Risk Data in High Mountain Asia

Scoping and recommendations

Summary of the HiRISK Workshop in Dhulikhel, November 2023

bring home national experts to explain risks and shape policy.

Atif Mian
John H. Laporte Professor of Economics, Public Policy and Finance
Princeton University
(on 24 November, 2023 at baat se baat/black hole with Pervez Hoodbhoy)

Content

Acknowledgements

This workshop and the following compilation of recommendations would not have been possible without the support from the GEO Mountains Small Grants Programme 2023 (*Adaptation at Altitude Programme, Swiss Agency for Development and Cooperation Project Number: 7F-10208.01.02*). We are grateful to initial recommendations coming from reviewers of the initial proposal as well as James Thornton and Carolina Adler.

The workshop was hosted by the Himalayan University Consortium (HUC), hosted at the International Center for Integrated Mountain Development (ICIMOD). We are grateful for the support received from Sudeshna Shrestha, Kritika Sharma and Shachi Truong.

1. Executive Summary

The HiRISK kickoff workshop brought together early career scientists, practitioners and journalists to discuss status, potential, gaps and possible recommendations for ways ahead on data on risks in High Mountain Asia (HMA). The group of experts came together motivated by varied struggles with data access, ownership, quality and literacy and a lacking regional network that allows for an information on these challenges from the bottom up, i.e. by both those impacted by risks we try to document as well as those at the forefront of state-of-the-art methods to produce, curate and use relevant data. The workshop was aimed at brainstorming and formulating potential ways ahead. It however quickly also made clear that even experts in the field are not aware of the number of resources and capacities that exist in the region. Overlap in interests, common concerns about gaps as well as similar ongoing approaches to work with relevant datasets in the region were quickly identified, providing opportunities for future collaboration and exchange.

This document provides a summary of the workshop. It includes the insights gathered from five keynote lectures from experts in the reinsurance, modelling, media and research domains (Section 2) as well as the insights on existing capacities and resources from the participants (Section 3). Motivation for collaboration in this domain, gaps and recommendations for ways ahead were identified and are documented in full length in this section. Section 4 provides an overview on existing resources and best practices in the context of risk data, including examples from outside the region to learn from as well as regional initiatives that need to be considered. Key recommendations aggregated from the discussions are summarized below.

Key recommendations

Do not recreate the wheel but provide a node for existing capacities. Many dashboards and other resources exist, many unknown, some incomplete, not operational or poorly documented. HiRISK should not be just another data interface but provide guideline to existing resources and capacities and identify and develop capacities to fill gaps. It should also further invest on bringing experts on governance on board to discuss appropriate measures.

Establish frameworks and capacities to integrate various data types. Very different ways of knowing risks exist, from satellite images to quantitative model outputs to oral stories from local resources and communities. HiRISK should support the establishment of capacities and methods to bring these ways of knowing together (while learning from existing initiatives elsewhere).

Prioritize crucial knowledge gaps on vulnerabilities, infrastructure, health and slow onset hazards. A number of crucial gaps with respect to knowledge and data have been identified that should receive future attention with respect to developing methods and standards. HiRISK can provide access to a large professional network and access to resources providing technology and capacities to further develop data as well as facilitate crucial access to funding and inform funders on needs from the bottom up.

Elevate the importance of (meta)data standards, documentation of gaps and language access. The documentation of data and associated gaps and documentation of access challenges can not keep up with the rate of new data production. HiRISK should provide recommendations and access to capacity development to develop standards and stakeholder engagement to identify challenges and concerns in making data accessible and useful.

2. Keynote lectures

Chandan Verma – Head of Agriculture – SwissRe India

Chandan presented the angle from a large reinsurance company, with a focus on agriculture on the subcontinent. He noted the need for, and challenge of recording losses accrued by farmers over time as well as the resulting change in income, which eventually impacts their decision making. Such data eventually feeds into the development of risk and loss profiles. Such profiles are a measure of expected losses for a certain time period based on historical data such as total losses, number of losses, average loss size, and payout patterns. Especially interesting is the collection of data on historical (re-)insurance coverage, currently not available for the region. A classical method is recording building quality, data generally not available from larger datasets or from remote sensing but crucial especially with respect to floods.

The biggest challenge to deal with, with respect to models used in the reinsurance context is the granularity of data. Model data is often at a resolution where a single pixel includes agricultural land of more than one proprietor. Agricultural area separated in small scale fields becomes difficult to account for with remote sensing data. Color changes may be detected but whether the plant has bloomed or not may be impossible to detect. Additionally, pay out schemes become challenging with varied experiences. Two farmers close to each other with different experience of impact during an event – but the weather station may show 'damaging rainfall for both'. What to do? Deny both? Pay both?

Recommendations for future steps:

- Enable platforms for farmers in mountain environments to report their experience and data with incentives and combine with geospatial data.
- Include reinsurance modelling community in future capacity building ventures and coordinate with Swiss Re Foundation on Climate Risk – combine with already existing nodes to the HOTOSM community.

Jannis Hoch – Senior Hydrologist – FATHOM

Jannis works predominately with flood models, at a scale that does not (yet) account for mountain environments. However regional and global models of that scale (including those for groundwater for example) have an increasing interest to resolve more complex environments (if the present exposure warrants it). Even after access to high resolution elevation models, a crucial shortcoming the models face is the lack of information on flood defense infrastructure data. This ultimately impacts the accuracy of models and has parallels for mass flow modelling in mountain

areas, where information of impeding infrastructure or infrastructure like check dams is largely absent, likely impacting the quality of modelling outcomes[1].

DEM data on the global scale has improved significantly and is now also available without buildings and trees otherwise found in global DEMs.

Crucial and often lacking data remains input (precipitation) and discharge – uncompromisingly simply put 'as much data as possible'. Discharge, contrary to precipitation, so far can not be properly replaced with Machine Learning (ML) techniques.
Customers interested to pay for modelling services based on such data include insurance companies, engineering companies (infrastructure stability) as well as the finance sector (value assessments before investments).

Recommendations for future steps:

- FAIR model and data production – companies like FATHOM show that a business model based on this approach is feasible and there is a market for solutions developed this way. Conversely companies are faced with dealing with lack of regional data in vulnerable environments. Potential exists for cross learning and capacity building.
- Regional and global models are faced with the lack of reliable discharge data. Such data exists for many locations with considerable temporal ranges but remains hardly accessible in HMA. Communicating the benefits and working towards balanced collaborations between the government and private sector would enable better use of such data with the eventual benefit for the data owners. This is in line with the idea to reassess the challenges around FAIR data (or data sharing more generally) in the region from a standpoint of unequal access to data but also the potential benefits of making the data accessible. Building on FAIR with CARE (as well as more recent deliberations on FAIR data in the time of AI), readiness in light of risk assessment should be evaluated in near future through stakeholder consultations.

Aruna Chandrasekhar – Climate/Environment Journalist – Carbon Brief

Access to presentation slides

Aruna communicated the need for journalists to have rapid access to high quality experts on risks in mountain environments. Especially hearing from underrepresented groups in the public discourse would further also elevate the reporting of Carbon Brief. Carbon Brief on the other hand

[1] Muhammad, Sher, Jia Li, Jakob F. Steiner, Finu Shrestha, Ghulam M. Shah, Etienne Berthier, Lei Guo, Li-xin Wu, and Lide Tian. 2021. "A Holistic View of Shisper Glacier Surge and Outburst Floods: From Physical Processes to Downstream Impacts." *Geomatics, Natural Hazards and Risk* 12 (1): 2755–75. https://doi.org/10.1080/19475705.2021.1975833.
Westoby, Matthew J, Neil F Glasser, Michael J Hambrey, James Brasington, John M Reynolds, and Mohamed A A M Hassan. 2014. "Reconstructing Historic Glacial Lakeoutburst Floods through Numerical Modelling and Geomorphological Assessment: Extreme Events in the Himalaya." *Earth Surface Processes and Landforms* 39 (12): 1675–92. https://doi.org/10.1002/esp.3617.

can offer outreach, as well as expertise on data visualizations and putting data into context. Critical is to keep stories as simple as possible without 'dumbing it down'. Keeping a close network of experts for journalists would also enable to inform journalists of developments, building on long term coverage and avoiding a reactive approach to coverage on specific events. More proactive reporting on developing issues needs careful communication but would align with what Carbon Brief is aiming to do. Related to this is a lack of reporting on slow onset events (droughts, societal changes).

Carbon Brief has experience with managing an experts database for the Global South with more than 1000 entries, including 1 from Afghanistan, 12 from Bangladesh, 185 from India, 7 from Nepal and 18 from Pakistan (as of January 2024, however notably none from Bhutan, Myanmar, Central Asia or possibly underrepresented groups in developed nations like China). One challenge faced with the database is assuring that contacts making their details available are responsive when being contacted. Somewhat in line with such an expert database would be access to visual (photographic) evidence of impacts, especially in regions where media coverage is otherwise sparse.

A lingering idea is bringing stories on climate change or other relevant topics to dashboards that become easily accessible in a similar manner as data. This matches with the general need to better communicate, visualize and quantify vulnerabilities as well as integrate local knowledge into risk assessments. It would also go in line with the need to document heritage loss associated to mountain risks through stories (see e.g. an attempt for Africa).

Journalists are facing the challenge on how to dal with poor quality global or regional data, as this affects their ability to report and potentially impacts the way e.g. the climate crisis can be credibly communicated for more vulnerable communities. Beyond reporting of data, communication on quality as well as the challenges of data collection needs to receive attention.

On specific data Aruna mentioned the lack of migration data being captured by current demographic data as well as the general lack of infrastructure data. Missing risks in terms of available data to report with remain health related issues (currently especially with respect to air quality) as well as data on governance (or its failure). This would also help reporting on whether or to what degree risks are related to climate change or for example institutional failure.

Recommendations for future steps:

- Carbon Brief has strong experience in communicating science with respect to climate change (see for example on climate change attribution). HiRISK could provide studies that are vetted and evaluated through its publications database.
- HiRISK has access to many more experts in the region and is able to vet for their ability to respond in a timely manner. A cooperation to set up an open or closed database for experts on risk specifically for High Mountain Asia (to limit the scope but also increase regional ownership) is an option under consideration. Fostering access in other languages than English would be one crucial component. Avoiding duplications or enabling cooperation would be crucial (e.g. WeADAPT, GAPHAZ, HUC).

- Attempts to put stories of those that are affected by e.g. a changing climate on a map and into context with data have already been made, for example by the Climate Vulnerability Monitor or the Canadian Climate Atlas, allowing to learn from successful examples. An evaluation whether this would be feasible and under what format for HMA would be necessary.

Claire Souch – Risk Modelling Expert – AWHA/RMS

Access to presentation slides

Claire provided insight into Catastrophe Modelling (CAT Models) in general, with a specific focus on aiming to work towards interoperability, spearheaded through the OASIS Loss Modelling Framework (LMF). The principle behind it holds that while the final aim may be different for different users, all rely on the same data provided. The code underlying the framework is accessible to anyone, so are guidelines on its use. Initially such efforts where developed under the Insurance Development Forum.
CAT Modelling aims at modelling all possible events that could potentially happen, including their probability of occurrence (or return period) and then the production of loss curves, i.e. the probability of occurrence versus the total loss accrued during said occurrence. Hazard, exposure and vulnerability are all entered into the model as empirical curves taken from literature or if available developed from available data. Probabilities can then be changed for future climate or socioeconomic scenarios. Probability curves for hazards can be generated from comprehensive hazard databases. After damage is calculated, pairing with a financial module allows for the development of exceedance probability curves.

Banks have an interest and are foremost customers for such products as they need to quantify climate risks for their assets and CAT models are used for cost benefit analysis. A big concern is also to understand how big events can become before the insurance on a good fails, i.e. goes bankrupt.

Exposure data for these models comes largely via building footprint data, by now available globally. Similarly global vulnerability as well as exposure have been recently mapped, albeit with a focus on earthquakes.

Creating vulnerability functions is important but fraught with a lack of data. Generally, damage and depth after flood events are recorded (or reported via claims) to create empirical functions, which obviously omits a lot of other aspects of impact.

Global efforts with respect to exposure and vulnerability exist, including from the scientific community following fully open data practices (Global Earthquake Model, including open datasets on vulnerability and exposure) as well as in the private market (ImageCat, relying however on OSM data).

Recommendations for future steps:

- OASIS LMF provides a framework that follows FAIR principles and is accessible. Capacity building in the risk modelling direction with the support of the private sector (e.g. hydropower development) as well as insurance sector should include it in future. HiRISK can also use the demand for accurate probability curves as a guideline on what data collection to invest in and how to improve these curves for HMA. Especially challenging in this regard is the representation of vulnerabilities, which needs further discussion for the mountain context.
- Global modelling initiatives exist – but their quality depends on the quality of input data. HiRISK can position its expertise on data from the region making it accessible for the global modelling community (including accessibility but also capacity building, through numerous networks)

Holger Frey – Research Associate – Univ. of Zurich/GAPHAZ

Access to the presentation slides

Holger spoke on the role of GAPHAZ in mountain risk and hazard research as well as general challenges and priorities. Like Carbon Brief, GAPHAZ maintains a list of experts.
A crucial challenge in addressing risks are the large differences in time scales. Singular events (e.g. glacial lake outburst floods and subsequent impacts and cascading risks) happen rarely at the same location and can happen rapidly. Often high profile if with significant impact they are challenging to work with in the context of forecasting. Long term hazards on the other hand (e.g. mountain droughts) are more challenging to monitor meaningfully and receive less attention in media. In mountains many disaster events happen only once. The challenge is to look at the right spot at the right time. However, it is now appreciated that in recent years we do see unprecedented changes in both impacts from climate change as well as socio-economic changes.

Future data compilations and event databases should focus on compiling exposure and vulnerability, which is so far largely lacking. Vulnerability so far has been largely treated as the 'basket where all the unknowns are stored in'. What is currently lacking on the hazard site is information on event probabilities. They are required for cost benefit analysis, decision makers as well as risk models.

Any data should also be stored in raw as well as processed form for potential future alternative uses and to make it traceable. Simply the access to data would already be a major advancement (links, contacts, sources), making it easier for practitioners and scientists to find what they are looking for from a single port of entry.

On the side of data quality, there is a need to talk more to affected people and collect that knowledge. It is important to take their perception of risk into consideration. A notable example are the People's Archive of Rural India, or local voices in the Loss and Damage context. The challenging question becomes how to store this kind of data and how to eventually pair it with other scientific data.

A clear documentation of risks would also help to learn across mountain regions and could hold as a basis for future interactions in global for a or scientific working groups.

Recommendations for future steps:

- Data access is crucial – it is not required to establish infrastructure to host data but it would be an important contribution to establish guidance on where to find what kind of data. This can be achieved by providing a “meta”-dashboard – a location that provides access to relevant databases hosted elsewhere with clear guidance on what to find there and under which data sharing protocols (i.e. following FAIR practices, requiring to contact data owners etc.)
- Risk data in other forms should be considered (see also deliberations with Carbon Brief). While building dashboards for data access, the inclusion of local knowledge in other formats needs to be considered. A number of global initiatives exist HiRISK could learn from for taking this forward in a mountain context.

3. Workshop deliberations

HiRISK members presented ideas of individual interest as well as ideas that have the potential to be taken up in the consortium for future implementation.

Principles and motivation

As an introduction a Vision and a Mission were presented that serve as a draft for a future clear communication on where to position the consortium.

Vision: *To educate and inform on mountain risk related data, models and local as well as regional initiatives in High Mountain Asia*
Mission: *Become the one stop solution to anyone searching for 'data on risks in High Mountain Asia'*

It has become clear during the deliberations that above would need to be sharpened and it is crucial to emphasize that HiRISK provides guidance on data and expertise as well as network opportunities rather than aiming at hosting everything under its name.

It is also pertinent to note that HiRISK should follow a few principles during its work.

HiRISK core principles

 *bottom up* – initiatives driven by HiRISK should be informed by needs from the community and affected stakeholders and help to inform funders as well as international initiatives less familiar with the HMA region

 *horizontal hierarchies and early career voices* – the consortium needs to carry itself and everyone is an expert who is part of it for a reason, keeping in mind that early career voices in the region should be supported and elevated

 *no reinvention of the wheel* – we do not attempt to provide solutions that are already available but rather provide a platform that makes access to existing expertise and data easier

FAIR and CARE principles – HiRISK will follow FAIR and CARE principles, provide support to promote them in HMA and critical reflection on potential challenges

A number of reasons exist why collaborating on risk data in HMA across countries and institutions would be beneficial. Some of the motivation to move forward with the idea of HiRISK comes from our own experiences and repeated requests on data availability, accessibility or interpretation as well as guidance on stakeholders, pressing challenges and local capacities. Motivations discussed during the workshop are detailed below, providing a baseline for future efforts under the consortium.

HiRISK motivation

central directory on mountain risks – Especially for those outside the data producer community (e.g. media, policy makers) it is difficult to understand what data portals, resources and most recent knowledge products are available in HMA.

lack of accessible data - There is a general understanding that we are faced with a *lack of accessible data* (while there may be a lot of *available* data) and a need for interpretation especially with regards to data quality. This becomes problematic for global assessments or with the advent of Machine Learning for training of models, when the HMA region is underrepresented, and its challenges hence not accurately captured.

lack of mountain specific data – Global databases for hazards and risks exist (e.g. EMDAT), so do modelling suites. However, they are often unable to account for the heterogeneity or the (relatively small) dimension of risks occurring in mountain environments. Covering this gap could contribute and further improve already existing global efforts.

lack of temporal and spatial resolution – Global datasets on both hazard but especially exposure and climate forcing do not manage to represent the heterogeneity of mountain environments. Knowledge in mountains predating the satellite area is also available but generally not included in risk assessments.

lack of standards – There is currently no framework existing for risk related data in mountain environments and a global effort was only launched recently. With mountain specificities as well as the appreciation of data ethics around indigenous ownership and FAIR and CARE data practices this is a gap to contribute towards. There also needs to be more discussion on how standards are enforced or monitored once they are agreed upon.

potential for outreach – Data access and visualization holds potential for outreach through links to media outlets. Experts on the outreach side exist (like Carbon Brief) but data needs to be easily accessible to be turned into material like infographics. This includes outreach to the public as well as for *science to policy* engagements.

attention on urban space in mountains – Urban areas have so far received limited attention in the context of mountain regions. However, not the least with the future IPCC focus on the issue, the topic will receive more attention and relevant data needs to become available.

lack of information on ecosystem risks – Risk for ecosystems in mountains due to natural hazards and socioeconomic changes remain poorly covered in regional datasets.

community resilience to risks – There is a lack of understanding and/or data on community resilience in the region. This goes in line with a lack of standards on how such data should be recorded and reported.

lack of insurance/data on insurance coverage – Mountain regions are often poorly penetrated by insurance (beyond large scale infrastructure) and any coverage that exists is inadequately documented.

lack of data on cascading risks – There is a general lack of documentation of cascading (and closely related *transboundary*) risks in mountains. Such data needs to be more comprehensively recorded, ideally with institutions already invested in the topic (e.g. AWB).

coordinate and map monitoring efforts – There are multiple monitoring efforts going on in HMA, both from the scientific community as well as by government stakeholders. Even without direct access to data collected, an overview of these efforts would be helpful for better coordination, cross learning and stock taking.

Existing capacities and resources

AKAH (Rahim Dobarya, Sharukh Vasaya):

AKAH maintains GIS data infrastructure at both the global and regional levels. Some of the resources are solely for internal operations, while others are publicly accessible, relying on commercial APIs (like Windy) as well as government data. They follow principles of ‘preparedness – response – building back better‘. They use the same ESRI backend environment to produce storymaps to communicate methodologies.

Future plans include the inclusion of mountain hazards into the national/regional dashboards and combination with relevant climate data for internal communication.

To integrate this data with the onsite HVRA (*Hazard, Vulnerability and Risk Assessment*), a bottom-up approach is followed. Offsite assessment is followed by onsite assessment, with information passed to a GIS expert producing a HVRA map with the final aim its integration into the Village Disaster Management Plan (VDMP). A crucial challenge remains the appropriate technology as well as communication of geospatial data to stakeholders in the field, e.g. farmers relying on risk data. Simulations and tabletop exercises using this data is an integral part of AKAHs work, to anticipate risk. They also take stock of coping and adaptive capacities in communities and co-develop adaptation and mitigation measures.

IIT Roorkee (Roopam Shukla, see Presentation for detailed visualizations of concepts)

Interest in her research cycles around connecting 'pixels – people – policy' – following the WISDOM model and making sure that there is a connection between *data*, *information* and eventually *knowledge*. Even only thinking, conceptualizing and documenting how e.g. farmer's decisions can be captured versus information from remote sensing data will be important to further improve our ability to respond to risks. Most lacking remains documentation of vulnerability in all its forms, including community vulnerability at the village level. As noted also for the application in the insurance sector, there needs to be appreciation for heterogeneity of hazard, exposure and vulnerabilities within a single *pixel*, i.e. what models or satellites cannot see. Going beyond the pixel but to model and study structures, nested scale studies should be considered (i.e. from local to regional/global). Scaling issues exist in purely physical science domains (e.g. for hydrological models or hazard assessments) but become even more complex when socioeconomic dimensions need to be accounted for.

Possibly in parallel to the need for better metadata standards we also need to share how data is collected and recorded (i.e. documenting methodologies) and in the process describe lack of important information. This would also help to avoid duplicating efforts in future.

These challenges should be addressed while integrating from the very start (rather than only upon completion of an intervention) both *different disciplines* as well as *local voices*.

WenClims (Haris Mushtaq)

WenClims has a climate, water and energy focus as a private consultancy company with strong integration into academic work (e.g. publishing peer reviewed articles, employing graduate students as interns, collaborating in international academic networks). A strong interest lies in *data mining* of available data (e.g. from government agencies on their respective web presences as well as from globally accessible datasets reworked for the region) and making it more accessible via interactive visualizations. This includes real time reading of data from other sources that are then visualized and made directly accessible as simple downloadable images for the user.

Gap assessment

During group work a list of crucial gaps were identified that were eventually aggregated into the recommendations following from this workshop.

- *Lack of general vulnerability data*
- *Lack of regional data on exposure* (available by now globally for buildings and population but lacking regional application and/or validation in a mountain context)
- *Lack of regional and local language access*
- *Lack of records of historical risk*
- *Lack of data on ecosystem stress*
- *Lack of settlement data and agroecological zones*
- *Lack of detailed land use data*
- *Lack of data on infrastructure quality*
- *Lack of disaggregated socioeconomic data (e.g. income, occupation, landownership)*
- *Lack of focus on heat stress, heat hotspots and heatwaves*
- *Lack of focus on (human) health*
- *Lack of focus on (snow) droughts*
- *Lack of data disaggregated socially and by gender*
- *Lack of data on soil on the geophysical side* (as well as limited understanding of the subsurface from a hydrological point of view)
- *Lack of a shared understanding of the meaning of vulnerability*
- *Lack of a shared understanding of the meaning of infrastructure*
- *Lack of a comprehensive overview on 'existing data', 'good to have data', 'data gaps' and 'serious data gaps'*
- *Lack of information on (seasonal) road accessibility*
- *Lack of records and information on slow onset risks*
- *Lack of willingness to address air pollution*
- *Lack of inclusion of local and Indigenous knowledge*

Recommendations for the immediate way ahead

As part of the group discussions several suggestions were made that should be explored or considered as immediate steps while moving ahead.

include governance experts. Future deliberations within HiRISK should include regional experts on governance to be able to assess risk holistically.

capacity building on data literacy, data mining and risk reporting. Capacity building should focus on (a) training policy makers (or associated bureaucrats) on how to use data for risk

assessments, (b) digitizing data that is available across the region, provided to early career researchers through trainings or hackathons and (c) the interpretation and use of risk related data for regional scientists.

community driven data gap filling. Establish opportunities to include communities in contributing towards data creation and quality control. In the Social Sciences as well as Climate Change research this receives attention and funding and best practices could be evaluated for the mountain risk.

data sharing mechanisms and protocols. The challenge of data sharing seems to be an endless but somehow unaddressed one. To move ahead it would be crucial to determine what hinders progress and what would stakeholder informed solutions be to progress on the issue with evolving risks in mind (as a survey and following white paper).

reach educators. Teachers and teacher trainers can reach both future policy makers, scientists as well as communities. They are also interested in material to produce course content. HiRISK has close connections to the community and should work towards a pipeline to make material accessible for schools and evaluate potential to reach communities in this way.

connect via webinars and stakeholder interactions. To keep the exchange on challenges with respect to mountain risk data going, the organization of webinars and/or talks from external experts is suggested. While this still needs to be gauged in terms of general webinar fatigue (potentially also while reaching out further to stakeholders as suggested for data sharing) this would also help to promote available resources through the portal. Crucial issues to be covered would be (a) a discussion across disciplines as well as integrating communities, (b) determining data literacy in the region across stakeholders and (c) visualize and discuss the heterogeneity in types of data and ways of communicating.

Other inputs shared:

Presentation by Jakob Steiner (University of Graz)

4. Risk resource node

A number of resources were noted by participants, either as already existing best practices for dealing with issues addressed during the deliberations or as resources that should be referred to through the HiRISK node. For the latter a central docking was established on the HiRISK portal, which needs to be populated and regularly updated. Brief introductions to the resources are also required for ease of access.

Global datasets and dashboards

International Disaster Database (EM-DAT)

Exposure data (with potential for validation in mountain environments):

Microsoft – building footprints

Meta – population

CLIMADA – infrastructure exposure value (initial validation suggests problematic quality for mountain areas in HMA)

Global Earthquake Model (GEM) – global exposure model

Global Energy Monitor – energy infrastructure trackers (potential for improvement for medium to small hydropower, see for example for the Upper Indus Basin by a HiRISK member)

Climate Risk Dashboard (currently still in development, but with participation of HiRISK members)

Vulnerability data

Global Earthquake Model (GEM) – global vulnerability model

Regional datasets and dashboards

National Cryosphere data center (China)
National TP data center (China)

Koshi Basin Information System – Regional climate data for the Koshi basin (China – Nepal – India)
Digital CPEC (China – Pakistan)

HI-CHAP – Hydrology visualization (HKH)
HIWAT – High Impact Weather Assessment Toolkit (HKH)
Regional Database System (HKH)

Global best practices (examples from outside the region)

https://climatevulnerabilitymonitor.org/stories/ - providing an example how narratives on risk can be presented

https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world/ - visualizing scientific evidence on a geospatial platform

Canadian climate atlas – combining scientific data with Indigenous knowledge

Climate Shift Index – visualizing climate change real time and interactively for any chosen region (US)

Regional best practices

AKAH HVRA documentation (Regional)
Indian Energy Security Scenarios (India)

5. Appendix – Workshop Participants

25 people participated during the workshop, partly online, 21 participants covering 5 of the regional countries, including 12 early career scientists.

Name	***Institution***	***Country***
Qiao Liu**	IMHE Chengdu	China
Lu Yuexuan	IMHE Chengdu	China
Arnaud Caiserman**	MSRI UCA	Tajikistan
Vitalii Zaginaev**	MSRI UCA	Tajikistan
Finu Shrestha**	ICIMOD	Nepal
Jakob Steiner**	University of Graz	Pakistan
Haris Mushtaq**	WenClims, Climate Analytics	Pakistan
Ravindra Kumar**	IIT Roorkee	India
Sharukh Vasaya	AKAH India	India
Rahim Dobarya	AKAH Global	India
Chi Huyen Truong	HUC	Nepal
Claire Souch	RMS/AWHA Consulting	UK
Chandan Verma	SwissRe India	India
Jannis Hoch	FATHOM	UK
Jan Kleinn	SLF Davos	Switzerland
Austin Lord	University of Toronto	USA
Amrit Thapa	University of Alaska Fairbanks	USA
Roopam Shukla**	IIT Roorkee	India
Holger Frey	University of Zurich/GAPHAZ	Switzerland
Sanita Dhaubanjar**	Utrecht University	Netherlands
Aruna Chandrasekhar	Carbon Brief	India
Birendra Bachracharya	ICIMOD	Nepal
Sudan Maharjan	ICIMOD	Nepal
Babar Khan	ICIMOD	Nepal
Moe Myint	ICIMOD	Nepal

**HiRISK member (contributors to the summary)