A BRIDGE FOR KNOWLEDGE TRANSFER – THE INDUS FORUM STUDY TOUR TO SWITZERLAND

Photo C. Leb

Report prepared by Boris Orlowsky and Tobias Bolch, University of Zurich, Switzerland

Setting the scene

Members of the Indus Forum gathered with European experts from 11th to 15th October 2016 in Switzerland to exchange knowledge on recent advances of glaciological and climate change research between the Hindu Kush Karakorum and the Alps. Participants represented both academia and stakeholders from governments and natural resource management institutes and agencies from the four basin countries (Afghanistan, China, India and Pakistan), as well as representatives from the International Center for Integrated Mountain Development (ICIMOD), the International Water Management Institute (IWMI) and the World Bank.

The study tour was organized within the context of the Indus Forum process, initiated in 2013 and supported by the World Bank under the South Asia Water Initiative, which addresses climate change as a common challenge shared by all countries sharing the Indus basin. One of main joint activities that resulted from this process is a joint research proposal, detailing a comprehensive research plan and associated specific research activities, to promote an evidence-based and regionally integrated adaptation to climate change. Glaciers and the cryosphere in general playing a substantial role for the region's water resources, one focus of the Study Tour to Switzerland was on research of glaciers and their fate under a changing climate. The Department of Geography of the University of Zurich (UZH), with its

decade-long experience in glacier research and several research collaborations in the Indus region, took over the role of hosting and organizing the Study Tour.

Following 2½ days of intense scientific exchange at the UZH campus between the participants and European experts the group continued the discussion during two days in Zermatt. Joint work sessions and informal discussions combined with a scientific excursion to Gornergrat, introducing the participants to glacier research activities in Switzerland.

The following two sections provide an overview of these two stages, followed by a section on resources (datasets, tools, software, scientific papers) that had come up during the discussions and are collected here for future reference.

Scientific exchange at the University of Zurich

This section aims at providing overviews of the different sessions, highlighting the most important points and findings. Copies of the presentations are available online on the Indus Basin Knowledge Platform for further reference.

Speakers and participants at the University of Zurich (Photo: B. Orlowsky)

Tuesday, October 11th

Opening session

After welcome remarks by Prof. Andreas Vieli, head of the organizing group at UZH, Christina Leb from the World Bank and the two organizers from UZH (Tobias Bolch and Boris Orlowsky), a first lecture by **Sven Kotlarski** from **Swiss National Weather Service MeteoSwiss** provided an overview of climate modelling, with a focus on future climate projections at the regional scale. He stressed the importance of not relying on single climate models, but to analyze ensembles of projections. In this way it is assured that not just one model is used which might be biased for a certain application or a specific region, and that

the variability of possible future scenarios is considered. Using ensembles provides also a more solid scientific basis for impact assessments and other uses of downscaled climate information.

An example are the ensembles compiled under the CORDEX (Coordinated Regional Climate Downscaling Experiment, see Resources) initiative. Experiences from implementing climate change adaptation in Switzerland are documented in two reports, referenced in the Resource section as well.

2nd morning session: Glaciers and Hydrology

This session brought together observational and modelling studies from the Swiss-European context and the Indus and Tarim basins. **Matthias Huss (ETH Zurich/University of Fribourg, Switzerland)** reported in the beginning on the Swiss Glacier Monitoring System (GLAMOS, see Resources), which systematically monitors Swiss glaciers, some of them over many decades. The first measurements of snout fluctuations started in 1880 and the first mass balance measurements in the early 20th century. These measurements confirm significant glacier mass loss in the 1940s and since the 1990s with a short period of positive balances in the 1970s. Further, Matthias Huss presented hydrological modelling results from Alpine catchments. Results indicate that the so-called peak water, that is the maximum outflow due to glacier melt, has already been reached and that in future, decreasing runoff contributions from glaciers are to be expected. Glacier runoff contribution can be over-proportionally important – while the fraction of glacierized area of the Rhine basin is negligible (0.2%), at the Rhine delta still 6% of its waters originate from glaciers in the month of August, and this fraction rose to 19% during the extreme hot and dry year of 2003.

As reported by **Francesca Pellicciotti (Northumbria University of Newcastle, UK),** observations from the Hunza Valley/Karakoram do not indicate that peak water has been reached already. Observational data in this region is scarce and often only allows for conceptual modelling of the processes, leaving model parameters as a major source of uncertainty in our understanding of the interplay between cryosphere and water resources. Current model results agree that there will be no significant decline of the run-off of Indus River until the end of this century. However, the uncertainties are large. Remote sensing offers an opportunity to monitor the glaciers and its surface characteristics and changes in detail, and to gain important information to reduce the uncertainties allowing to better constrain glacio-hydrological models. Many of the glaciers in the Himalaya, inclunding the Indus Basin, are covered by supraglacial debris. Although a thick debris mantle insulates the ice, the debris favors the development of supraglacial ponds and ice cliffs which are hot spots of ice melt. Hence, these processes are important to include in the models.

Doris Düthmann (GFZ Potsdam, Germany/Technical University of Vienna, Austria) presented an investigation of the past and simulated future run-off Tarim river located in Xinjiang region (North-West China). The river has some similarities with the Indus: it is a transboundary river with the main tributary originating from Kyrgyzstan, it is highly glacier-fed, flows through arid land and is the main artery for the region. The natural run-off of this river increased during the last decades, but the run-off in the middle and lower reaches decreased in the past, mainly due to increased water extraction for irrigation. A modelling exercise based on the WASA model (see Resources) revealed that temperature was the main driver for the run-off increase in the highly glacierized catchments, while precipitation was more influential in the snow-fed catchments. Model results revealed a reduction of the glacierized area by 30-90% by the end of this century, depending on the underlying scenario. This results in a slightly decreased runoff, but especially increased runoff variability as the base flow provided by the glaciers will be reduced.

1st afternoon session: Climate impact on glaciers in the Upper Indus Basin

During this session, three talks by participants from the four Indus Basin countries, provided an overview of the general water situation in the Indus basin, including research on water sources such as the cryosphere and the rising demand from increasing population. The talks also introduced the specific research activities carried out by the presenting participants.

Sharif Shobair (Ministry of Energy and Water, Afghanistan) presented a detailed assessment of the snow-fed Kabul River basin, which drains into the Indus. He showed that that the run-off decreased in the past, and will probably further decrease in the future due to increasing temperatures and evapotranspiration rates. Other pressures, such as increase in water demand due to population growth, are expected to cause serious water stress in the Basin. As throughout the region, observational data is scarce, therefore the speaker recommended to extend the hydro-meteorological network to have a reliable data base. In addition, he recommended dam construction in Kabul River to regulate water allocations based on actual needs, a better integrated watershed management, and policy measures for adaptation and mitigation.

Wang Run (Hubei University, Wuhan, China) presented relevant past and ongoing research activities on climate and hydrology of the Chinese participants. The gained knowledge and expertise could be of high interest also for the Indus Forum group.

Shakil Romshoo (Kashmir University, India) stated that peak water in the Indian catchments has probably been reached in the mid-1990s, when river discharges began to decline. He highlighted that out of the more than 7000 glaciers in the Indus basin, approximately 600 have been studied, but only few in detail in the field. Many of the glaciers in the Upper Indus Basin are stable, with a few retreating and a few even advancing, in particular in the Karakoram. However, despite advanced knowledge compared to few years ago, the cryosphere in the Himalayas is still understudied, resulting in an overly simplistic glaciological division. He pointed out that a research cooperation is needed to bridge the knowledge gaps and highlighted that the Indus Forum initiative is a valuable effort in that direction. In addition, he concluded that a cooperation on climate and water issues has a potential for generating a trustful basis to address other issues.

2nd afternoon session: Snow and Glaciers in the Karakoram – Himalaya

Focusing on Pakistan, **Danial Hashmi (WAPDA, Pakistan)** highlighted the strong dependence of the country on the Indus River waters, of which 70-80% originate from snow and ice melt. Since 2010, Pakistan is officially declared water-scarce per the availability per capita threshold of 1000m^3. WAPDA has initiated and conducted several field measuring campaigns, including the setup of new weather station and glacier monitoring networks. An interesting finding from available climate data is a cooling trend in the summer months over the last decades, which results in decreased river discharges (all other months show increasing discharge). However, most of the weather stations are located in the valleys, and there is a need for establishing more stations in high elevations. He also recommended isotope measurements which allow to distinguish the different moisture and run-off sources. To conclude he highlighted the importance of further develop transboundary knowledge and data sharing mechanisms, and to arrange field visits by the Indus Forum partners in the different catchments.

Knowledge about the water stored in the Himalayan glaciers is important for long-term predictions of water availability, but the existing estimates vary significantly and field measurements are extremely scarce. **Holger Frey (UZH)** presented several approaches for deriving volume estimates from remote sensing data, such as simple area-volume relations, slope-thickness relations, and spatially distributed thickness modelling. The uncertainties of all approaches are high, but all agree that the mean glacier thickness in the Karakoram is much higher than in all other parts of the Himalaya. The spatially distributed

thickness modelling allows for comparison with *in-situ* measurements and comes with a satisfactory performance, although the uncertainty is still in the range of 30%. Results revealed that large portions of the ice are located in flat low-lying glacier tongues, which are most affected by temperature increases. Since the required input data is available globally, the approach can be used to compute a global inventory of glacier volumes (see Resources).

Samjwal Bajracharya (ICIMOD) presented the ICIMOD glacier inventory of the Hindu Kush-Himalayan region, and the derived decadal changes for the period 1980 – 2010 for several sub-regions. Glacier areas decreased in 1980-2010 by more than 20% in the Jhelum basin located in both, India and Pakistan. Similar high recession was found in parts of Nepal and Bhutan, while smaller decreases of about 6% were observed in the Irrawaddy region in Myanmar. These glacier outlines and respective reports can be found in the extensive online resources published by ICIMOD (see Resources). Samjwal Bajracharya concluded by highlighting the needs for a joint identification of regular glacier monitoring sites with a standardized quick methodology for glacier monitoring.

Wednesday, October 12th

Participants are following a talk during the workshop in Zurich (Photo: B. Orlowsky)

1st morning session: Glacier Mapping and Monitoring

While the previous sessions highlighted the importance of systematic observation and monitoring of glaciers, this session was dedicated to different programs and initiatives. As **Samuel Nussbaumer** from the **World Glacier Monitoring Service (WGMS)** reported, the Global Terrestrial Network on Glaciers (GTN-G) is jointly run by the World Glacier Monitoring Service (WGMS), the U.S. National Snow and Ice Data Center (NSIDC), and the Global Land Ice Measurements from Space (GLIMS) initiative. GTN-G aims to compile, and systematically bring together remote sensing and *in-situ* observations with observations from new technologies such as drones (or Unmanned Aerial Vehicle, UAV), and mass and energy balance modelling. This is important for an improved understanding of global glacier changes. He presented the tiered strategy for glacier monitoring (see resources). Since the 1940s, direct observations on 427 glaciers of the globe and1830 from remote sensing are compiled. The data is updated on an annual basis. Samuel Nussbaumer highlighted that there is a lack of long-term observations and mass-balance measurements in the focus region, and that many front variation measurements were discontinued. He recommended to establish at least one detailed process-oriented observation program, to establish additional 3-10 glacier

mass balance programs with reduced stake networks in each country, and to make the data and the related meta data freely available through GTN-G.

With a specific regional focus, the Capacity Building and Twinning for Climate Observing Systems (CATCOS) project, which is co-funded by Swiss Agency for Development and Cooperation (see Resources) supports selected countries of Latin America and Central Asia in (re-) establishing glacier monitoring, among others. Capacity building and knowledge transfers to these developing regions are a central component of the project. **Martin Hoelzle (University of Fribourg, Switzerland)** reported on such activities in Kyrgyzstan and Uzbekistan, where during the dry season melt water from glaciers provides an import source of water. Long-term monitoring programs from times of the Soviet Union were shut down, e.g. the permanent station at Abramov Glacier in Kirgizstan, which was destroyed in a terrorist attack and not rebuilt. Within CATCOS, stake networks on Abramov Glacier are re-established, and Kyrgyz scientists are trained to maintain the observational record. Promoting a mix of different observation methods, e.g. combining the stake observations with snow line cameras, provides an accurate as possible picture, given budget and logistics constraints.

Increasing the height of flight considerably, **Frank Paul (University of Zurich)** presented analyses of remote sensing data from large regions such as Patagonia and the Himalayas. He showed that for certain regions, old aerial photography or satellite imagery of the 1960s can be combined with more recent satellite observations to produce images of glacier changes over many decades. He highlighted challenges and their solutions when detecting glaciers from remote sensing pictures, for example that the ratio of the visible light bands and the short-wave infra-red band can be used to detect ice, or that low correlation of several SAR pictures can be used to define debris covered glaciers. Findings from his analysis include massive ice loss in Patagonia despite cooling temperatures, surging periodicities of 40-50 years, and on average stable non-surging glaciers in the Karakoram.

2nd morning session: Glacier Mapping and Monitoring

Tobias Bolch (University of Zurich) showed, based on differencing digital elevation models generated from historical spy satellite images and recent high resolution data, that glaciers in the Hunza River basin (Central Karakoram) were on average in balance. This was not only during the last decade, but also since the 1970s. He could also confirm that heterogeneous glacier behavior, and frequent surge activities were also characteristic prior to 2000. Observation of snow cover using MODIS data showed no significant trends, but indications for a decreased snow line elevation at the end of summer, which is in line with stable glaciers. He concluded that old stereo satellite images, such as Hexagon from the 1970s, and especially recent very high resolution imagery are valuable sources for glacier mass balance assessments. However, careful post-processing are needed to improve the accuracy and the results. He further stressed the need for extended *in-situ* and geodetic measurements, as well as modelling to fully understand the past and predict the future of the glaciers. He suggested that attention should be given on the surge-type glaciers, which occur quite often in the Indus Basin.

Bringing the glaciers back to the people, **Matthias Winiger (University of Bonn, Germany),** adopted a more comprehensive perspective of the region, including society and their reliance on water resources, based on his 25 years of research experience in the Upper Indus Basin. Around 75% of the water is used for irrigation, which is regulated by various water agreements, but also influenced by population dynamics, and sometimes competing demands that creates tensions among different users. These pressures are exacerbated by climate change impacts. Further, urbanization is projected to increase from 20% in the 1960s to 60% by 2050, leading to an increase in water demand, and to the disappearance of traditional livelihoods and agriculture, which, as a side effect, has already lead to a “passive” reforestation. Water balances are altered significantly by such land use changes.

Further, increasing population has increased settlement areas, partly in vulnerable locations. When disaster such as landslides strike, one needs to be careful not to blame climate change for fatal consequences of bad planning. Local experience can be limited and disregarded in the bigger picture. For example, people recently settled in the lower part of the Batura Glacier, ignoring the fact that the upper part is gaining mass. A detailed understanding of such glaciers is therefore needed to reduce the exposure of local populations through improved planning. Based on his experiences, he recommended a multi-level approach combining local and regional scales, field observations, remote sensing and modelling studies. He also stressed the importance of considering the compatibility of monitoring stations/data sets as the quality and (measurements) techniques can vary considerably from one station to the other. As a general recommendation, existing networks of research institutions and universities (such as the Himalayan University Consortium), should be contacted for collaboration before initiating any new initiative to avoid redundancy, and ensure an optimal use of resources.

Afternoon sessions: Joint work on proposal

The afternoon session was chaired by the World Bank representatives and brought forward an engaging discussion of the joint research proposal. Briefly summarizing the history of the Indus Forum process, Christina Leb (World Bank) went through its main stages, from the kick-off in Afghanistan in 2013 where Climate Change was chosen as a topic of common interest to all Indus countries, and the necessity of coordinating research in this area lead to the decision of preparing the joint research proposal. At the following meetings in Ecuador (2014) and Pakistan (2015) and two working group meetings in China (2015) and Bangkok (2016) the work packages of this proposal were defined and elaborated. The proposal was further defined throughout two working sessions during this study tour. The World Bank's role in this process is to facilitate its network and resource mobilization for implementation.

Thursday, October 13th

1st morning session: Water Management

This session turned from system understanding and impacts of climate and socio-economic changes to planning and water resource management solutions. In the opening presentation, **Markus Disse (Technical University of Munich, Germany)** introduced the SuMaRiO project, dealing with the Tarim basin, Xinjiang/China, where a larger consortium of Chinese and German institutions developed a comprehensive decision support system for water management, including components on the cryosphere, ground water, water allocation, irrigation, cropping calendars and farmers' economies. The model setup was complemented by the installation of several meteorological and ground water/soil moisture stations. Regarding the ecological situation of the Tarim basin, since the foundation of the People's Republic of China, increased irrigated cotton cultivation led to dying forests downstream, the speaker highlighted the need for sound sustainable water management in this basin. The Chinese government plans to decrease irrigation intensity in the coming years to reduce the said pressure. The project was despite all existing hurdles quite successful, and the results were well acknowledged by local partners. The Indus Forum could benefit from the gained knowledge and developed methods, and an adjusted approach could be considered for the Indus Basin as well.

Sustainable water management is at the heart of IWMI's mission, represented **by Azeem Shah and Nitasha Nair**, who elaborated on the water availability situation of the Indus basin, with a strong focus on Pakistan. Water reserves of Pakistan last for 15 days only, making the population vulnerable to water scarcity. Illegal ground water pumping is a strong concern, tube wells have increased from 200,000 to 1,000,000 since 1980, together with ground water depletion (especially around large cities) and salinization. Agricultural intensity has also increased from 63% (1960) to 150% today.

Addressing this situation, the UK Department for International Development (DFID) funded a holistic program with three main components that respond to these objectives: (a) consolidating knowledge; (b) understanding decision making; and (c) facilitating dialogue. The Indus Basin Knowledge Platform, part of the first component (see Resources), provides a one-stop web portal with a complete offer of non-spatial and spatial data and publications. The other two components aim at strengthening decision framework mechanisms and enhance dialogue at different levels. It is set-up to foster a basin-wide stakeholder dialogue, including training of media people to report adequately about these issues. Based on social media platforms, this community has begun an independent self-organization.

Brining in a donor's perspective, **Mirjam Macchi** from **Swiss Agency for Development and Cooperation (SDC)** introduced the Indian Himalayas Climate Adaptation Program (IH-CAP) in India (see Resources), which has a similar approach as the Indus Basin Knowledge Platform's. A focus of IH-CAP lies on inter-university cooperation, having resulted in joint collaborations between Indian and Swiss academic institutions on climate change and glaciology. This efforts are currently under implementation at different Indian universities. SDC has been supporting projects in India for five decades, always with joint funding schemes involving contributions from India. Since 2011, climate change related projects are a key focus of SDC's agenda. Currently, there is an open call for proposals for research in India (see Resources). SDC in Pakistan is now revising its strategy, with still open outcomes, although one focus of future activities will be on water.

2nd morning session: Adaptation Strategies and Summary

The last session brought contributions on climate change adaptation experiences.

Nadine Salzmann (University of Fribourg) detailed some of the activities within IH-CAP, related to glacier lake outburst floods (GLOFs). From another SDC funded project in Peru, studies of climate change impacts on river runoff and cropping cycles had become instrumental to regional adaptation. Lessons learned from these two projects include the importance of baseline data, integration of local stakeholders in research and adaptation planning and implementation, capacity building and establishing and maintaining networks with regional policy makers. One of the disaster preparedness challenges mentioned during the discussion was the human perception to risks, which sometimes pose an added difficulty to the said adaptation strategies.

ICIMOD's activities, presented by **Samjwal Bajracharya**, provided good examples of how to establish and promote a comprehensive network of stakeholders, integrating policy makers from all involved countries, as well as international scientists; and support for extending and maintaining observational networks on cryosphere, hydrology and climate. Collection and provision of these, and other publicly available data of the region in ICIMOD's web portals (see Resources) provide essential resources for scientist and policy makers.

Christina Leb concluded with a brief summary of the two and a half days of sessions, highlighting the diversity of the contributions and the good spirit and constructive discussions.

Field trip to Zermatt

The trip to and the days in Zermatt allowed for more informal exchange. The journey by coach from Zurich to Taesch, which is the last village before Zermatt that can be reached by car, traveling through the impressive landscapes of the Swiss Alps, including a train-transport of the bus through the Loetschbergtunnel, brought forward relaxed conversations about previous days.

With weather worsening, the original schedule needed some adaptation, and the first morning in Zermatt (Friday, October 15th) brought a rainy walk to the suspension bridge above the Furri cable car station, which inspired the cover photo of this report. Participants' mood turned out to be extremely resistant to the bad weather, making this short excursion a memorable experience despite adverse conditions. The afternoon was dedicated to another group session, where the next steps for the joint research proposal were agreed upon.

The following and last day of the Study Tour compensated for the heavy rain of the previous day through the most splendid conditions, and the group went up by train to Gornergrat at 3100 m a.s.l. Spectacular views on the Matterhorn (4478 m a.s.l.) and the many other peaks above 4000m a.s.l. in the Zermatt area provided the perfect setting for an improvised lecture by Tobias Bolch, who, based on conference posters about Swiss glacier research, snow and permafrost, introduced the changing cryosphere landscapes surrounding the group, and the monitoring stations and data transfer mechanisms used to monitor these glaciers in Switzerland.

Improvised lecture at Gornergrat about the changing cryosphere in Switzerland (Photos: N. Nair, B. Orlowsky)

In the afternoon, the bus ride back to Zurich went all according to plan, and the group celebrated farewell and an inspiring and productive time together at the final dinner in Zurich.

Dinner with birthday in Zermatt and Farewell dinner in Zurich (Photos: A. Shah, B. Orlowsky)

Resources

Relevant reports / projects:

Reports on climate change scenarios and adaptation strategies in Switzerland
www.ch2011.ch
www.ch2014.ch

CATCOS project
http://www.meteoswiss.admin.ch/home/research-and-cooperation/projects.subpage.html/en/data/projects/2011/catcos.html
A project supported by SDC supporting selected developing countries in Latin America and Central Asia for climatological and glaciological monitoring and observations

SuMaRiO project
http://www.sumario.de/project
Developed a comprehensive decision support system for water management in the Tarim basin

Glaciers_cci project
www.esa-glaciers-cci.org

IH-CAP (Indian Himalaya Climate Change Adaptation Program) project funded by SDC
http://ihcap.in

GTN-G/WGMS Monitoring strategy
http://www.gtn-g.ch/intro/

Glacier data

GLAMOS (Glacier Monitoring program in Switzerland)
http://glaciology.ethz.ch/swiss-glaciers/
Observations include mass balances and length changes of approximately 100 glaciers in Switzerland.

World Glacier Monitoring Service (WGMS)
www.wgms.ch
Compilation of glacier mass balance and front variation data, annually updated

GLIMS (Global measurements from space initiative)
www.glims.org
Glacier outlines from many regions of the globe

Global terrestrial network on glacier observations
www.gtn-g.org
Joint website from WGMS, NSIDC and GLIMS with links to data access (remote sensing and in-situ data of glaciers worldwide, glacier photograph collection).

Randolph Glacier Inventory (RGI)
www.glims.org/rgi
Global glacier inventory based on different source (incl. GLIMS outlines)

Glacier Thickness
www.gtn-g.org/glathida.html
Data base about available glacier thickness data compiled by WGMS

Climate model data

Coordinated Regional Climate Downscaling Experiment CORDEX,
www.cordex.org
Standardized past and future climate projections from Regional Climate Models (RCMs) for several regions of the world, including covering the Indus basin.

Remote sensing and DEM data

Landsat and ASTER data
www.glovis.org

Sentinel-2 data
https://sentinel.esa.int/web/sentinel/sentinel-data-access

Webportals from NASA and USGS to order several EO data (incl. declassified spy imagery, Landsat and ASTER data, ASTER GDEM and SRTM data)
http://earthexplorer.usgs.gov/
http://reverb.echo.nasa.gov/reverb/

SRTM DEM
srtm.csi.cgiar.org

WorldDEM
http://worlddem-database.infoterra.de/
Global DEM based on TanDEM-X data (with costs)

Resource web portals

The Indus Basin Knowledge Platform (IBKP) by IWMI
www.indusbasin.org
Spatial and non-spatial data as well as publications related to water management the Indus basin.

ICIMOD data and information portals
http://www.icimod.org/publications/
http://geoportal.icimod.org/
http://rds.icimod.org

Annexes

The Annexes contain the list of participants and speakers, the agenda, the link to the presentations from the Zurich workshop. Please note that the material of these presentations is intended for internal use only. Should you want to use any of these for your presentations or publications, please ask the respective authors for their consent.

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Agenda

Indus Forum Workshop Switzerland

Knowledge Exchange on Glaciers and Climate

11 – 15 Oct. 2016, University of Zurich, Switzerland

Day 1 (Tuesday, 11 October). University of Zurich, Building RAA, Floor G, Room 01 (morning) and 15 (afternoon)

Time	Content	Presenter	Organisation/Country
9:00 – 10:30	**Opening Session**		
	Welcome Remarks Welcome Remarks, Background of the Workshop Welcome Remarks / Logistics Future Climate Projections and their Uncertainties	A. Vieli C. Leb Bolch/Orlowsky S. Kotlarski	Inst. of Geography/UZH World Bank Inst. of Geography/UZH Meteoswiss
10:30 – 11:00	*Coffee Break and Group Photo*		
11:00 - 12:45	**Glaciers and Hydrology**	Chair: T. Bolch	
	Glacier monitoring and glacio-hydrological studies in Switzerland Glaciohydrological Modeling and Runoff in the Indus Basin Future Runoff Prediction: Experiences from the Tarim Basin	M. Huss F. Pellicciotti D. Düthmann	ETH Zurich University of Newcastle GFZ Potsdam/Univ. Vienna
13:00 – 14:00	*Lunch*		
14:00 – 15:30	**Climate impact on glaciers in the Upper Indus Basin – Report on the Countries' Activities**	Chair: C. Leb	
	Afghanistan - Climate Change Impact on Water Resources of Kabul River Basin, Afghanistan China – Activities in China and on Indus Basin India - Impacts of climate change on Indus basin cryosphere	S. Shobair Wang Run A. Shakeel Romshoo	Ministry of Energy and Water (MEW) Hubei University, Wuhan Kashmir University
15:30–16:00	*Coffee Break*		
16:00 – 17:45	**Snow and Glaciers in the Karakoram - Himalaya**	Chair: B. Orlowsky	
	Pakistan – Title TBD Glacier Volume in the Indus Basin Glacier Changes in the HKH Region	Danial Hashmi H. Frey S. Bajracharya	WAPDA, Lahore University of Zurich ICIMOD, Kathmandu
18:00–19:00	*Dinner*		

Day 2 (Wednesday, 12 October). University of Zurich, Building RAA, Floor E, Room 30

Time	Content	Presenter	Organisation/Country
9:00 – 10:45	**Glacier Mapping and Monitoring** (Chair: T. Bolch)		
	International Glacier Monitoring (Re-)establishing Glacier Monitoring in Central Asia Mapping Glaciers and Surging Glaciers in the Karakoram	S. Nusbaumer M. Hoelzle F. Paul	WGMS, Zürich Univ. of Fribourg University of Zurich
10:45 – 11:15	***Coffee Break***		
11:15 – 12:15	**Glacier Mapping and Monitoring** (cont.)		
	Snow and Glacier Changes in Upper Indus Basin 25 years of environmental research in the Upper Indus Basin - approaches, results and recommendations	T. Bolch M. Winiger	University of Zurich University of Bonn
12:15 - 12:45	**General Discussion and Discussion on Proposal (Chair: J. Newton)**		
	General Discussion about the presented work		
	Start with Joint Work and Discussion on Proposal		
13:00 – 14:00	***Lunch***		
14:00 – 15:45	**Joint Work and Discussion on Proposal**		
15:45–16:15	***Coffee Break***		
16:15 – 17:30	**Joint Work and Discussion on Proposal (cont.)**		
18:00	***Conference Dinner (Palmhof)***		

Day 3 (Thursday, 13 October). University of Zurich, Building KOL, Floor G, Room 212

Time	Content	Presenter	Organisation/Country
9:00 – 10:45	**Water Management**		
	Experience with Water Management and Decision Support Systems from the Tarim Basin	M. Disse	TU München, Germany
	Water Management and Hydrological Research Issues in Indus Basin	A. Shah	IWMI
	SDC activities and strategies in the KHK region	M. Macchi	SDC
10:45 – 11:15	***Coffee Break***		
11:15 - 12:45	**Adaptation Strategies and Summary**		
	Role of science for climate adaptation	N. Salzmann	Univ. of Fribourg
	Overall activities and experiences from ICIMOD	S. Bajracharya	ICIMOD
	Summary of workshop and outlook for Zermatt Tour	C. Leb/B. Orlowsky	
13:00 – 14:00	***Lunch***		
14:00 – 19:00	**Travel to Zermatt**		
19:30	***Dinner at Hotel Zermatt***		

Day 4 (Friday, 14 October). Zermatt, Sunstar Style Hotel

Time	Content	Presenter	Organisation/Country
9:00 – 11:30	**Excursion to Gornergrat**		
	Introducing Swiss Glaciological Research Activities in Matter Valley	T. Bolch	University of Zurich
11:30 – 12:30	***Lunch at Gornergrat***		
13:00 – 14:00	**Return from Gornergrat**		
14:00 – 16:00	**Discussion on Resource Mobilization Strategy and Partners for Joint Proposal (at the Hotel)**	Chair: C. Leb	
16:00–16:30	***Coffee Break***		
16:30 – 17:45	**Discussion on Resource Mobilization Strategy and Partners for Joint Proposal (cont'd)**		
17:45 – 18:30	**Summary and Way Forward**		
19:00	***Dinner (Hotel)***		

Day 5 (Saturday, 15 October). Zermatt and Zurich

Time	Content	Presenter	Organisation/Country
8:00 – 12:00	**Excursion, free time or work**		
	Excursion to Sunnegga (Matterhorn view and glaciology), optional: work on proposal		
12:30 – 13:30	***Lunch***		
14:00 – 19:00	**Return to Zurich**		
19:00	***Farewell Dinner (Linde Oberstrass)***		

Presentations

The presentations can be downloaded at the following URL:

www.indusbasin.org

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