon, and snow, as well as establishing the contribution of glacier melt to downstream river discharge. Knowledge on the sustainability of the existing hydropower sector in the face of ongoing climate change impacts also remains somewhat lacking. Many data are available on the centre's website, and a form enables additional data to be requested if necessary.

Mohd. Farooq Azam, IIT Roorkee – Meteorological Observations over Two Reference Glaciers in India (online)

Dr. Azam presented observations from two reference glaciers in India: Drang Drung and Chhota Shigri. At both glaciers, meteorological conditions, snow depth, and glacier mass balance are measured. Photographs of numerous stations were shown, and the various fluxes they measure listed. Some of the surface energy balance calculations that can be made with the resultant data were also presented.

12:30 – 13:40: **LUNCH**

13:30 – 15:00: Invited presentations on existing mountain observatories / experimental basins / local networks (II)

Jakob Steiner, University of Graz / Himalayan University Consortium (HUC) – Catchment Science in High Mountain Asia: the Langtang Monitoring Site

Dr. Steiner began his presentation by suggesting that whilst monitoring activities and associated data generation are now conducted at numerous sites across the region, a key issue is that the accessibility of those data often remains lacking. In addition, whilst many high elevation regions are now fairly well-covered by monitoring infrastructure, improvements are arguably still required in the intermediate elevations.

Station maintenance was also highlighted as being a key challenge, whilst improving data sharing mechanisms will be imperative if efforts in the region are to be more fully recognised and contribute to global analyses and assessments. The Langtang catchments, with its steep gradients of climate and ecology, has been an active place of research over recent years; sustaining monitoring in such an environment is challenging and implies considerable costs.

Miriam Jackson, ICIMOD – ICIMOD-supported observation networks in Nepal

Dr. Jackson explained that ICIMOD operates a strategic group working on the cryosphere and associated risks. The group maintains several observation networks in Nepal, namely in Langtang, Mustang, and Humla, and also conducts activities in other HKH countries. At the Yala Glacier, the group collaborates with several different institutes to foster student training and capacity development.

In Langtang, monitoring foci includes snow and biodiversity. Efforts have also been made to engage with the local community in the valley, exploring links between the cryosphere and livelihoods. The group's future plans in Langtang include continuing to develop projects involving community stakeholders at the nexus of ecosystem, food security, and agriculture.

At the Rikha Samba Glacier, previous monitoring has not been continuous, but two new snow monitoring stations were recently installed and permafrost measurement have also now begun. Meanwhile, in Humla, extensive work with the local community commenced two years ago, with the objective of increasing capacities and the community's understanding of the ongoing scientific activities.

Min Feng, Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS) – National Tibetan Plateau/Third Pole Environment Data Center (TPDC)

The Tibetan Plateau Data Center (TPCD) is the only data centre dedicated to the Tibetan Plateau in China, and contains multiple types of data including remote sensing, in situ, and simulation / reanalysis data spanning several different disciplines. The FAIR principles are followed, and DOIs are issued for all datasets. The TPCD also provides an outlet for individual scientists and research institutions to share their data.

Jeniya Shakya, SmartPhones4Water–Nepal – Citizen Science-Based Hydro-Meteorological Monitoring in the Kathmandu Valley

SmartPhones4Water is an organisation that facilitates citizen science-based (CS) environmental observations. The approach can be a powerful way to mobilise communities (including the general public and students) to close gaps in traditional measurements. Originally the focus was on water resources monitoring in Kathmandu Valley, although activities have now been extended to other regions too. The main variables monitored correspond to rainfall, groundwater, and stream discharge. Mobile technology plays a crucial role in supporting CS observations. Each year, an expedition is organised during the monsoon period, during which intensive observations are made. To ensure data quality, checks are undertaken prior to publication.

Christoff Andermann, Université de Rennes – High Mountain Plateau Margin Critical Zone Observatory

Dr. Andermann's presentation emphasised the need to look beyond glaciers. For example, previous research which demonstrated the importance of groundwater storage and discharge in the region's river flow dynamics was presented. Fundamental measurement challenges encountered in high mountain systems were highlighted, notably the measurement of extreme river flows. The group's research is increasingly exploring landscape responses to earthquakes. Another area of work is the development of bespoke sensors able to withstand the region's extreme conditions. For example, a novel precipitation sampler (for isotopic analysis) has been developed. The group intends to build upon existing monitoring activities in the Kali Gandaki catchment and establish the site as a multi-disciplinary Critical Zone Observatory (CZO). To that end, an invitation was extended by Dr. Andermann to any participants who may be interested in collaborating or contributing to this effort. The presentation concluded by emphasising the need to establish strong networks, comprising diverse actors, to collect and exchange data.

Tom Matthews, King's College London – Improving Metrological Monitoring Capacity in High Mountain Regions (pre-recorded)

In general, weather stations in the region are extremely lacking above glacier equilibrium lines. Data measured at several such stations established during the National Geographic expeditions to Mount Everest are free and available here. Besides scientific applications, the installation and sustained operation of high-elevation weather stations can have societal co-benefits, for instance in relation to the forecasting of extremes or resource management (e.g. hydropower dam operation). A main challenge, however, is scale mismatch between the resolution of Numerical Weather Prediction (NWP) models and point station observations. To improve forecasts at specific locations, NWP model outputs can be empirically corrected using station observations. To that end, Dr. Matthews and colleagues are currently working on a project under GEO Mountains' Small Grants Call 2023; At-Scale Model Output Statistics (AtsMOS) will result in an open, user-friendly tool in which several different algorithms can be applied to make these corrections. The group is also working on improving the resilience of stations for operation in such extreme conditions (e.g. cold, high winds).

15:00 – 15:30: BREAK

15:30 – 16:45: **Discussion I: Towards more coordinated research-oriented monitoring and enhanced data availability and capacity exchange: good practices, challenges & opportunities (All)**

Participants were divided into five groups of approximatively 10 people each. An online group of 11 participants was also formed. Each group was invited to appoint one or more Rapporteur(s), and independently discuss the following question:

With respect to the coordination of research-oriented monitoring and exchanging associated data and capacities, what examples could you give of:

- *Good practices*
- *Current challenges*
- *Potential solutions / future opportunities?*

All participants then reconvened for a reporting session in Plenary. The main outcomes, combined across all groups, were as follows:

Most groups highlighted specific examples of good monitoring practices, for instance in long-term glacier monitoring. The growing availability of Automatic Weather Station (AWS) data and high-resolution satellite data were also remarked upon. The considerable potential of CS-based approaches, and efforts to incorporate Indigenous knowledge more generally, were likewise identified. It was suggested that improvements in relation to data sharing are still required, and that the existence of a common platform or portal to facilitate this could be extremely beneficial – for instance to integrate the monitoring systems / data established in individual countries. Furthermore, it was suggested that regular workshops on monitoring could also help maintain a comprehensive, up-to-date understanding of the state of mountain system monitoring conducted across the region by researchers and other agencies, and would likely support enhanced collaboration.

Several other challenges were independently identified by serval groups. The accuracy, availability, fragmentation, and exchange of data remain major concerns. Indeed, many groups mentioned the difficulty of finding free and accessible data, and suggested that in some cases this can be attributed to communication issues, i.e. data are generated, but are not necessarily

well shared/communicated with the research community and other stakeholders (e.g. practitioners or policymakers). Other challenges impeding data exchange are linked to geopolitical tensions between certain countries in the region. High costs and lack of sustained funding programmes represent further challenges to the sustenance of long-term observations. Other participants noted that incentivizing citizen scientists and maintaining their interest can be difficult. Language barriers must also not be neglected, especially in relation to exchange with colleagues from China.

Several associated solutions were proposed by participants, including:

- Finding a means to (further) **improve collaboration and communication among various stakeholders** working in HKH countries (including the research community, national agencies, local decision makers, policymakers etc.) appears to be a key recommendation for enhancing data and capacity exchange;
- Creating/applying **guidelines for the standardisation of data and metadata**;
- Creating **transboundary data repositories** to facilitate consistent storage and access to data; and,
- Obtaining **additional funding** would enable various groups to maintain long-term monitoring with good quality observations in remote areas and enable the necessary attention to be paid to enhancing free and open data access.

Further details of each group's answers are available in Annex 3.

16:45 – 17:00: Summary of the Day's Proceedings (James Thornton & Sudip Pradhan)

A summary of the day was given, before participants were invited to proceed to attend the poster session in the garden.

17:00 – 18:00: Poster Session

In total, 20 posters were presented during this well-attended session. Photographs of all posters are available here.

Day 2

Tuesday 7th November

9:00 – 10:30: Invited Presentations on Mountain Monitoring & Data: An Operational Focus

Adina Croitoru, WMO & Babeş-Bolyai University – The vision of the World Meteorological Organization Research Board on Data Exchange with the Research Sector.

The WMO is increasing the emphasis it places on the cryosphere and polar and high mountain areas. Priority is being given to vulnerable regions and to enhancing data exchange, including with the research sector. For mountain applications, the WMO's Panel on Polar and High Mountain Observations, Research, and Services (PHORS) is especially relevant.

In addition, following a request from the WMO's Infrastructure Commission, a task team on data exchange with the research sector (TT DERS) has been established under the WMO's Research Board to support the involvement of the research / academic community in the implementation of the WMO's (relatively recent) Unified Data Policy, which requires free and open exchange of data related to the cryosphere and all Earth system domains is enhanced. TT DERS also seeks to help ensure that researchers' needs for operational data are met. Indeed, two members of the task team from the HKH region can assist researchers with access to national agency data (see the slides presented for details).

Previous WMO engagements with the scientific communities in different meetings/regions have revealed that many challenges or situations are highly region-specific, with very different visions or approaches being applied both by individual countries within a given region, as well between regions. Despite these differences, there are also certain commonalities. For instance, access to hydrological data from national agencies is generally much more limited than weather or climate data, if available at all.

The most important actions foreseen for the WMO Task Team on Data Exchange with the Research Sector are to:

- Conduct further consultations (online and in person) to identify data needs for research purposes;
- Advocate for the mutual benefits of sharing data, including by seeking to demonstrate the bi-directional benefits of enhanced data sharing between the research and operational communities through strategic communication;
- Identify good practice examples (a few exemplars have already been identified) for data sharing, promote them to the other NHMSs, and invite them to present lessons learned;
- Explore the technical possibility to establish a catalogue/inventory of operational data that are available for the research community, alongside derived from research activities; at a first step, it is intended to be available here as a *Catalogue of Recommended Data* beneath the *Catalogue of Core Data*; data sets will be made available by their DOIs (if available), URL links, or APIs, ensuring that metadata and re-use conditions are presented; and
- A special issue of may also be curated to help present the available weather, climate, water, and environmental-related data. Data providers will be invited to present their datasets/databases, which are freely available, together with metadata, limitations and conditions for re-using the data. Finally, (video) tutorials showing examples of use would represent a step forward for data accessibility.

In addition, the possibility of integrating the data collected by the research community in the WIS database was confirmed by the representatives of the WIS working group. For ease of integration, it would be recommended that, where possible, researchers install monitoring stations that meet WMO specifications and standards. The WMO's Capacity Development Division could help ease "the final mile" of the data exchange process.

Being aware that member states are in contrasting "starting positions" with respect to data sharing, the WMO encourages and provides support for both NHMSs and research communities for mutual free data sharing, aiming to provide, in each member state and community, better

quality weather, climate, and water services based on good-quality data, and making use of advanced research and scientific achievements.

In summary, the message of the TT DERS is that enhancing data-sharing is an ongoing process, and the importance of small steps should not be underestimated. A huge effort is needed from all actors involved (i.e. NHMSs, research organisations, decision-makers, public authorities, and communities) towards better adaptation to extreme weather events and climate change impacts; by working together, we become stronger.

Md. Abdul Matin – Bangladesh Meteorological Department (BMD)

Although not an especially mountainous country, Bangladesh relies heavily on ecosystem services from the mountains. The BMD deploys a range of operational systems to monitor multiple key weather variables and provides weather forecasts and storm warnings. The country can be affected by multiple types of natural hazards, including floods, landslides (mainly due to intense rainfall), and earthquakes.

Minghu Ding, Chinese Academy of Meteorological Sciences (CAMS) – Cryospheric Observation Network on the Tibetan Plateau, China

Much of the work of Prof. Ding's group focuses on quantifying the distribution change of the cryosphere, and the associated impacts, across the Tibetan Plateau. Almost all glaciers in China have been retreating since 1960. Permafrost across the Tibetan Plateau retreated by about 25% since 1966, damaging infrastructure and increasing carbon emissions. CAMS has proposed a Third Pole Regional Climate Centre Network, which is being established under the WMO (PHORS). At present, there are currently 30 glaciers and 130 permafrost sites which are monitored in the long term. However, the network was established mainly for scientific purposes and therefore lacks consistency. A major effort is currently underway to construct 96 new cryosphere monitoring stations before 2025, although only a small proportion are currently finished. In order to help train and involve the next generation, this effort is being supported by a youth team.

Niraj Shankar Pradhananga, Department of Hydrology & Meteorology, Nepal – In situ measurements in Nepal Himalaya

The main purpose of the department is to collect and disseminate hydrological and meteorological data, and issue forecasts and early warnings for extreme events. An online dashboard presents the station network. Software has been developed and applied to enable the digitisation of paper records. Tracer-based methods are used for river discharge measurements, some cryosphere monitoring is also undertaken, and 19 new snow monitoring stations are planned. Glacial lakes are also monitored, and interventions made to lower two potentially dangerous ones in recent years. Some data from the last six days can be downloaded free of charge from the Department's website. However, according to the organisation's prevailing policy, historical data are not freely available and their sharing (e.g. with researchers) incurs charges.

Adnan Shafiq Rana, Pakistan Meteorological Department (PMD) – PMD Operations for Mountain Monitoring

The organisation's main areas of service are meteorology, hydrology, seismology, and astronomy. The situation in the Karakorum, whereby some glaciers are exhibiting positive mass balance, is anomalous in the broader regional and global context. Records exhibit an increasing trend in the frequency of hot days, and a decreasing one in the frequency of cold nights. The number of glacial lakes has increased over recent years in most regions, and 36 have been identified as potentially dangerous. Several projects are underway in the mountainous territory, including community-based flood early-warning systems and extensive fieldwork, and have had the effect of increasing the available observations.

10:30 – 11:00: **BREAK**

11:00 – 12:00: Discussion II: Towards enhanced exchange of data and capacities between the research and operational monitoring communities: Good practices, challenges & opportunities (All; led by Prof. Croitoru).

Participants once again formed small discussion groups before reconvening for Plenary reporting. The specific questions posed during this segment of the workshop were as follows:

1. *What kind(s) of data are (freely) shared in your country between the NHMSs and the research sector? (record length, frequency, variables…)*
2. *What are the limitations / barriers for such data sharing? (e.g., data policy, infrastructure, capacity, data format)*
3. *What kind of support (e.g. from WMO) would be needed to share more data?*
4. *What other possibilities can be explored to enhance data exchange and capacity?*

Below, the main responses and perspectives are summarized by each group; further details are provided in Annex 3.

Group 1:

- In Nepal, China and India, data on precipitation, temperature, discharge, snow, and hydrology generally exist, but are not free: either payment is necessary, or having a direct contact sometimes enables data to be obtained on more favourable terms. In China, temperature and precipitation data (for instance) can be purchased, but discharge data remains restricted. The process that must be followed to access and eventually use the data is time-consuming. In contrast, Pakistan shares most data for free, but also restricts discharge data.
- Limitations include changing or conflicting data policies, the lack of interoperability (e.g. different organisations providing data in inconsistent formats) and geopolitical sensitivities, the latter seeming to be the main reason for hydrological data restriction.
- Support in developing intergovernmental mechanisms and legislation could help enhance data exchange and increase collaboration with the research community.
- Improving the financial support for data-sharing activities could also be beneficial, as could highlighting successful data-sharing from this region or other regions around the world.

Group 2:

- In Nepal, groundwater and socio-economic data are available. Meteorological and hydrological data are available but limited by funding, data-sharing policy, and also in

terms of temporal resolution. Further funding and support regarding technical aspects would be helpful.
- In India, meteorological and various spatial environmental data are available, but there are limitations in the spatial resolution of certain data (e.g. precipitation). Data sharing policy has recently been updated, but further facilitation efforts remain required to enhance the involvement of local agencies.

Group 3:

- Climatic variables of precipitation, temperature, pressure, humidity, and air surface data are available with different record lengths in each country, with longer records being available in India and Pakistan than Bhutan, for instance.
- Records of hydrological variables such as river water levels are available in most countries with lengths on the order of 10 to 20 years. The corresponding discharge data are naturally also available, but their sharing is restricted in most of the cases.
- Countries' data policies are the main limitation.
- Lack of data infrastructure (e.g. data portals) to support sharing beyond organisations can represent another barrier. However, it must be noted that several free options exist that are especially suited to research data (e.g.).

Group 4:

- In India, the Indian Meteorological Department's precipitation, temperature, and various gridded data products are available only for Indian government employees.
- In Nepal, wind speed, temperature, precipitation, solar radiation, humidity, and sunshine duration are recorded routinely at station locations.
- Limitations to data exchange include policies which limit access to only certain groups (e.g. other government agencies, researchers within that country etc.), data gaps / lack of spatial coverage in certain regions, funding and resources constraints, institutional and bureaucratic barriers or administrative complexity; incomplete long-term historical data; and finally, the limited sharing of AWS data.
- Intergovernmental agencies could help improve the situation, as could the signing of effective Memoranda of Understanding (MoU) between respective agencies, where necessary. Support could also be used to help develop new technologies, obtain funding, enhance regular station maintenance, and help develop associated capacities.

Group 5:

- In general, meteorological data and some other environmental datasets are available. In China, meteorological data are freely accessible. Meanwhile, in India and Nepal, such data are only partially accessible for free.
- The limitations lie in the data quality, the quantity of administrative work, the geopolitical sensitivity, the lack data accessibility (e.g., language), and in some cases the data's temporal resolution.
- Support to help release more freely accessible data and binding agreements at national and international level would be required.
- Intercomparability and interoperability of data, universal standard methodologies or protocols, and collaboration between the scientific and operational community were identified as key factors that could further enhance data sharing.

Organisers' Summary & Comments:

Free sharing of weather / climate data by NHMSs with the research community in the region is quite limited for most of the participant countries, while (Bhutan excepted) hydrological data is completely restricted.

Group 1's assertion that meteorological data from China are free apparently contradicts the perspective of Group 5, that they are not. This situation may have arisen due to the Chinese participants, who represent several different intuitions including the China Meteorological Administration (CMA) or the Tibetan Plateau Research Center (TPRC), having different perspectives/positions (or perhaps incomplete knowledge of the systems): researchers, employees of the. Thus, after a quick check, it seems that data from the CMA are available on their website, but researchers from abroad are not allowed to access them. Also, the TPRC seems to be available only in Chinese (at least the registration form for data download). However, near-real-time observation data are available from the CMDC platform for different world regions. Except for China which seems to have available data integrated into a dedicated platform developed by the CMA (namely the China Meteorological Data Service Centre, from which data can be downloaded), data from the other countries in the region seems to be only available on a request basis.

NHMS weather and climate data are shared free of charge in China and Pakistan, but in the other countries are charged for. Participants provided apparently conflicting information whether NHMS weather and climate data were available free of charge, or only with cost, in India; Group 1 noted that data are available, but not for free; Group 2 noted that data for all climactic variables are shared for free; and Group 5 noted that data from India are only partly available for free. Hydrological data is not shared in any country in the region except for Buthan, which exchanges data with India. The main reason for not making hydrological data available, as communicated by the NHMSs' representatives, was that they are "strategic data".

In general, **national policies and regulations** and **geopolitical sensitivities** in the region were identified by the great majority of the participants as the main reasons for not sharing NHMS data with research communities, or even with services of other countries for operational purposes.

Some other, sometimes broader limitations identified by the participants were:

- The existing formats of certain datasets (those in a non-digital format are especially challenging if not impossible to share);
- The coarse temporal/spatial resolution of certain datasets (i.e. limited utility of certain datasets);
- Spatial and temporal gaps / sparse coverage of certain datasets;
- Difficulties in sharing certain AWS datasets due to lack of / poor data acquisition, storage and sharing infrastructure, and knowledge;
- Insufficient funding for certain human and technical capacity building activities in relation to data-sharing; and,
- Institutional bureaucracy leading to a long time to process certain data requests.

In order to improve data sharing, many of the participants who were representing NHMSs identified the following types of support that are needed or could be beneficial at national/institutional levels:

- Increased cooperation between researcher and operational communities;
- Establishing Memoranda of Understanding between different intergovernmental agencies (at regional level);
- Financial support to establish and improve technical capabilities for database development and data-sharing activities (enabling the implementation of dedicated platforms);
- Training support for capacity development of employees of the NHMSs in the region for data and database management; and,
- Sharing good practices from exemplar countries, perhaps from other regions of the world, who are already implementing free and unrestricted data exchange (including with research communities).

To provide this support, the possibilities of what could be offered by the WMO will be explored, as will the establishment of twinning projects or exercises that could be organised by bringing member states who are already successful in data sharing for research together with those with willingness to follow their example.

The WMO furthermore highly encourages establishing Memoranda of Understanding at the regional/national level between different governmental agencies and education/research organisations for data sharing without charge, as recommended by the WMO Unified Data Policy.

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12:00 – 13:15: **LUNCH**

13:30 – 14:30: Invited presentations on mountain monitoring and data: An ecological focus

Irfan Rashid, University of Kashmir – The Current Status of Plant Invasions in Global Mountain Regions: Insights from the MIREN Network

Dr. Rashid's presentation focused on the Mountain Invasion Research Network (MIREN), which monitors invasive plant species in mountain regions. A protocol, the MIREN road survey, was developed and has now been applied in many regions to generate unique data collections spanning elevational gradients. The data themselves are freely accessible. There are some regional data gaps, including in the HKH (which has not yet been covered as well as certain other global mountain regions). MIREN would like to increase collaboration with meteorological agencies to enhance understanding of the drivers of changes in invasive species in mountains.

Pierce Hu, Yunnan University – Butterfly Monitoring in Mountain Regions

Dr. Hu's presentation introduced the topic of butterfly monitoring in mountain regions. Globally, a dramatic loss of butterfly biodiversity has occurred, with major possible societal implications. However, the situation in mountain regions is relatively little studied and is therefore not well understood. Data sharing is especially important in such less-studied fields. This work contributes

to GEO-BON (China BON-Butterflies), and efforts are underway to make the data more intercomparable within the country. The protocol developed and applied was described, and further international collaboration is planned.

The challenges include species richness (which is very high in all China's mountain regions), the high population size of some communities (which can be tackled by estimating populations instead of counting individuals), seasonal variation in populations, rapidly changing weather, and topographic constraints. Discussions towards promoting regional data sharing are ongoing with China's Ministry of Ecology, and an online data repository to curate Lepidoptera DNA barcodes has been made available.

14:30 – 14:45: Sundar Sharma, National Disaster Risk Reduction and Management Authority of Nepal – Data & Information for Disaster Risk Reduction

The National Disaster Risk Reduction and Management Authority of Nepal is a Governmental institution. The main function is to collect, analyse, store, and disseminate hazard and risk data, as well as develop an information system for early-warnings. Portals have been developed (including NDRRMA or Bipad) to enhance disaster risk reduction efforts and early warning systems.

14:45 – 15:00: Amina Maharjan, ICIMOD – Socio-economic data across the HKH and its integration with biophysical data: examples from HI-WISE

Overall, the HI-WISE report sought to go beyond the cryosphere; other chapters cover, for example, the hydrosphere, biosphere, and society. Many non-climatic changes such as demographic, economic, and governance changes are occurring in the region, that have major adverse and differential implications for mountain livelihoods (concerning agriculture, livestock, and tourism). For instance, extreme events cause crop and livestock losses and increase disaster risk for tourism. Traditional knowledge can also easily be lost; for instance, a village in Langtang lost almost 25% of its inhabitants in the 2015 earthquake, including the only carpenter.

Given the speed and magnitude of the changes, various adaptation limits may be reached. Rather than trying to react to current changes, the focus should be on shaping the future through inclusive and anticipatory adaptation programmes. Inclusion of communities and their knowledge is crucial in this regard. For instance, in delineating hazard zones in Langtang a blend of western and local knowledge was utilized to create integrated hazard and risk maps. Such information is useful for various end-users such as first respondents, guides and porters working in tourism, and visitors to the area. Looking forward, efforts must be made to better appreciate or account for intangible impacts and consequences, for instance those related to mental health issues.

14:45 – 15:15: **BREAK**

15:30 – 16:15: Discussion III: Extending the thematic scope of existing observatories and opportunities to enhance involvement of Early Career Researchers / use of observatories for student projects (All) (led by James Thornton).

Again, participants formed small groups. Participants were free to change groups from the earlier discussions if they wished to. In this discussion, the specific questions posed were as follows:

1. *Are you interested in extending the thematic scope of your mountain observatory/ research site?*

2. *If so, what are your priority themes (ecology, societal data, etc.)?*
3. *How can we enhance opportunities for Early Career Researchers and to make use of the existing infrastructure (field courses, summer schools, internships, etc.)?*

Below, the main responses are summarized by each group; further details are provided in Annex 3.

Some members of Group 1 (Dr. Andermann and colleagues) have been investigating the possibility of establishing a CZO, which would take an integrated, interdisciplinary approach, including satellite data. In this context, there is a need to understand the need for observatories within the local communities and work to ensure that the data generated would also be useful for them. Collaboration between the (research-oriented) observatories and various relevant institutions would be essential. Sufficient funding must also be secured.

Group 2 classified their priorities into four groups: a) socio-economic data (population, income, and education); b) quantifying risk posed by extreme events (hazard, exposure, and vulnerability); c) ecology (flora, fauna, and pollution), and d) culture and heritage (e.g. tourism, beliefs, and heritage). Corresponding actions have respectively been identified, as follows: a) conducting focus group discussions to raise public awareness and enable participatory processes to collate socio-economic data, b) establishing early warning systems and improving capacity building at local levels to reduce the risk associated with natural hazards, c) organising ecological field visits and training activities (e.g. summer schools), and d) developing novel approaches to account for non-economic losses to culture and heritage assets.

Group 3 emphasised interdisciplinarity and the idea of connecting different sectors who can benefit from research, including private industry. Setting impact-based priorities and bridging the gap from science to action were identified as crucial. Defining ecological observation networks to enhance collaboration, mobilising resources from stakeholders, and working on public health were proposed as key priority topics. Finally, the group proposed to establish international workshops for ECRs, which could be funded by the MRI or other organisations (NGOs etc.), and to support international student exchanges. Small grant programs for young students and international summer schools could be implemented, enabling for example students from different universities to convene for two-week sessions and expeditions.

Group 4 focused on the cryosphere and the impacts of cryospheric change, identifying socio-economic data (including data on buildings, hydropower installations, and other infrastructure) as a key priority for the expansion of monitoring or data collection activities. They also proposed that opportunities for ECRs could take the form of summer or winter schools, workshops and training events, dedicated funding opportunities, and internship, exchange, or mentoring programmes.

Priority topics suggested by Group 5 include atmospheric composition, air and water quality, the carbon cycle, and socio-economic data. Regarding ECR opportunities, they proposed to establish a community of young scientists, led by ICIMOD, the MRI, and/or the WMO, who could hold an annual workshop and organise other training events such as summer or winter schools. An exchange programme was also proposed with could help further build and develop international relationships for the future.

Organisers' Summary & Comments:

Briefly, all the groups responded favourably to the first question, which shows that there is indeed a general interest in extending the thematic coverage encompassed by mountain observatories or research sites in the region. In terms of priority themes identified by each group (the second question), most of them concurred towards an interdisciplinary and impact-based approach by using a great diversity of data (satellite data, observation, crowd-sourcing data) with appropriate financial support for community development to diverse priorities identified (socio-economic data use, hazard identification, ecology, and culture & heritage), to exposure, vulnerability and risk assessment as well as analysis on infrastructure by connecting sectors/actors and bridging gaps from science to act to protect life and life stocks.

Many responses were also similar for the third question, with participants agreeing that opportunities for ECRs could be significantly enhanced through the further provision of international webinars/workshops, field courses, summer schools, internships, mentorships, and other types of exchanges by making use of the existing infrastructure. To support both such activities and in other ways, further support from organisations such as the MRI and its partners (including NGOs, international organisations, and funding agencies) will be beneficial for the engagement of young scientists in mountain research and development work.

16:15 – 16:30: Summary of the Day's Proceedings (James Thornton & Sudip Pradhan)

The day's proceedings demonstrated that the necessary policies have been established by the WMO, and now require more consistent implementation. The WMO can provide technical, infrastructure, and capacity assistance. NHMSs conduct a great deal of monitoring and, in many cases, have plans to enhance or extend their networks, but not all data generated are yet routinely exchanged. There is a general appetite for the vision of mountain observatories which are integrated (i.e. multi-discipline, multi-method, including non-traditional approaches such as citizen science), sustained in the long-term, and directly involve local communities.

18:00: Workshop Dinner at Hotel Himalaya

Day 3

Wednesday 8th November

9:00 – 10:30: Presentation and activity on identifying "Essential Socioeconomic Variables" (ESVs) for general applications across the HKH (contribution to GEO Mountains' Task Group 2.3) – led by James Thornton, Amina Maharjan, Jakob Steiner & Stefan Schneiderbauer

Dr. Thornton introduced the session highlighting that the issue of the lack of standardisation was raised in the previous days, and that the concept of "Essential Variables" could potentially help in this regard. He proceeded to briefly summarise GEO Mountains' work on Essential Mountain Variables, including those related to climate and climate impacts (Thornton et al., 2021).
Dr. Schneiderbauer from the Center for Global Mountain Safeguard Research (GLOMOS), which aims to support sustainable mountain development worldwide, presented steps that have already been undertaken in the context of GEO Mountains' Task Group 2.3 to identify Essential Societal Variables in mountains. In summary, a very considerable number of candidate variables (approximately 350) have been identified and grouped into one of the following four categories:

(1) demography; (2) physical infrastructure and land use; (3) social structure and wellbeing, and (4) livelihoods. Now, the objective is to make a more parsimonious and practically achievable selection of variables (such that the corresponding data layers can be compiled and shared) that, where necessary, reflect regional priorities and differences.

Dr. Steiner then introduced the morning's activity. Participants were asked to divide themselves into four separate groups according to the categories listed above. Each participant was then issued with a worksheet listing the candidate variables corresponding to that topic. Participants were encouraged to discuss their views on each variable with their neighbours or wider group, before deciding which they personally consider to be "essential". In case of those identified as "essential", participants were also asked to indicate which variables they consider this to be the case a global sense, or whether they are essential specifically at the regional (HKH) level. Any further comments or annotations could also be added. The worksheets were then collected for processing and future collaboration by the Task Group, and there was the opportunity for a short Plenary discussion.

The full results will be presented in due course via the outputs generated by the Task Group. However, it is useful to mention some of the verbal responses and comments made.

For example, participants noted that fact that there is some (unavoidable) overlap, shared information content, or dependence between different variables (sometimes in the same group, sometimes in different groups). Care must, therefore, be taken to ensure that the "joint importance" of these variables is accounted for (e.g., by dropping or combining them). It may also be useful to consider conducting a sensitivity analysis on the final selection of variables according to how variables are defined/distinguished from one another, plus their corresponding importance scores.

In the social structure and well-being category, some participants suggested that an explicit variable on mental health was missing, that literacy and corruption metrics were crucial (and somewhat connected), that variables related to food security and its impacts in terms of malnourishment and stunting could potentially be combined, and that data on access to birth control is also extremely relevant (since there can be considerable differences between areas).

In the livelihoods category, variables capturing household income, sources of that income, access to land/proportion of land ownership, and the extent to which households are dependent upon subsistence agriculture were all deemed to be very important.

In the infrastructure and land-use category, it was suggested that the seasonality of road accessibility be considered (e.g., in the context of monsoon conditions). Variables on housing quality and the availability of mobile and other telecommunications were also proposed for inclusion, as was land-use itself, housing quality, and the consideration of disabled people in terms of access to services (e.g., markets). It was suggested by some participants that the more general variable of water use, rather than the more specific one of water use in agriculture, would be more useful. Finally, participants suggested that the individual constituent components of risk (i.e., hazard, vulnerability, and exposure) should be treated as separate, fundamental variables (which can subsequently be combined as necessary to produce full risk estimates).

Examples were given of the differences in the "strength" or importance of related variables. For instance, it was noted that the proportion of households living by subsistence is important and provides broad information, yet data on the outcome in terms of the proportion of people living

below the poverty line (irrespective of their livelihood) would arguably be more important to collect and report.

It was also noted that certain variables (e.g., level of corruption) are crucial, but may not always be straightforward to quantify. Finally, participants noted that establishing thorough, agreed definitions of each variable would be key to ensure common understanding, avoid overlapping variables, and enable consistent evaluations to be made.

10:30 – 11:00: BREAK

11:00 – 12:00: Discussion IV: Identifying potential high impact projects that could be conducted collaboratively using existing data (**All**)

The workshop's final activity consisted of a general Plenary discussion to identify potential future collaborative projects. Dr. Thornton asked some questions to stimulate the discussion:

1. *How can we take collaborations forward from this workshop?*
2. *What are the scientific, policy or practical challenges in the region that have not been yet addressed, but that could (for instance by combining the cross-discipline, sector and region data and expertise that the workshop participants and their institutions represent)?*

- The first response came from Dr. Andermann, who reiterated his invitation for anyone interested in collaborating at the prospective Kali Gandaki CZO site to contact him. There is high interest in expanding the observatory's thematic scope, including with the involvement and ownership of scientists from the region.
- Mr. Rana suggested to work jointly on glacial lakes, and specifically to explore mechanisms to use glacial lake water for irrigation purposes; this would have the additional benefit to local communities of reducing lake outburst flood risk.
- Mr. Sharma proposed to use knowledge and data from mountain regions to develop collaborative development projects focusing on air pollution; he suggested that a gap regarding air pollution at regional scale exists which could be tackled by working collaboratively.
- Dr. Cook proposed an application or tool which could be used by local communities or citizen scientists to report/inventory extreme events, which could be used by scientists for event reconstruction and longer-term hazard and risk assessment. Such tools already exist in Europe, and could potentially be integrated into the early warning systems that are to be improved/set up under the UN Early Warnings for All Initiative, in which the UN Office for Disaster Risk Deduction (UNDRR) and WMO play key roles (Pillar 1 of the initiative corresponds to Disaster risk knowledge and is coordinated by UNDRR, while Pillar 2 concerns detection, observation, monitoring, analysis, and forecasting, and is coordinated by the WMO.
- Prof. Tiwari suggested that priority topics should be the management of water resources / improving the availability and access to water for local communities, and more broadly "mid-elevation" regions where high-density populations are extremely dependent upon agriculture. As evidenced by the failure of the draft declaration that emerged from the WCRP Open Science Conference (2023) to explicitly mention mountains, further lobbying and drawing greater attention to issues of sustainable mountain development is still urgently required. He also suggested that workshops and training programmes should be organised at a local level with local stakeholders and communities, and thanked the MRI for organising the regional workshop.

- Dr. Rashid suggested, as a first collaboration, to work on together to develop a scientific publication based on the workshop presentations and this report (e.g., focusing on the current state of multidisciplinary monitoring, challenges, and future recommendations in the region).
- Another point raised was that sustainability of monitoring and other activities is difficult to achieve without strong public involvement, implying the need to involve local communities in all project phases. Since conducting research in remote areas is challenging both financially and physically, it was suggested to develop a network of local researchers who in turn can train people in local communities to make measurements / conduct basic maintenance.
- Best general practices on communication and data exchange should be something to further discuss and share. Somewhat related to this, the organisers highlighted the existence of the Adaptation@Altitude Solutions Portal, which provides a set of examples of actual mountain climate change adaptation interventions, which could inspire or be modified to inform new interventions in similar mountain settings elsewhere.

Finally, Dr. Thornton returned to the participants' initial expectations of the workshop by asking whether they had been met, and whether there were any suggestions or comments to consider for such events in future.

- A question came up regarding the possibility for the MRI and GEO Mountains to engage directly at the national level. Due to capacity limitations, this is challenging and in addition, many challenges are transboundary. The MRI and GEO Mountains rely heavily on its members, many of whom will have the necessary connections (e.g., with ministers and other decision-makers) to bring about positive changes at national levels. A concrete next step in this regard would be to write a paper or policy brief which identifies which challenges are regional in nature, and which should be better addressed at the national level through specific policies.
- Another final suggestion was to organise a dedicated field visit as part of the programme in the future.

4. Conclusions

The workshop addressed challenges and opportunities in data exchange, collaboration, and capacity-building. Invited presentations featured representatives from the research community and NHMSs from several countries, each of whom shared insights into their monitoring efforts and experiences. Extensive discussions around data-sharing practices, limitations, and the support needed ensued, and an interesting poser session was also held. Whilst considerable attention was places on traditionally prominent topics such as climate, cryospheric, and hydrological monitoring, ecological and socio-economic monitoring and data also featured.

The participants highlighted various impediments regarding data sharing and availability from the research groups and NHMSs in the region, including geopolitical sensitivities, national policies, communication barriers, and the importance of sustained funding for long-term observations. Proposed solutions included improved collaboration, standardised guidelines for data collection and sharing, and additional funding to support data sharing and observational system maintenance.

The WMO emphasised the mutual benefits of enhancing data exchange between research and operational communities, as well as the policies and infrastructure that are in place to support this. Some recommendations arising from the workshop include raising awareness of the potential benefits to NHMSs of freely sharing the data with the research sector, developing intergovernmental mechanisms, improving data management/sharing infrastructures, and promoting collaboration between operational and research organizations.

Participants provided regional insights on Essential Socioeconomic Variables (ESVs), and potentially high-impact collaborative projects were identified. Participants expressed considerable interest in extending the thematic scope of observations undertaken, to include socio-economic and ecological data, where possible strongly involving local communities (for instance via Citizen Science and continued engagement).

The concluding discussions highlighted the desire to produce a scientific publication based on the workshop's outcomes. Participants' expectations were generally met, and suggestions made for future events included workshops or seasonal schools targeted specifically towards ECRs.

In closing, the organizers warmly thanked the co-organisers from WMO, ICIMOD, and HUC, all invited speakers for their excellent contributions, and all participants for sharing their time and expertise.

A workshop evaluation survey was sent to all participants (see Annex 5).

Authors / Note takers: Alexandrine Massot, Adina Croitoru & James Thornton

Annex 1. Link to Presentations

All presentations given during the workshop are publicly accessible from this online repository. The recordings made are available upon request (james.thornton@unibe.ch). The pictures of the poster session can be found here.

Annex 2. Lists of Attendees

The full list of in-person workshop attendees is provided below. 88 registered for online participation, with 20 joining the meeting online at some point during the three days.

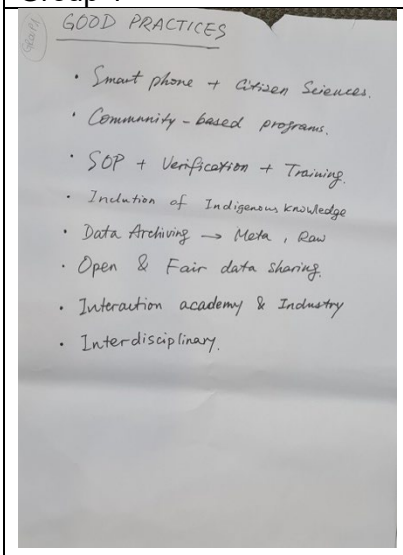
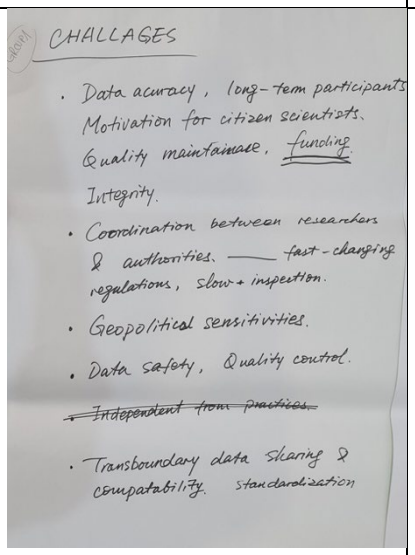
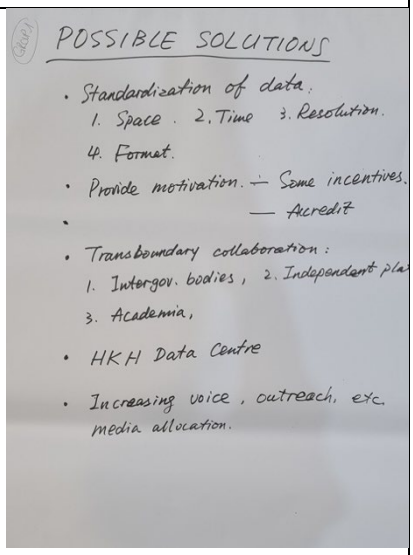
#	First Name	Last Name	Affiliation	Country
1	Munawar	Ali	Government of Gilgit-Baltistan	Pakistan
2	Syed Hammad	Ali	Glacier Monitoring Research Centre (GMRC), Pakistan Water and Power Development Authority (WAPDA)	Pakistan
3	Christoff	Andermann	Université de Rennes, Geosciences Rennes	France
4	Mohd. Farooq	Azam	IIT Roorkee	India
5	Muzaffar Ali	Baig	University of Chitral	Pakistan
6	Giacomo	Butte	UHI Perth/ICIMOD	Italy
7	Dipesh	Chapajain		Nepal
8	Manavi	Chaulagain	Tribhuvan University	Nepal
9	Tao	Che	Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS)	China
10	Siyang	Cheng	China Meteorological Administration	China
11	Arindam	CHOWDHURY	North-Eastern Hill University, Shillong	INDIA
12	Kristen	Cook	Université Grenoble Alpes	France
13	Adina-Eliza	Croitoru	Babes-Bolyai University / World Meteorological Organization	Romania
14	Rahul	Das	Assam Water Centre	India
15	Bharat	Dhungana	Tribhuwan University	Nepal
16	Bharat	Dhungana	Tribhuwan University	Nepal
17	Minghu	Ding	Chinese Academy of Meteorological Sciences (CAS)	China
18	Min	Feng	Institute of Tibetan Plateau Research (ITP), Chinese Academy of Sciences (CAS)	China
19	Narayan	Gaire	Tribhuvan University	Nepal
20	Shudarshan	Hamal	Tribhuvan University	Nepal
21	Pierce	Hu	Yunnan University	China
22	Shakir	Hussain	Rawalpindi Women University	Pakistan
23	Miriam	Jackson	ICIMOD	UK
24	Salina	Joshi	Central Department of Environmental Science, Tribhuvan University	Nepal

25	Babar	Khan	ICIMOD	Nepal
26	Robin	Kim	University of Virginia	United States
27	Ravindra	Kumar	IIT Roorkee, India	India
28	Rohit	Kumar	Indian Institute of Technology Roorkee	India
29	Sonam	Lhamo	National Centre for Hydrology and Meteorology	Bhutan
30	Merensangla	Longkumer	Forest Research Institute Dehradun	India
31	Amina	Maharjan	ICIMOD	Nepal
32	Ranjeeta	Mahat	Education For Empowerment	Nepal
33	Susa	Manandhar	Tri-Chandra Multiple Campus, Tribhuvan University	Nepal
34	Sunwi	Maskey	ICIMOD	Nepal
35	Alexandrine	Massot	MRI	Switzerland
36	Md. Abdul	Matin	Bangladesh Meteorological Department (BMD)	Bangladesh
37	Arighna	Mitra	Coalition for Disaster Resilient Infrastructure	India
38	Nawaz	Muhammad	Landell Mills International	Pakistan
39	Sanjiv	Neupane	SmartPhones4Water-Nepal	Nepal
40	Upendra	Oli	NAXA	Nepal
41	Vedika	Pant	Uttarakhand State Disaster Management Authority, Government of Uttarakhand	India
42	Sandip	Poudel	Agriculture and Forestry University	Nepal
43	Indira	Poudel	Tribhuvan University	Nepal
44	Sudip	Pradhan	ICIMOD	Nepal
45	Sanej	Pradsadsuwal		Nepal
46	Adnan Shafiq	Rana	Pakistan Meteorological Department	Pakistan
47	Irfan	Rashid	University of Kashmir	India
48	Sanjay	Saifi	Indian Institute of Technology Bombay	India
49	Huda	Sarwar	Rawalpindi Women University	Pakistan
50	Stefan	Schneiderbauer	EURAC	Germany
51	Trishla	Shaktan	Forest Research Institute Deemed to be University	India
52	Jeniya	Shakya	SmartPhones4Water-Nepal	Nepal
53	Niraj	Shankar Pradhananga	Department of Hydrology & Meteorology, Nepal	Nepal
54	Sundar	Sharma	NDRRMA	Nepal
55	Rajesh	Shrestha	ICIMOD	Nepal
56	Smriti	Shrestha	Kathmandu University	Nepal
57	Bimal Raj	Shrestha		Nepal
58	Jakob	Steiner	Himalayan University Consortium	Pakistan
59	James	Thornton	MRI	Switzerland

60	Prakash C	Tiwari	Kumaun University, Nainital, Uttarakhand Himalaya	India
61	Chi Huyen (Sachi)	Truong	Himalayan University Consortium (HUC)	Nepal
62	Navneet	Yadav	Doers	India

Annex 3. Outcomes of Discussions

Discussion I – Monday 6 November:

Group 1		
		
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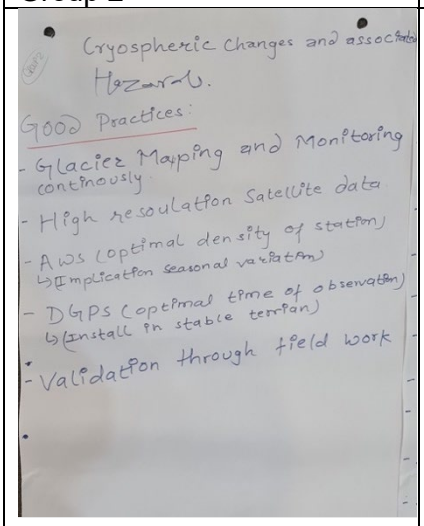	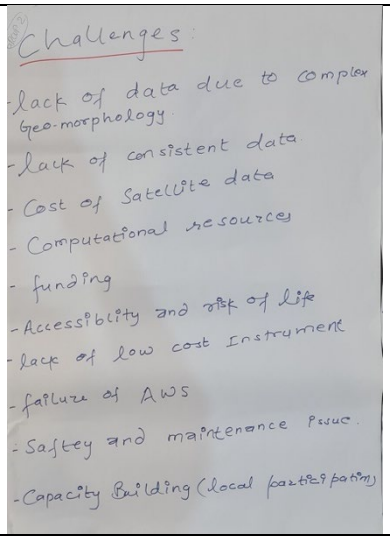	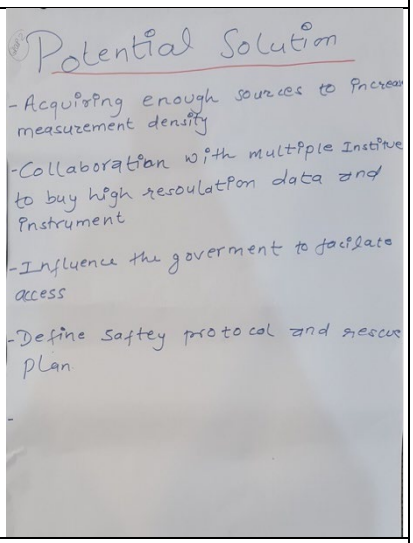
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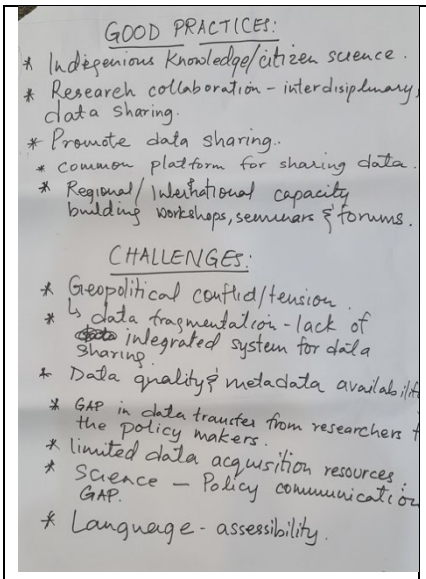	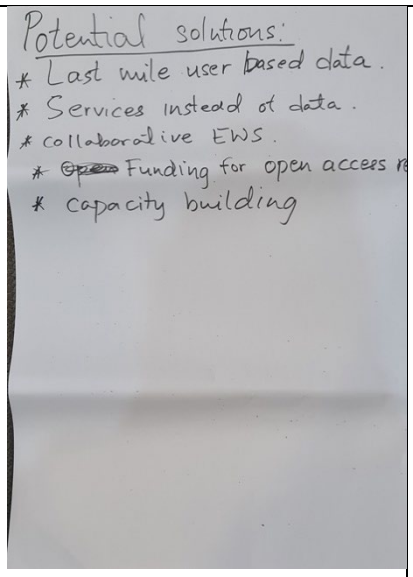	
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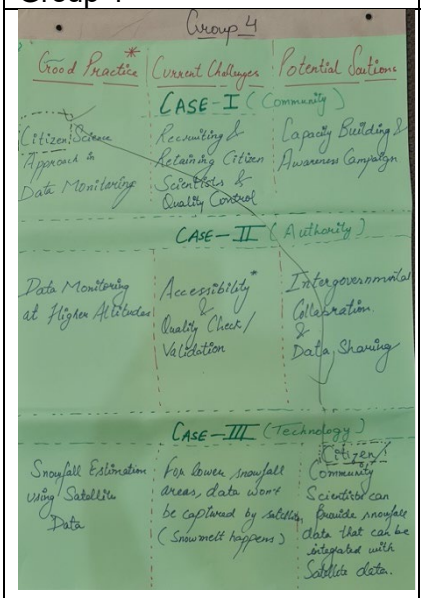
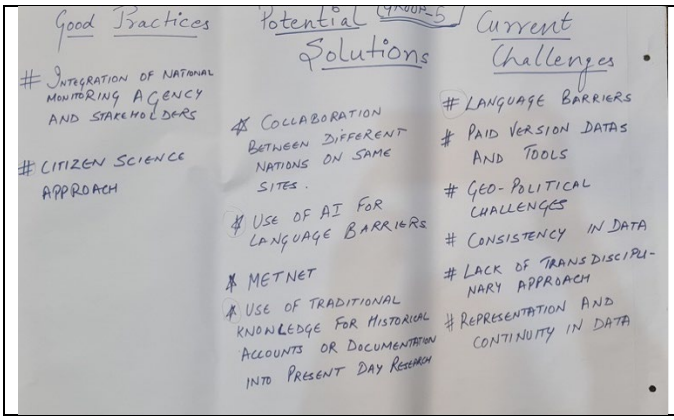
		
Group 5		

Discussion II – Tuesday 7 November:

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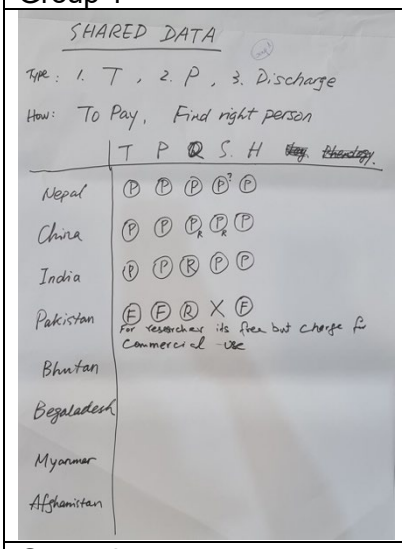	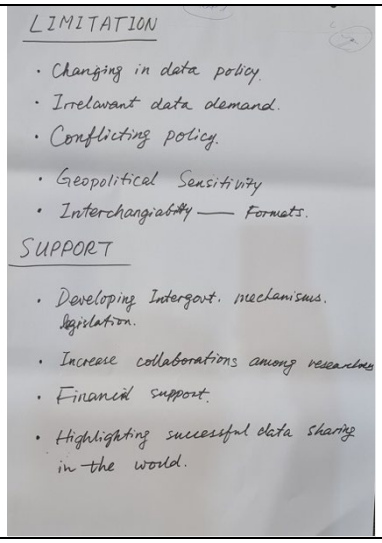	
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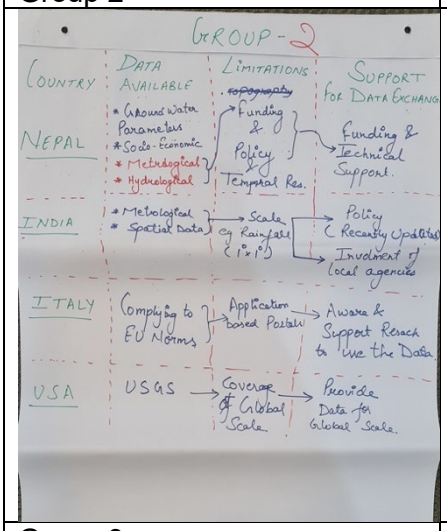	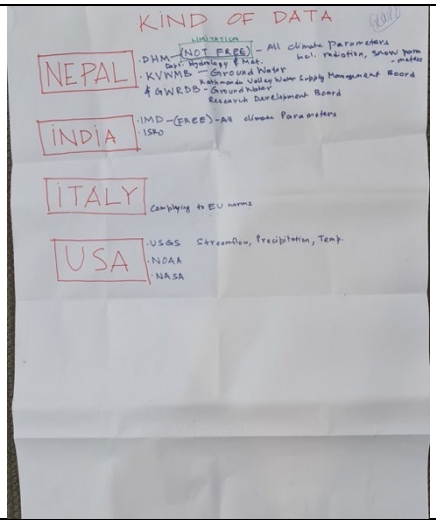	
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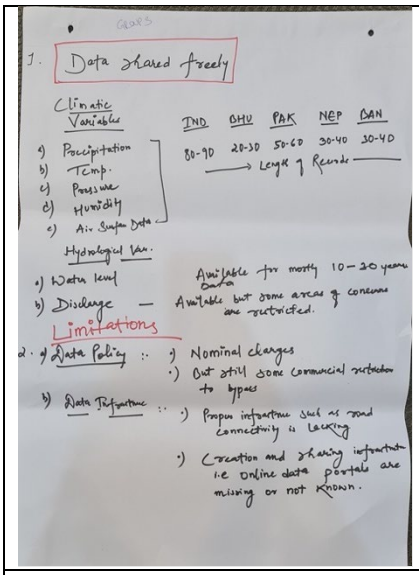

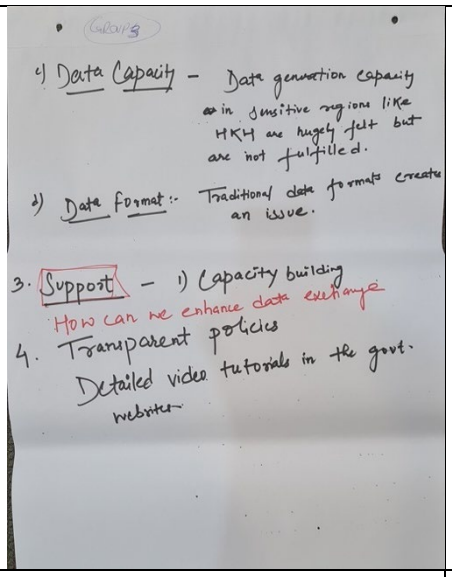

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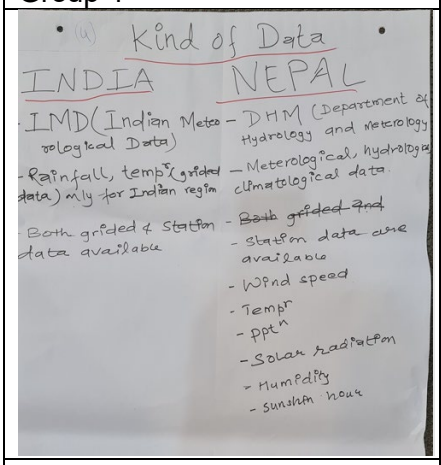

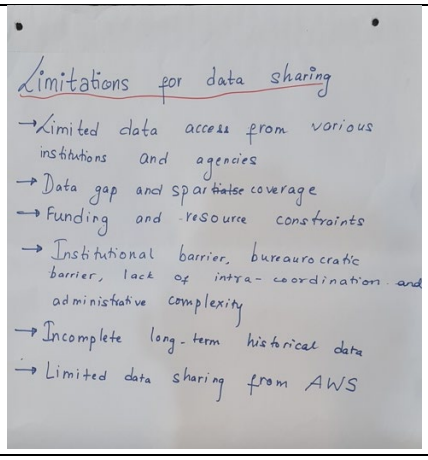

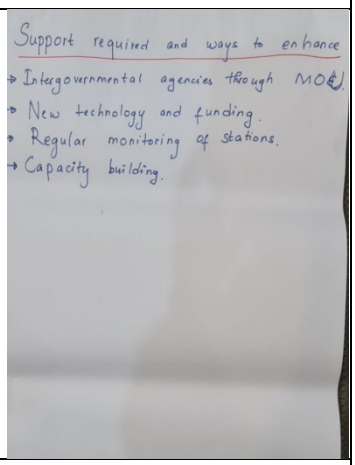

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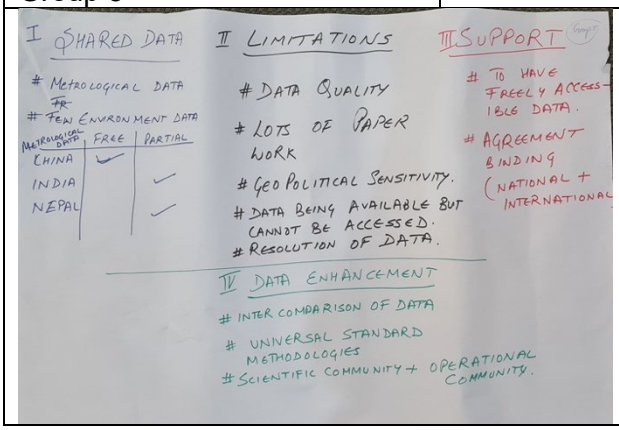
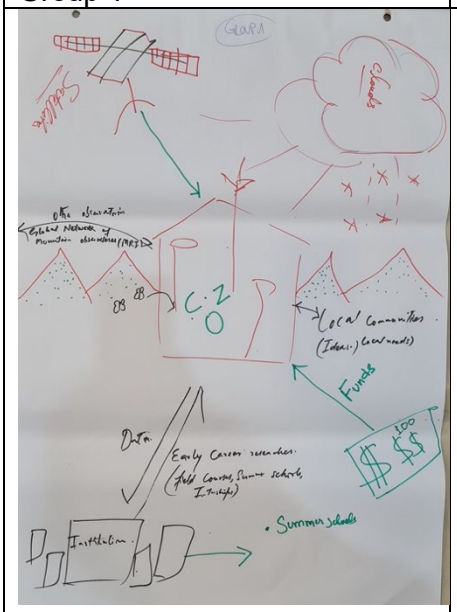
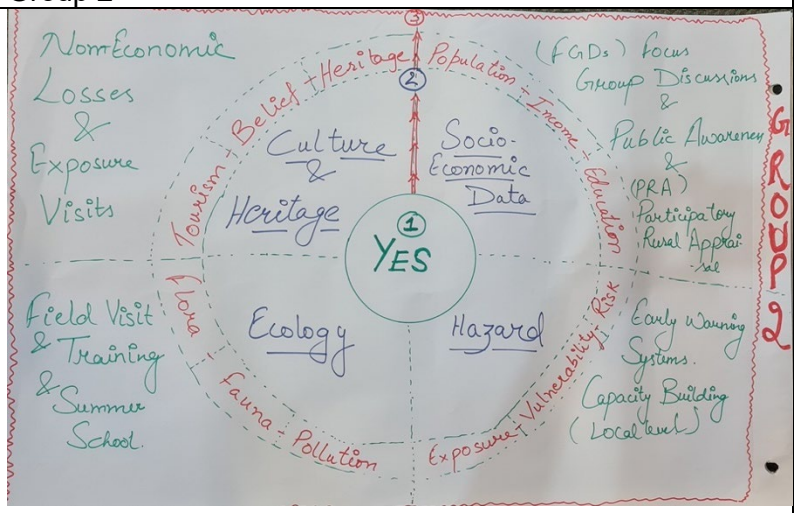


Discussion III – Tuesday 7 November:

Group 1	Group 2
	
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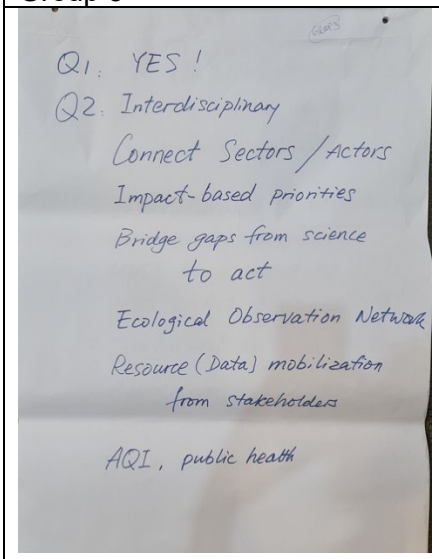	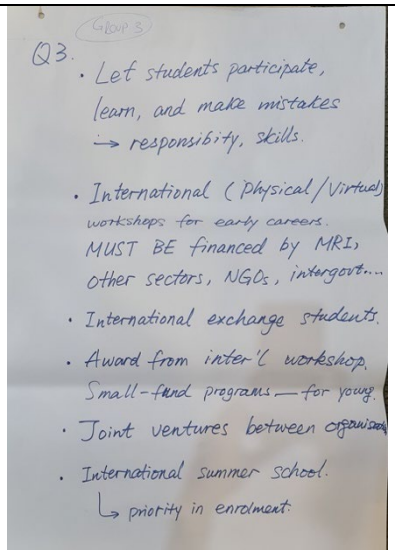

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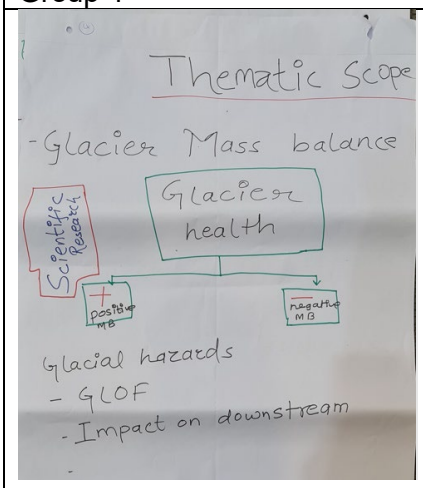
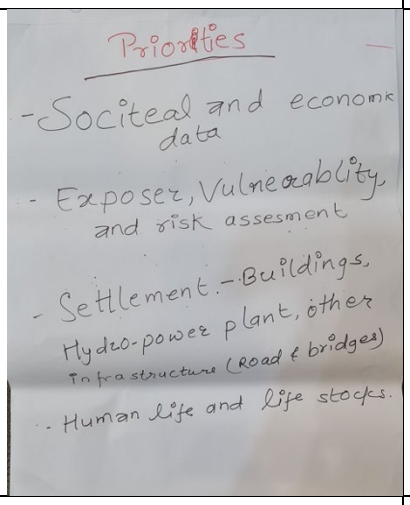
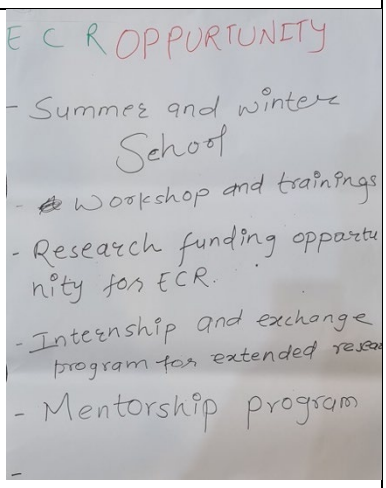
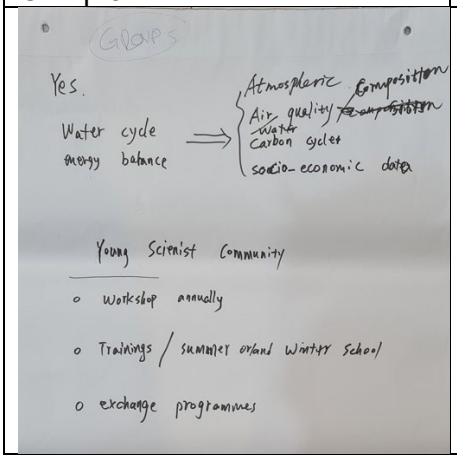
		
Group 5		
		

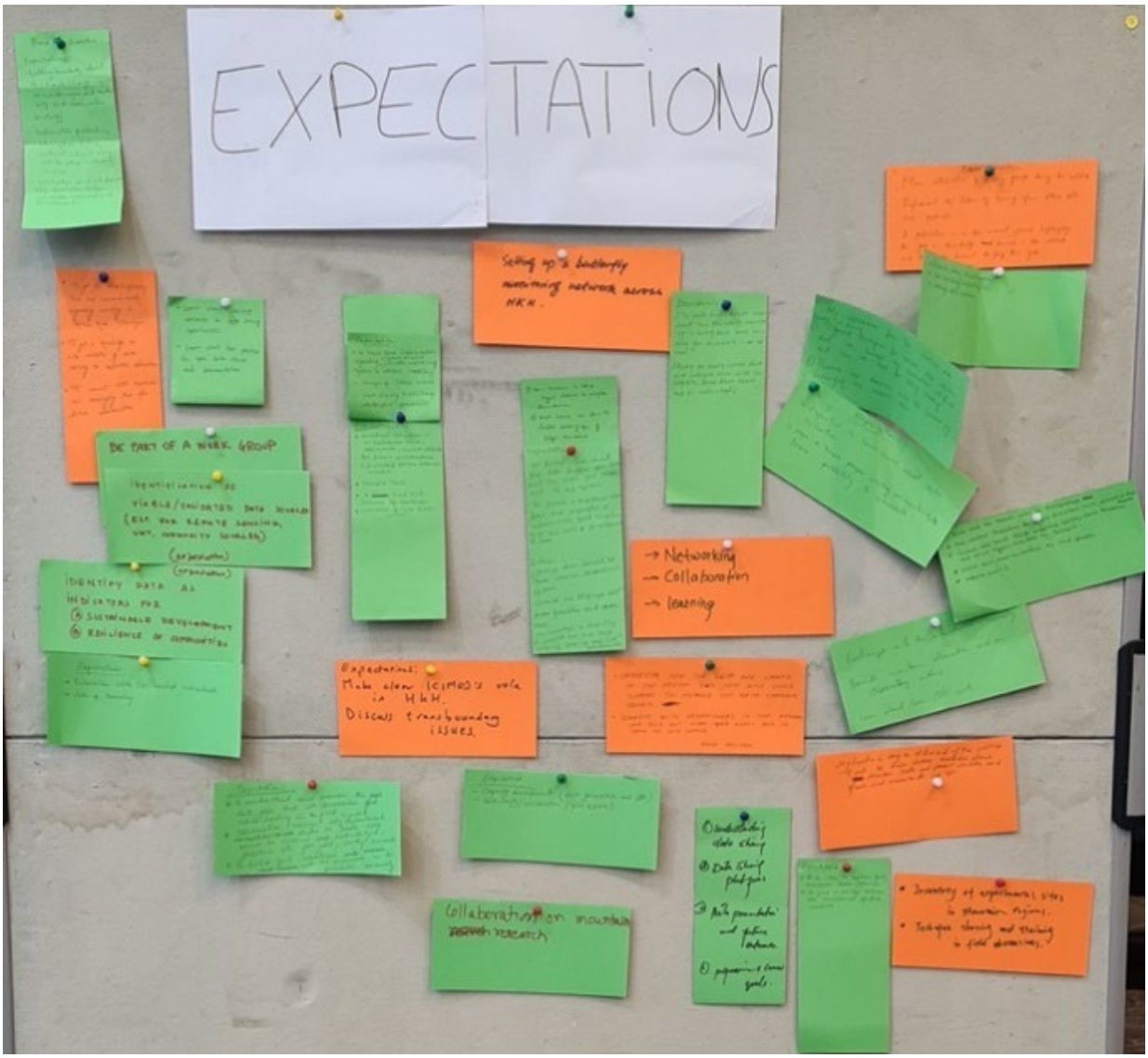
Annex 4. Photographs

Several photographs taken during the workshop are reproduced below:

Dr. Pema Gyamtsho, ICIMOD (Photo: ©ICIMOD)

Participants during the plenary session (left) and group discussion (right) (Photo: ©ICIMOD)


IDEAS
DISCUSSION ON CHALLENGES + BOTTLENECKS FOR DATA
To late to establish weather stations at high altitude areas. Need to increase such stations soon.
SET UP SPRING WATER HKH DATASET
DISCUSS 2nd ORDER BENEFITS OF MOUNTAIN OBSERVATORIES FOR POLITICAL TRACTION/INCREASED INVESTMENT
DISCUSS DATA THAT QUANTIFIES RELATION BETWEEN MOUNTAIN COMMUNITY, ENVIRONMENT, ECOSYSTEM
DATA SHARING PROTOCOLS BETWEEN ICIMOD, IUCN, GEO-BON, & GEO MOUNTAINS
Identify biological indicator species across HKH with regional collaboration.
Use with meteorological data! Common, comparable.
→ Citizen Science Approach in Data monitoring
→ Free Access to data



“Ideas” & “Expectations” boards, on which participants were invited to post their reflections on following the opening segment of the workshop (Photo: © Alexandrine Massot / MRI).

The responses are available here.

Annex 5. Feedback Survey

MOUNTAIN RESEARCH INITIATIVE

Hindu Kush Himalaya Workshop

6-7-8 November 2023

How did you attend the workshop?

- ◯ In person
- ◯ Online

a) On a scale from 1 (poor) to 5 (excellent), please rate the overall quality and relevance of the workshop content (i.e., was it comprehensive and/ or informative?): *

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

b) On a scale from 1 (poor) to 5 (excellent), please rate the format and facilitation of the workshop (i.e., organization, interaction, tools, tasks, duration etc): *

	1	2	3	4	5	
Poor	◯	◯	◯	◯	◯	Excellent

c) If you have any comments to qualify your rating, or suggestions for improvement with regards to content and/ or facilitation of the workshop, please use the space below:

e) If you have any other general comments or suggestions for future events, please feel free to use the space below to provide your response.

Type here...

Submit | Print your responses