

REPORT

International workshop on **‘Himalayan Permafrost under the Changing Climate’**

India Habitat Centre, New Delhi: 12 August 2016



Organised by

National Institute of Hydrology, Roorkee
&

International Centre for Integrated Mountain Development (ICIMOD) Kathmandu



International workshop on
‘Himalayan Permafrost under the Changing Climate’

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Patrons

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Dr. David Molden, DG, ICIMOD
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Organising secretary

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Scientific Advisor: Dr. Stephan Gruber, Carleton University, Canada

Local Organising Committee

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Co- Sponsors

Indian Himalayan Climate Adaptation Programme (IHCAP)
Science Engineering Research Board (SERB)

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Background

The hydrology of the Himalayan region and its changes are being closely watched today as it is vital for the sustenance of a very large mountain population as well as the people in the plains downstream. Several of the big rivers originate in the Himalaya and civilizations are built and sustained in its flood plains. Today, with the increasing population and unpredictable climate, water resources in the region is experiencing an unprecedented stress. Regionally, mountain communities are trying to cope with greater uncertainty of water related issues, such as floods and water availability. These scenarios forces us to look into the finer details of the water resources dynamics in the Himalayas. The Himalaya is known for its glaciers and snow cover from time immemorial and during the past decades, most of the attention focused on these two cryospheric components. The climate change debates during the past two decades have given a fillip for the Himalayan glacier research and an increased vigour in research activities are visible today on this front. However, knowledge about frozen ground, and more specifically permafrost in the high altitude regions of the Himalaya is sparse till date. Permafrost is the thermal state of ground material, which remains at or below 0°C for more than two years. However, normally frozen water is part of permafrost. The layer above permafrost is termed ‘active layer’ and thaws during the warm season. A lack of appreciation of permafrost stems primarily from the fact that it is hidden beneath the ground surface. Furthermore, the impact of thawing permafrost on the mountain eco-system in comparison to other cryospheric components is largely unknown. However, recent studies have suggested widespread occurrence of permafrost in the Himalayan region and its potential role in local/regional water availability as well as disasters such as landslides. This is especially true for the arid regions of the Himalaya and more so under the changing climate. As permafrost lies beneath the ground, we need to employ robust monitoring and modeling strategies to understand the permafrost and its characteristics in the Himalayan region. To achieve this, we need trained and dedicated manpower as well as sufficient funds to undertake research in the high altitude terrain, and institutions with committed programmes to sustain such research activities and capacity building. Hence the workshop was aiming at bringing together various national and international stakeholders with following objectives a) Sensitize the local government, funding agencies, research institutions, universities and other stakeholders on various issues related to the permafrost thaw/ ground ice in the Himalaya with an aim to promote permafrost research and knowledge generation in the Indian Himalayan region (IHR) and b) Explore research collaborations with experts in the field who can help in fostering permafrost research in India.

1 Opening Session

The one-day workshop organised at the India Habitat Centre, New Delhi was attended by 48 participants from 29 institutions in the country and overseas. In the inaugural session of the meeting Dr. Renoj Thayyen, Organising Secretary of the workshop welcomed the guests and participants of the workshop. Er. R.D Singh, Director, National Institute of Hydrology (NIH), Roorkee highlighted the need for making a collective effort to build a permafrost programme for the Indian Himalayan region incorporating the best practices in the field with robust international collaborations. Dr. David Molden, Director General, International Centre for integrated Mountain Development (ICIMOD) Kathmandu summarized ICIMOD's initiatives to develop permafrost research in the HKH region with the active support of the member countries. Dr. Shirish Sinha, Deputy Director, Swiss Development Corporation explained the initiatives under the Indian Himalayan Climate Adaptation (IHCAP) programme for the permafrost studies in the Himachal Pradesh and expressed the desire to promote permafrost related activities in future as well. The list of workshop participants are given in the annexure-II.



2 Technical session- I: Himalayan permafrost in the global context

The first Technical session on “Himalayan permafrost in the global context” was chaired by Dr. M.R Bhutiyani, Director, DTRL. Dr. Stephan Gruber from Carleton University, Ottawa, Canada delivered the key note presentation. He described the various landforms associated with the permafrost and highlighted the complexities in modelling due to huge spatial variability of ground temperatures. He emphasised that while physics of permafrost remain same for all regions, the configuration of this in the HKH region could be different. Dr. Stephan appraised participants of the results of the modelling studies carried out in the HKH region which suggested significant area of high elevation region of the Himalaya holding permafrost. He also touched upon the history and activities of International Permafrost Association (IPA). Second talk was by Dr. Nadine Salzmann from University of Fribourg, Switzerland and provided an overview of the pioneering work done in the Swiss Alps since 1970’s and more focussed studies under the Swiss Permafrost Monitoring Network (PERMOS) programme since 2000. Dr.Nadine also explained various methods helpful for permafrost monitoring such as ground surface temperature, geophysical



methods especially resistivity method, borehole temperature monitoring etc. She reported that the borehole temperature monitoring revealed significant warming trend during past one and half decades in the Swiss Alps. In the perspective of global scenario on permafrost research discussed earlier, Dr Dorothea Stumm from ICIMOD followed it up with a proposal for an observation strategy in the Hindu Kush Himalayan (HKH) region with an aim to understand the permafrost –climate linkage in this part of the world. A borehole transects across HKH region for long-term monitoring and selected super sites in various climate regimes were the highlight of the suggested strategy apart from routine ground temperature and active layer thickness measurements.



3 Technical session- II: Climate change and Permafrost thaw: Regional issues

The second technical session on “Climate change and Permafrost thaw: Regional issues” was chaired by Dr. Arun Shrestha from ICIMOD. The session started with the presentation by Dr. M.R Bhutiyani on few rock



avalanches on North Terong glacier and Siachen glaciers area in recent past. He suggested that the rock avalanches and landslides in the very high altitude glacier regime could be linked with high temperatures and associated thawing of the frozen grounds of the high mountain Karakorum region. Dr R.J Thayyen from NIH, Roorkee presented the results from a case study in the cold-arid region in Ladakh which showed significant and consistent melt water yield from the catchment during the years of early snow melt and snow cover disappearance from the catchment. Higher electrical conductivity of stream water and its in phase variations with discharge during these years suggests ground ice melt contribution to the streamflow. Dr. Thayyen also suggested the need for better modelling studies to incorporate the aspect of ground ice melt component in the cold-arid region. Dr Simon Allen from University of Zurich University, Switzerland presented the insights developed from a study under the Indian Himalayan Climate Adaptation Programme (IHCAP) in the Kullu region of Himachal Pradesh. The study has mapped potential permafrost zones of the basin by using the topographic controls such as slope morphology, aspect and mean annual



temperature of the elevation zone. Prof. A.P Dimri discussed the physical processes forcing the permafrost conditions in the mountain environment and its near surface dynamics. He highlighted the challenges in understanding the climate forcing on the permafrost regions in the high elevation Himalaya.



4 Technical session- III: Group discussion: Thrust areas of Himalayan permafrost research

The third session was a group discussion on thrust areas of Himalayan permafrost research. The session was chaired by Dr. Stephan Gruber, Carleton University, Canada and co-chaired by Prof. A.P Dimri, JNU, New Delhi. Dr. Philippus Wester from ICIMOD gave the introductory talk outlining the framework of a Permafrost research proposal in the HKH region. He elaborated on the ICIMOD initiative in promoting the permafrost research in the HKH region and briefed about the previous two workshops held at ICIMOD, Kathmandu during the past two years. He also mentioned the forthcoming permafrost training programme in collaboration with Karakoram International University at Gilgit, Pakistan. After this talk, the Chair invited the for suggestions and feedback from the participants. All the participants were invited to express their views during the course of the



discussion. An overwhelming concern of the participants were on the assessment of the permafrost area in the Indian Himalaya and the method of identification. The need for combining the modelling efforts with field validation was also highlighted by the participants. Another important suggestion was to investigate the linkages between permafrost - livelihood aspects and ecosystem responses. Impact of permafrost thaw/ ground ice melt on local water supply has emerged as one of key research question during the discussion. Permafrost thaw and linkages with mountain hazards such as landslide, debris flow and landslide dam outburst flood (LDOF) was also flagged by the participants.



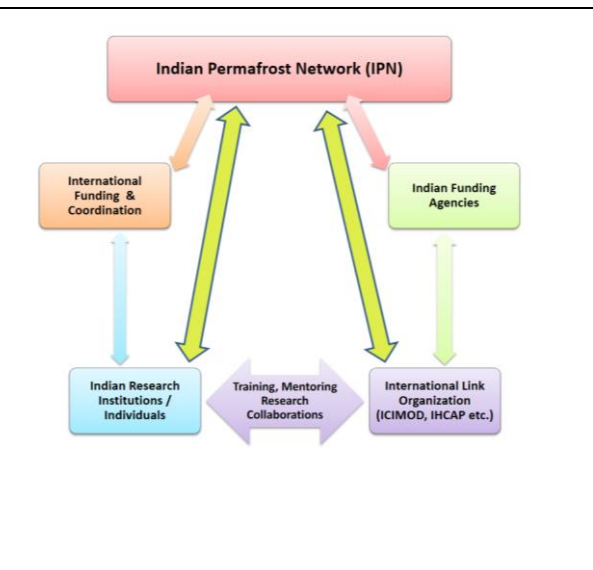
Effective use of chemical and isotopic tools to identify the ground ice melt components in the stream flow was suggested by a number of participants. Some members raised questions regarding the potential of remote sensing techniques in identifying the permafrost regions in the country. Discussion also highlighted the need for greater interactions within the research community for data and knowledge sharing. The need to distinguish between permafrost and periglacial processes were also stressed by a few participants. Dr. Stephan Gruber concluded the session by suggesting that the ground temperature monitoring could be the best inexpensive way to identify permafrost areas, and the borehole temperature study is the best but expensive way of studying permafrost.



5 Technical session- IV: Workshop Synthesis. Way forward & networking

The fourth session was aimed at consolidating various issues discussed in the workshop and structure a roadmap for the future work in the Indian Himalayan region. The session was chaired by Dr. Renoj Thayyen of NIH, Roorkee and co-chaired by Dr Flip Wester and Dr Dorothea Stumm from ICIMOD. The lack of research and knowledge on permafrost in the Indian institutions and universities necessitate training and mentoring as a first step towards promoting the permafrost research in the country. It is proposed to form an Indian Permafrost Network (IPN) to ensure a collective effort on these goals, which also will ensure regular interaction between the participants. It is suggested that the National Institute of Hydrology, Roorkee could lead the IPN and the participants welcomed the proposal. The IPN is proposed to coordinate between national / international research institutions, universities and funding agencies for research and training. Participants were given a chance to express their willingness to join the Indian Permafrost Network and chose their preferred thrust areas out of eight thrust areas defined for the purpose. Those thrust areas are:

1. Field monitoring (Ground temperature)
2. Hydrology
3. Modelling



4. Chemistry and isotope studies

5. Kinematics and Dynamics

6. Remote Sensing

7. Geophysical Survey

8. Instrumentation and Sensors.

25 participants from 15 institutions expressed their interest to be part of the IPN. It was also decided to make an effort to expand the permafrost network through various activities.

6. Closing Session

The Workshop ended with the closing session chaired by Dr. David Molden, Director General, ICIMOD. Dr. MR Bhutiyani, Director, DTRL and Mr Deepak Srivastava, Ex. Dy DG, GSI and Dr. Stephen Gruber shared the dais and gave their closing comments. All of them appreciated the need for greater emphasis on permafrost research in the Himalayas and expressed happiness in the enthusiastic participation of delegates from various institutions across the country. The formation of the Indian Permafrost Network (IPN) was counted as decisive step to foster permafrost research in the Indian Himalayan Region. It was suggested that the organisation of a training session in the immediate future could be the next activity of IPN. Dr. Dorothea Stumm, co-organising secretary from ICIMOD proposed vote of thanks and the workshop ended with a strong determination to make a collective effort to take the permafrost research in India forward.



Workshop Highlights & Way forward

- Wide appreciation of the knowledge gap and need for permafrost and frozen ground research in the Himalayan region.
- Identification of key problem areas: A. Lack of research background in Indian institutions and universities B. Lack of funding opportunities for permafrost/frozen ground research.
- Establishment of Indian Permafrost Network (IPN) with National Institute of Hydrology, Roorkee as the lead organisation.
- Expression of interest to be part of the Permafrost Network by 25 Individual members belonging to 15 institutions.
- Identification of thrust areas for permafrost research in the Himalayan region 1. Field monitoring (Ground temperature) 2. Hydrology 3. Modelling 4. Chemistry and isotope studies 5. Kinematics and Dynamics 6. Remote Sensing 7. Geophysical Survey 8. Instrumentation and Sensors.
- Identified organisation of a training programme and project mentoring as immediate next step to promote permafrost research in the country.
- Willingness of international participants/institutions in collaborations for training and research.

**International workshop on ‘Himalayan Permafrost under the Changing Climate’
India Habitat Centre, New Delhi: 12 August 2016
Programme (0930 to 1730 Hrs)**

9:30-10:00	Welcome: Dr. Renoj Thayyen (5') Remarks: Er. RD Singh, Director, NIH (5') Dr. David Molden, DG, ICIMOD (5') Dr. Shirish Sinha, Deputy Director, SDC (5')	
Technical Session 1: Himalayan permafrost in the global context		Chair: M.R Bhutiyani, Director, DTRL
10:00-10:35	Keynote: Stephan Gruber, Carleton University, Canada (30'+5'): Introduction to permafrost, its drivers, indicators and impact of permafrost thaw on various systems.	
10:35-10:55	Nadine Salzmann, UFR (15'+5'): The Swiss Alps, a mountain permafrost 'pioneer': Experiences in research, monitoring strategies and hazard prevention.	
10:55-11:15	Dorothea Stumm, ICIMOD (15'+5'): Permafrost Observation Strategy in the Hindu Kush Himalayan region: a Proposal	
11:15-11:30	Group photo Tea break	
Technical Session-2: Climate change and permafrost thaw: Regional issues		Chair: Arun Shrestha
11:30-11:50	M. Bhutiyani (DTRL) (15'+5'): An extreme high temperature event induced rock avalanche over the North Terong Glacier in Nubra valley in Karakoram Himalaya: A case study of permafrost thawing related to climate change.	
11:50-12:10	R.J Thayyen, NIH (15'+5): Permafrost thaw and implications in the cold-arid Himalaya.	
12:10-12:30	Simon Allen, UZH (15'+5): Initiating collaborative permafrost studies in the Himalaya. First experiences from India and Nepal	
12:30-12:50	A.P Dimri, JNU (15'+5): Climate forcing and feedback on soil surface in mountains in the context of permafrost environment.	
13:00-14:00	Lunch	
Technical Session 3: Group discussion: Thrust areas of Himalayan permafrost research. Expression of interest by institutions/universities/researchers		Chair: Stephan Gruber Co-Chair: Prof AP Dimri
14:00-14:10	Flip Wester, ICIMOD (10'): Introductory talk: Outlines of a Permafrost Initiative in the HKH region	
14:10-15:30	Group discussion	
15:30-16:00	Tea break	
16:00-17:00	Technical Session 4: Workshop synthesis: Way forward and networking. (collaborations, training and funding) Comments by: Institutions, universities, funding agencies (MoES, SERB, IHCAP, ICIMOD etc.)	Chair: Renoj Thayyen Co-Chairs: Flip Wester, Dorothea Stumm
17:00-17:30	Closing session Summary Vote of Thanks	Chair: David Molden

List of Participants

Sl. No.	Name & Affiliations
1.	David Molden, DG, ICIMOD
2.	Arun Shrestha, ICIMOD
3.	Flip Wester, ICIMOD
4.	Dorothea Stumm, ICIMOD
5.	Stephan Gruber, Carleton University, Canada
6.	Moti Rijal, Tribhuvan University, Nepal
7.	Rijan Kayastha, Kathmandu University, Nepal
8.	Nadine Salzmann, University of Fribourg, Switzerland
9.	Simon Allen, University of Zurich, Switzerland.
10.	P.S Rao, Advisor, SERB, New Delhi
11.	M.R. Bhutiyani, Director, DTRL, Delhi
12.	Deepak Srivastava, Ex-GSI Dy.DG, Lucknow
13.	Prof.A. L. Ramanathan, JNU, New Delhi
14.	Prof. A. P. Dimri, JNU, New Delhi
15.	Jeelani, Kashmir University, Srinagar
16.	Shubhra Sharma, WIHG, Dehradun
17.	Paramanad Sharma, NCAOR, Goa
18.	Indra Sen, IIT, Kanpur
19.	Rajesh Kumar, Sharda University, Greater Noida
20.	Shirish Sinha, IHCAP,SDC New Delhi
21.	Mustafa Khan, IHCAP, SDC,New Delhi
22.	Divya Mohan, IHCAP, SDC, New Delhi
23.	S.S. Randhawa, HPSCSTE, Shimla
24.	John Mohd. Wani, IIT, Roorkee
25.	Lt.Col. Manish Kapil, BRO, Ministry of Defense, New Delhi
26.	S.P Shukla, GSI, Lucknow
27.	Pratima Pandey, IIRS, Dehradun
28.	Anul Haq, NIIT University, Neemrana, Gurgaon
29.	ShresthTayal, TERI, New Delhi
30.	Argha Banerjee, IISER, Pune
31.	R.D. Singh, NIH, Roorkee
32.	Suryanarayanan Balasubramanian, SECMOL, Leh
33.	Sanjay Gangapue, BRO, New Delhi
34.	Sujata Dash, DTRL, New Delhi
35.	Debashish Sen, PSI, Dehradun
36.	Liesbeth Segaar, ICIMOD
37.	Tribhuwan Singh Rawat, DTRL, New Delhi
38.	Shyam Ranjan,
39.	Sidahrth Singh, Advocate, MoEF
40.	S. K. Garg, DS, MOWR, New Delhi
41.	S. K. Kataria, US, MOWR, New Delhi
42.	Nathaniel, TERI, New Delhi
43.	Dharmeet, TERI, New Delhi
44.	Dr. P.G. Jose, WHRC (NIH), Jammu
45.	Sh. Manish K. Nema, NIH, Roorkee
46.	Farooq Azam, INSPIRE Faculty,NIH, Roorkee
47.	Mritunjaya Kumar, RA, NIH, Roorkee
48.	Dr. Renoj Thayyen, NIH, Roorkee

List of Institutions

Sl. No.	Institution
1.	International Centre for Integrated Mountain Development (ICIMOD), Kathmandu
2	Tribhuvan University, Nepal
3	Kathmandu University, Nepal
4	Carleton University, Ottawa, Canada
5.	University of Fribourg, Switzerland
6	University of Zurich, Switzerland.
7	Science Engineering Research Board (SERB), New Delhi
8	Defense Terrain Research Laboratory (DTRL), Delhi
9	Geological Survey of India (GSI), Lucknow
10	Jawaharlal Nehru University (JNU), New Delhi
11	Kashmir University, Srinagar
12.	Wadia Institute of Himalayan Geology (WIHG) Dehradun
13	National Centre for Antarctic and Ocean Research (NCAOR) Goa
14	Indian Institute of Technology (IIT), Kanpur
15	Sharda University, Greater Noida
16	Indian Himalayan Climate Adaptation Programme (IHCAP), New Delhi
17	Swiss Development Corporation (SDC), New Delhi
18.	HP State Council for Science, Technology and Environment (HPSCSTE), Shimla
19.	Indian Institute of Technology (IIT), Roorkee
20	Border Roads Organisation (BRO), Ministry of Defense, New Delhi
21	Indian Institute of Remote Sensing (IIRS), Dehradun
22	NIIT University, Neemrana, Gurgaon
23	The Energy and Resources Institute (TERI), New Delhi
24	Indian Institute of Science Education and Research (IISER), Pune
25	Students' Educational and Cultural Movement of Ladakh (SECMOL), Leh, Ladakh
26	People Science Institute (PSI), Dehradun
27	Ministry of Environment and Forest (MoEF), New Delhi
28	Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD&GR), New Delhi
29	National Institute of Hydrology (NIH), Roorkee

Indian Permafrost Network (IPN)

Lead: National Institute of Hydrology, Roorkee

Contact: Dr. Renoj J.Thayyen, WRS Division (renojthayyen@gmail.com, Ph:01332-249237 (o))

1). Remote Sensing

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- T.S Rawat (DTRL)
- Mrityunjay Singh (NIH)
- Shubra (WIHG)
- Pratima Panday (IIRS)
- Rajesh Kumar (Sharda University)
- Randhawa (HPSET)
- Ainul Haq (NIIT Rajasthan)

2). Kinematics and Dynamics

- Farooq Azam (NIH)
- Anul Haq (NIIT Rajasthan)
- Mrityunjay Singh (NIH)

3). Modelling

- John Mohd Wani (IIT Roorkee)
- Argha Banerjee (IISER Pune)
- AP Dimri (JNU)
- R.J Thayyen (NIH)

4). Geophysical Survey

- Parmanand (NCAOR)
- Mrityunjay Singh (NIH)
- Pratima Panday (IIRS)
- Ramanathan A (JNU)

5). Chemistry and Isotopes

- Indra Sen (IIT Kanpur)
- Ramanathan A (JNU)
- Jeelani G (University of Kashmir)
- Jose P.G (NIH Jammu)

6). Ground Temperature

- Anul Haq (NIIT Rajasthan)

- Rajesh Kumar (Sharda University)
- Randhawa (HPSET)
- Shubra Sharma (WIHG)
- Mrityunjay Singh (NIH)
- Sujata Dash (DTRL)
- T.S Rawat (DTRL)
- R.J Thayyen (NIH)

7). Hydrology

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- Jose (NIH Jammu)
- Parmanand (NCAOR)
- Sujata Dash (DTRL)
- Rawat TS (DTRL)
- S. Tayal (TERI)
- R.J Thayyen (NIH)

8). Instrumentation and Sensors

- Sujata Dash (DTRL)



Participants of the August 2016 New Delhi workshop on Himalayan Permafrost under the changing climate



