High Altitude Wetlands in the Indian Himalaya

CONSERVATION & MANAGEMENT

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DISCLAIMER:
This document, as a follow-up of the workshop 'Conservation & Management of High-Altitude Wetlands in the Indian Himalaya', has been prepared as a Discussion Paper to stimulate greater debate on High Altitude Wetlands to define their status and design conservation and management plans. The document includes compiled information from various sources. Therefore, for any omission or factual error thereon, the Institute or the team engaged with compilation cannot be held responsible.

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[Discussion paper based on the workshop on ***'Conservation & Management of High-Altitude Wetlands in the Indian Himalaya'***]

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Foreword

Wetlands are known to play pivotal role in safeguarding water and food security. They offer multifarious ecosystem services ranging from ranging from breeding ground for many animal species to act as a natural sponge; recharging groundwater aquifers to act as source and sink of biological, chemical and genetic material; cultural and spiritual heritage to natural sites of tourist attraction, etc. Wetlands, therefore, directly and indirectly support millions of people across the globe. India is gifted with rich diversity of wetlands that range from the coastline and reefs in the marine environments to High Altitude Wetlands (HAW) in the Himalaya.

In the Himalaya, wetlands are known since time immemorial for their spiritual and religious values. Many wetlands in the region are located in higher altitudes often fed by glaciers or snow from the surrounding mountains. These High Altitude Wetlands contribute significantly to the sustenance of downstream landscapes and communities by providing ecosystem services, such as regulating river flows, and maintaining productivity. They also provide habitats for trans-boundary migrants and create ecosystem conditions for several unique floral and faunal assemblages in surrounding high altitude landscapes. Yet, these wetlands have remained grossly underexplored.

Realizing the above fact, during an event ''National Policy Framework for Wetlands Conservation and Wise Use'' at MoEF&CC (January 2019) urgent need for focused brainstorming on HAWs of Indian Himalaya was emphasized. As a follow-up, G. B. Pant National Institute of Himalayan Environment organized a one day Brainstorming-cum-Workshop on "Conservation & Management of High Altitude Wetlands (HAWs) in the Indian Himalaya" (May 8th, 2019). Diverse range of expertise, drawn from orgnizations located in the five Indian Himalayan states (Arunachal Pradesh, Sikkim, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir), enriched the event deliberations.

It is heartening to see, as a follow-up of the event, this Discussion Paper "High Altitude Wetlands in the Indian Himalaya - Conservation & Management", which provides comprehensive information on Indian Wetlands initiatives, wetlands of the Himalayas and more detailed analysis of knowledge and understading on high altitude wetlands. More importantly, paper includes the proceeding of the workshop wherein way forword w.r.t HAW in Himalayas on Science, policy, and Practice domain has been suggested. I belive this Discussion Paper will ignite a constructive debate to further strengthen the cause of HAW conservation and management in the Himalaya. The Institute team deserves appreciation for preparing this informative booklet, which will serve the purpose of diverse groups of stakeholders.

November 2020

(Manju Pandey)

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ABBREVIATIONS

amsl	Above Mean Sea Level
APSCS&T	Arunachal Pradesh State Council for Science and Technology
ATREE	Ashoka Trust for Research in Ecology and the Environment
BSI	Botanical Survey of India
Ca	Calcium
CBCM	Centre for Biodiversity Conservation and Management
CEA&CC	Centre for Environment Assessment and Climate Change
CITES	Convention on International Trade in Endangered Species
Cl	Chloride
CLWRM	Centre for Land and Water Resource Management
CSED	Centre for Socio Economic Development
GBPNIHE	G. B. Pant National Institute of Himalayan Environment
GLOF	Glacial Lake Outburst Floods
GoI	Government of India
ha	Hectare
HAL	High Altitude Lakes
HAW	High Altitude Wetlands
HKH	Hindu Kush Himalayas
HPSWA	Himachal Pradesh State Wetland Authority
ICIMOD	International Centre for Integrated Mountain Development
IHR	Indian Himalayan Region
IUCN	International Union for Conservation of Nature
km	Kilometre
m	Meter
Mg	Magnesium
mm	Millimetre
MoEF&CC	Ministry of Environment, Forest and Climate Change
NMHS	National Mission on Himalayan Studies
NTFPS	Non-Timber Forest Products
NWCP	National Wetland Conservation Programmes
PA	Protected Areas
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
TH	Total Hardness
TII	The (Economics of Ecosystems and Biodiversity) India Initiative
UCOST	Uttarakhand State Council for Science & Technology
UNDP	United Nations Development Programme
UT	Union Territory
WCM	World Class Manufacturing
WII	Wildlife Institute of India
WQI	Water Quality Index
WWF	World Wide Fund for Nature

CONTENTS

EXECUTIVE SUMMARY

Wetlands are globally important for survival of human and other living beings. However, their contributions for human wellbeing, and overall sustenance of biodiversity, have remained unrecognized. As a result, wetland management often finds backseats in development planning. Also, evidences suggest that the natural wetlands are in long-term decline around the world.

India, with its prevailing geographical diversity and climatic conditions, supports diverse wetland habitats ranging from coastal to trans-Himalayan cold desert regions. These wetlands support diverse and unique habitats, and provide various ecosystem services, including regulation of water flow in many rivers, maintaining productivity and habitats for sustenance of diversity of life. Despite their proven value, most of the wetlands in India are under threat due to rapidly growing pressure of urbanization, industrialization and agricultural intensification.

Realizing the wide ranging values and the vulnerability of wetlands, the Govt. of India has accorded a high priority to conservation and management of these ecosystems across the country. In this context, India became signatory to Ramsar Convention, in 1982. National Wetland Conservation Programmes (NWCP) was made operational in 1985-86, and in 2010 the Wetlands (Conservation and Management) Rules 2010 were framed. More recently, the Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt of India, has notified the new Rules as Wetlands (Conservation and Management) Rules, 2017. These rules decentralise management of wetlands by giving states powers to not only identify and notify wetlands within their jurisdictions but also keep a watch on prohibited activities. It has also indirectly widened the ambit of permitted activities by inserting the 'wise use' principle.

The Indian Himalayan region (IHR), among others, is known to harbour diversity of wetlands. Many wetlands in the region are located in higher altitudes often fed by glaciers or snow from the surrounding mountains. These wetlands located above 3000 m amsl, are considered as High-Altitude Wetlands (HAWs), occupy an area of about 1,26,253 ha. However, this area is expected to further increase if the actual area of wetlands below 2.25 ha is also included. Several of high altitude water bodies (glacial or other lakes) are smaller than the actual mapping unit. Such small HAWs, as per an estimate, account for 42% of the total high-altitude wetlands of the country. The Himalayan wetlands in high altitude areas, while known for diverse ecosystem services, are specifically recognized for their spiritual and religious values.

HAWs are home to unique mountain biodiversity and endemic species. They provide important breeding ground for continental migratory birds and low altitude migrants of Indian sub-continent. These wetlands are the only breeding ground (outside China) for globally threatened (Vulnerable, IUCN Category) Black-necked crane *(Grus nigricollis)*. HAW landscapes are also home for unique big animals, for examples, near threatened (Argali, *Ovis ammon hodgsoni*), vulnerable (Urial, *Ovis orientalis vignei*), low risk (Bharal, Pseudois nayaur), and least concern (Wild Ass, *Equus kiang*). The big cat of high mountains, Snow leopard *(Panthera uncia)* that falls under vulnerable category of IUCN also enjoys services of wetland complexes.

However, HAWs are facing a lot of challenges. For instance: (i) many large HAWs and their surroundings have emerged as centre of attraction for unregulated tourism activities thereby leading to an issue of solid waste and garbage management in hitherto pristine environment; (ii) changing economic interests and aspirations of indigenous communities, who are traditionally depended on pastures and wetland ecosystems of High altitude areas, is resulting in increased resource extraction but poor involvement in conservation activities; and (iii) the projected trends of warming in higher Himalaya and its likely implications for wetlands and their surroundings is fast emerging challenge for conservation and management of HAWs.

Further, due to lack of empirical evidences and adequate resources, comprehensive climate change vulnerability assessment of HAWs is missing. As a result, appropriate conservation and management plans under changing climate scenario are not available. This calls for an urgent attention in terms of conservation priorities and addressing specific challenges using scientific evidences.

During an event ''National Policy Framework for Wetlands Conservation and Wise Use'' (MoEF&CC, January 2019) it was realized that the HAWs are least investigated and most sensitive to changes, and thus deserve greater attention. With this realization, G. B. Pant National Institute of Himalayan Environment, under the guidance of MoEF&CC, organized a Brainstorming-cum-Workshop "Conservation & Management of High Altitude Wetlands (HAWs) in the Indian Himalaya" on May 8th,2019. The oobjectives included- (i) to take stock of knowledge base on HAWs, (ii) to reflect on Conservation and Management challenges and Opportunities, (iii) to analyze Institutional framework and policy support available, and (iv) to suggest way forward for ensuring effective conservation and management of HAWs in IHR.

Wide range of expertise (36 number), drawn from 20 organizations located in five Indian Himalayan states (Arunachal Pradesh, Sikkim, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir), enriched the discussion during the event. Presence of the Ministry of Environment, Forest & Climate Change, GoI, at senior official level provided necessary guidance for structuring the discussions. Participation from State Wetland Authorities of two Himalayan states (Himachal Pradesh and Uttarakhand) brought in the state perspective during the deliberations. Involvement of professionals of UNDP, Wetland International, WWF-India, and Himalayan Universities, added value to the contents of deliberations. Following way forward for Science, Policy, and Practice domain was suggested:

(a) Science – towards holistic understanding of HAW landscape, ensure availability of systematic data and its synthesized knowledge products to support conservation practices by analysing drivers of changes (Anthropogenic/Natural) contributing towards the degradation of landscape/wetland complexes, promote coordinated multidisciplinary research in HAW complexes and develop indicators for monitoring.

(b) Practice - focus on landscape and integrated approach of management for HAWs and their complexes, which is supported by scientific evidences, indicators for selection and prioritization for conservation, management, monitoring, and documentation of good practices (including religious) in wetland/landscape.

(c) Policy- formulate wetlands management plans as per WCM Rule 2017, demonstrate exemplary wetlands management plans as motivating factor for state wetlands authorities and involve dependent communities in decision making and make provisions for tangible benefits in lieu of imposed restrictions.

This discussion paper is meant to generate more debate on Conservation & Management of HAWs, and subsequently feed to a 'Policy Brief' and a strategic Planning Document on HAWs of Indian Himalaya.

1. WETLANDS - VALUABLE ECOSYSTEMS UNDER THREAT

Samiti Lake, Sikkim

Wetlands are globally important for survival of human and other living beings. They offer plethora of ecosystem services with countless benefits[1,2]. The economic and biodiversity value of wetlands far outweighs many terrestrial ecosystems, yet their contributions for human well-being, and overall sustenance of biodiversity, have remained unrecognized. As a result, wetland management often finds backseats in development planning[3]. As these values of wetland ecosystems are not factored in decision making, most of the wetlands are facing challenges of land use change and the economic consequences of such changes unfortunately remain underestimated[4].

BOX 1

Defining Wetland

"Wetland" means an area of marsh, fen, peat-land or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes.

A "wetlands complex" is defined as two or more ecologically and hydrologically contiguous wetlands and may include their connecting channels/ducts.

"Zone of influence" means that part of the catchment area of the wetland or wetland complex, developmental activities in which induce adverse changes in ecosystem structure, and ecosystem services.

Wetlands (Conservation and Management) Rules (2017)

Tsokar lake, Ladakh

Pangateng Tso Lake, Tawang, Arunachal Pradesh

As per the recent statistics, Asia has the largest share (31.8%) of global wetlands area followed by North America (27.1%) and Latin America & the Caribbean (15.8%). Wetland area contribution of Europe (12.5%), Africa (9.9%) and Oceania (2.9%) is smaller (Fig. 1).

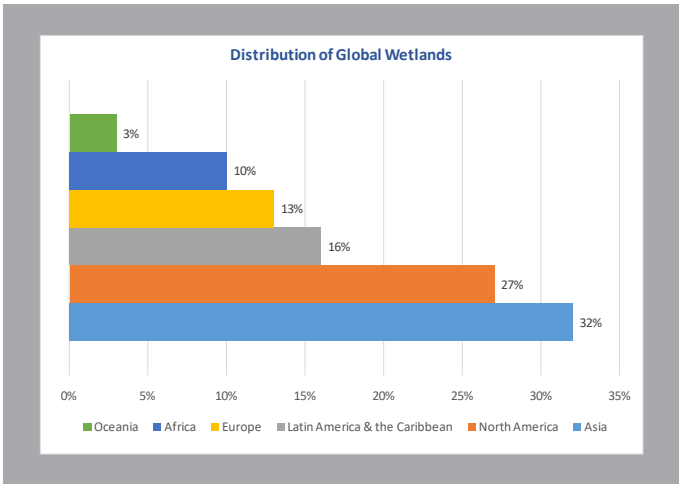

Fig. 1. Distribution of Global Wetlands

Wetlands are recognized amongst most vulnerable ecosystems. Recent Global Wetlands Outlook (2018) reports that since 1970: (i) natural wetlands are in long-term decline around the world; inland and marine/coastal wetlands both declined by approximately 35% (where data are available), three times the rate of forest loss; and (ii) 81% of inland wetland species populations and 36% of coastal and marine species have declined. It is also indicated that the water quality trends in wetlands are mostly negative, the land use change and water regulation infrastructure have reduced connectivity in many river systems and with floodplain wetlands, and the increased temperatures under climate change are expected to increase greenhouse gas emissions from wetlands, particularly in permafrost regions. All these trends call for greater global attention for management and wise use of wetlands across the world (Box 2). Especially in the context of climate change and sustainable development wetlands have become more critical than ever.

Black-necked Crane *(Grus nigricollis)*

BOX 2

Wetlands Require Better Attention

- Wetlands have considerably high ecological and economic values as compared to many other ecosystems, yet their contributions have grossly remained under-recognized.
- Developmental planning more often lacks consideration for biodiversity and ecosystem services values of wetlands, which leads to their overall neglect and consequent degradation.
- The evidences across the globe are indicative that natural wetlands are in long term decline and large proportion of wetland species populations have declined.
- Further decline of wetlands and dependent biodiversity is imminent under fast changing land use and increasing temperature due to changing climate. All these facts and many more calls for greater attention. The Himalayan wetlands, especially the High Altitude Wetlands (HAWs), due to higher sensitivity to perturbations (i.e., natural and anthropogenic) deserve a much larger focus.

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2. INDIAN SCENARIO - ENCOURAGING INITIATIVES

With nearly 5% of area under wetlands, the national mapping of wetlands in India[6] reveals that majority (69.2%) of wetlands in India are inland (10.56 m ha area), followed by coastal wetlands (27.15%; 4.14 m ha area), and others (<4%). Among the inland wetlands, more than forty five thousand six hundred bodies are natural inland wetlands, which together occupy an area of nearly 6.6 lakh ha[7] (Fig. 2 & 3).

These wetlands in India support diverse and unique habitats, and provide diverse ecosystem services, including regulation of water flow in many rivers, maintaining productivity and habitats for sustenance of diversity of life[8]. Nearly 1,200 floristic[9] and 18,000 faunal species[10,11] are known to occur in these ecosystems. Over 3000 fish species alone are reported from such environment[12]. These wetlands provide critical resting, roosting, feeding and foraging habitats for 276 recorded water bird species[13].

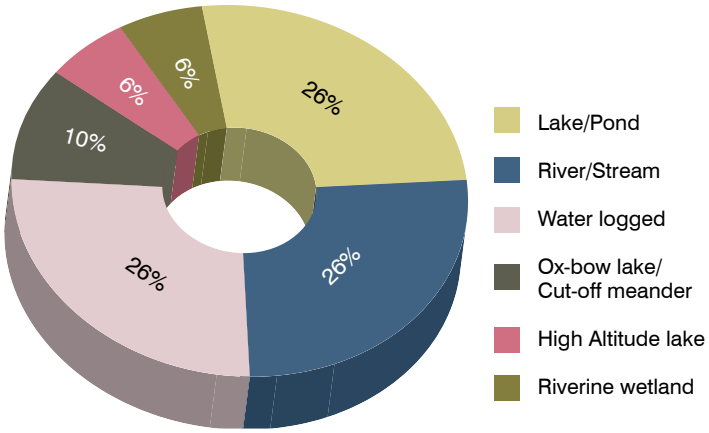

Fig. 2. Natural Inland Wetlands (by number) in India (Total number > 45600)
Based on EnviStats-India 2020

A number of globally threatened species, which need urgent conservation action, inhabit the wetlands in India. For instance, of the 28 species of freshwater turtles found in the country's wetlands 21 have been assessed as being globally threatened[12]. Similarly, 49 species of water birds are classed in threatened category (4 as critically endangered, 7 endangered, 16 vulnerable and 22 near threatened)[13]. Chilika maintains a good population of Irrawaddy Dolphin *(Orcaella brevirostris)*; Keibul Lamjao, a floating National Park on the south of Loktak Lake is the only known natural habitat of globally endangered Brow-antlered Deer *(Rucervus eldii eldii)*; riverine wetlands of River Son, Girwa and Chambal are habitats for the largest

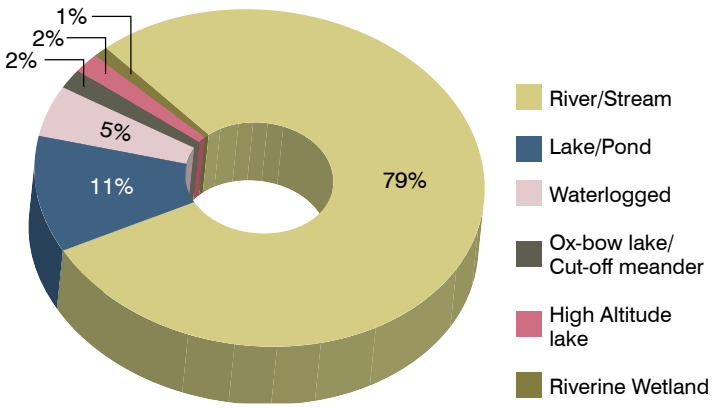

Fig. 3. Natural Inland Wetlands (by area) in India (Total Area > 66,23,000 ha)
Based on EnviStats-India 2020

remaining populations of critically endangered Gharial *(Gavialis gangeticus)*; wetlands of Ladakh are the only known breeding grounds of globally vulnerable Blacknecked Crane *(Grus nigricollis)*.

Indian mangrove species diversity represents nearly 60% of the globe[14]. Recorded 39 true mangrove species include the world's largest block of halophytic mangroves (Sundarbans which straddles India and Bangladesh), that include two globally threatened species, Sonneratia griffithii and Heritiera fomes. Similarly, the coralline diversity in the country, constituted by 478 species of 89 genera, forms 60% of the global hermatypic genera[15]. Indian wetlands are host to 81 extralimital seasonal immigrants from Palaearctic Region beyond the Himalaya – in Central and Northern Asia, and Eastern and Northern Europe. This includes, critically endangered Baer's Pochard *(Aythya baeri)*, Spoon-billed Sandpiper *(Calidris pygmaea)* and Sociable Lapwing *(Vanellus gregarius)*[4].

Sela lake, Arunachal Pradesh.

Realizing the wide ranging values of wetlands, the Govt. of India has given a high priority to conservation and management of these ecosystems across the country. India became signatory to the Multilateral Environment Agreements through Convention on Wetlands, known as Ramsar Convention, in 1982. Growth of Ramsar Sites in India is given in Fig. 4. A list of Ramsar Sites in India is placed in Annexure I. National Wetland Conservation Programmes (NWCP) was operationalized in 1985-86. In 2010, with notification of Wetlands (Conservation and Management) Rules India's commitment to ensure better conservation and management and to prevent degradation of existing wetlands took a leap forward. Further, recognizing the need, the Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt of India, has more recently notified the new Rules as Wetlands (Conservation and Management) Rules, 2017 that decentralise management of wetlands by giving the states powers to not only identify and notify wetlands within their jurisdictions but also keep a watch on prohibited activities. It also indirectly widens the ambit of permitted activities by inserting the ***'wise use'*** principle.

Fig. 4. Progress of Ramsar Sites in India
(adopted from https://rsis.ramsar.org/ris-search)

Parvati kund, Uttarakhand

Recognizing the importance, continuous deliberations are on in the country to find out best possible ways of conservation and sustainable use of these ecosystems. The TII (The Economics of Ecosystems and Biodiversity - India Initiative) initiative by the Ministry of Environment, Forest & Climate Change, Govt of India, through nine pilot studies has used an evidence building approach to highlight pathways for using economic arguments to address policy issues related with conservation and wise use of wetlands. The outputs of these pilot projects have been placed in the national context in the form of a sectoral synthesis report[4]. Among others, the policy consultation on Himalayan wetlands (August 2018), organized by Ashoka Trust for Research in Ecology and the Environment (ATREE) in partnership with WWF under sponsorship of Department of Science and Technology, Govt of India, deserves a mention. More recently, in one of the similar events at MoEF&CC (January 2019) on ***''National Policy Framework for Wetlands Conservation and Wise Use''*** it was realized that the High Altitude Wetlands (HAWs) in the Himalaya are least investigated and most sensitive to changes, and therefore, deserve greater attention.

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3. HIMALAYA - WETLANDS RICH LANDSCAPE

Wetlands in the Himalayan mountains are known since time immemorial, especially for their spiritual and life support values. A few examples of widely known wetlands include, Mansarovar in Tibetan Autonomous Region of China, Tso Moriri in Ladakh UT, Chandra Taal in Himachal Pradesh, Roopkund in Uttarakhand, Gurudongmar Lake in Sikkim, etc.

Hemkund Sahib, Uttarakhand

Occurrence of wetlands in Indian Himalayan Region (IHR) has been described and discussed by several agencies and individuals[16,17,18]. Many wetlands in the Himalayan region, located in higher altitudes, often fed by glaciers or snow from the surrounding mountains. These wetlands located above 3000 m amsl, have been presently considered as High-Altitude Wetlands (HAWs). However, by earlier definition [Wetlands (Conservation and Management) Rules 2010] a HAW was recognized as a wetland having size more than 5 ha and located at 2500 m or above elevation. However, criteria for defining HAWs differs considerably in national or state level mapping (>3000 m, mapping unit 2.25 ha). Realizing the existing ambiguity in literature on altitude limit of HAWs and considering that in majority of the descriptions of natural vegetation, "high altitude" is usually referred to areas at or above timberline (which generally falls around 3000 m in most part of the Himalaya). Broadly, this is the area where forest vegetation gives way to alpine meadows and thereafter the snow peaks. Therefore, in the present context, all wetlands located above 3000 m amsl altitudes have been grouped under HAWs. Based on the information available, diversity and distribution of high altitude lakes in states of IHR is presented (Table 1).

As per the available inventories, only 0.8% of the total wetlands (lakes) of the country are located in high altitude (above 3000 m) areas of the Indian Himalayan region. All together these HAWs occupy an area of about 1,26,253 ha. However, considerable ambiguity prevails in the literature while calculating area or

Table 1: High Altitude Lakes in the Indian Himalayan Region[19].

Sr. No.	High Altitude Lakes	Jammu & Kashmir	Himachal Pradesh	Uttarakhand	Sikkim	Arunachal Pradesh
1	Total (Number)	2104	271	118	534	1672
2	Density (per 100 km^2)*	1	9	0.7	12.6	8
ALTITUDINAL DISTRIBUTION						
3	Above 5000 m (No.)	416	83	10	205	20
4	4000-5000 m (No.)	1245	168	68	323	862
5	3000-4000 m (No.)	443	20	40	6	790
AREA						
6	Total Area (km^2)	110.13	5.75	2.31	33.24	118.64
7	>500 ha size (ha)	95449	-	-	-	-
8	100-500 ha size (ha)	4124	-	-	497	372
9	25-100 ha size (ha)	3272	103	-	874	3117
10	10-25 ha size (ha)	2821	78	17	826	3937
11	2.25-10 ha size (ha)	3454	164	125	852	3997

**calculated by authors for the area of the lakes situated above 3000m amsl in the respective state.*

mapping wetlands. For instance, the wetlands below 2.25 ha were mapped as point feature (not describing actual area of a wetland but nominal 1 ha area was taken for each entity to calculate total area under HAWs; and in another study it was considered 0.25 ha) and many high altitude water bodies (glacial or other lakes) are smaller than this mapping unit. Such small HAWs accounted for 42% of the total high-altitude wetlands of the country. In general, there are several smaller wetlands in higher Himalaya, which form an important landscape feature. This can be elaborated with an example of Sikkim state where 259 medium/large size (more than 2.25 ha) lakes are present above 3000 m altitude covering an area 3050 ha[6]. In the same landscape, smaller wetlands (<2.25 ha), however, accounted for about 51% of the total wetlands of the state and actual area of these wetlands remain unknown.

BOX 3

Small High Altitude Wetlands: *Issues and Challenges*

- Frequent formation of Glacial Lakes that are severely affected by climate change
- Smaller lakes need to be captured through high resolution mapping so as to include such small entities in conservation planning.
- Conservation value documentation of small HAWs (w.r.t. unique species, speciation, breeding ground, etc.) in a landscape complex.
- Ecosystem services, contribution to flow of rivers, and spiritual values of small HAWs

Among states of Indian Himalaya, high altitude area (>3000 m asl) constitutes about 23.8% (Arunachal Pradesh) to 78.8% (Jammu and Kashmir) of the total geographic area of these states[20]. On an average, high altitude lake size was more in eastern Himalaya (average size 6.2 ha in Sikkim, and 7.0 ha in Arunachal Pradesh) than the western Himalayan states (1.9 ha and 2.1 ha for Uttarakhand and Himachal Pradesh, respectively). However, average size of HAWs was much higher (52.4 ha) in North-western Himalayan State, Jammu and Kashmir, largely due to existence of some of the large lakes of the Himalaya. Occurrence of high altitude lakes, as reflected by the density (number of lakes per 100 km^2), varies considerably in the region. The highest density was observed for Sikkim (12.6) and lowest in Uttarakhand (0.7). In other Himalayan states, the lake density (per 100 km^2) was 1 (Jammu and Kashmir), 9 (Himachal Pradesh), and 8 (Arunachal Pradesh). However, these details are limited to larger (>2.25 ha) high altitude lakes. There are several issues and challenges w.r.t. smaller wetlands in the Himalaya (Box 3). Likewise, few issues pertaining to status and monitoring of HAWs in Himalaya are pertinent to be mentioned (Box 4).

BOX 4

Status & Monitoring: *Key Issues*

- There is a need for a working definition, which is acceptable to different parties, for harmonizing dataset generated by various agencies.
- Monitoring and mapping of all wetlands (including other than lakes) and wetland complexes is required for holistically capturing their ecological and economic significance.

Chandertal, Himachal Pradesh

The special publication[21], an outcome of Regional Expert Symposium on 'Managing Wetland Ecosystem in the Hindu Kush Himalaya: Securing Services for Livelihoods' organized by the International Centre for Integrated Mountain Development (ICIMOD), while synthesizing the deliberations of symposium has summarized the Challenges and Way Forward for wetland of HKH region (Box 5).

BOX 5

Key Challenges and Way Forward for Wetlands in HKH Region

KEY CHALLENGES

- A clear data gap on wetlands in the HKH region, especially in the high altitude regions, for e.g., limited data available on the ecology, hydrological cycle, peatland distribution, and the possible impacts of climate change on wetlands and wetland resources.
- Complexity in integrating research into policy.
- Ownership issue with different government institutions claiming jurisdiction over the wetlands, resulting to lack of coordinated and strategic efforts for wetland management.
- Lack of engagement of local people and other stakeholders in the planning and decision making process.
- Poor understanding about the dependency of local communities on wetland resources, ecosystem dynamics and functions.
- Unplanned development activities, unregulated tourism, overharvesting of wetland resources, waste disposal and sedimentation.

THE WAY FORWARD

- Conduct a complete inventory and mapping of wetlands in the HKH region and integrate it into national level planning. For inaccessible areas in the HKH region, use of new technologies like radar, drones and remote sensing could be helpful.
- Conduct action research for wetland biodiversity assessment, stock assessment of commercial wetland commodities, water quality control, vulnerability and risk assessment for understanding climate change impacts, environmental economics (valuation of tangible and intangible resources).
- Develop a holistic understanding of the dynamic nature of wetland ecosystems for better planning and implementation of adaptive management.
- Design wetland based adaptation measures after modelling climate change impacts in both upstream and downstream.
- Implement integrated watershed management by linking upstream and downstream communities to protect the wetlands in the HKH region.
- Carry out long-term wetland monitoring under the close supervision of interdisciplinary experts.
- Strengthen regional cooperation for regulating wetland ecosystem services and conserving the transboundary wetlands through an integrated landscape approach and for sharing both technology and knowledge on wetland management to generate comparable data between the countries.
- Develop a comprehensive and participatory wetland management action plan with clear institutional arrangements, incorporating the local government's programmes and plans.
- Increase collaboration with local government authority for wetland restoration and management to upscale best practices.
- Encourage co-management efforts by involving local communities and all relevant stakeholders for sustainable management of wetland and its resources. This would be a more cost-effective way for sustainable management of wetlands and also creates a sense of ownership among the stakeholders.
- Institutionalize a benefit sharing mechanism e.g., Payment for Ecosystem Services scheme to incentivize local communities and encourage them to co-manage wetlands.
- Use an appropriate economic valuation tool for analysing tradeoffs and synergies between wetland ecosystem services to understand how the ecosystem value may change in future climate change scenarios. This will help policy makers to realize the importance of wetlands and ultimately take optimal management decisions.
- Strengthen communication between scientists and policy makers for integrating research findings into policy formulation.
- Undertake systematic documentation of traditional knowledge and/or indigenous/ customary practices and amalgamate it with scientific knowledge to ensure effective management and design adaptation plans.
- Promote outreach and awareness raising activities to encourage local participation.
- Revive the "Himalayan Wetland Initiative".

(Based on - Bhatta, et.al. 2018)[21]

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4. HIGH ALTITUDE WETLANDS - LESS UNDERSTANDING

Ecosystem services emanating from Himalayan wetlands contribute significantly for the sustenance of many Asian countries. The wetlands in high altitude areas, while known for diverse ecosystem services, are specifically recognized for their spiritual and religious values. Therefore, HAWs deserve better understanding, which goes much beyond the context of climate change sensitivity.

4.1. Less explored HAWs

Despite their proven value dimensions, HAWs in the Indian Himalaya have largely remained unexplored. The scientific explorations, if any, have confined to few larger wetlands only; mostly focusing on inventories of higher plants and birds. Review of lietrature from 1980-2020, reveals a total of 146 published studies pertaining to HAWs in general. Of these, most of the studies have focused on biodiversity aspects (51; 34.93%), followed by status & inventory (71; 48.63%), ecosystem services (11; 7.53%) and climate change issues (13; 8.90%) (Fig. 5). Socio-cultural dimensions of such understanding are altogether missing. Therefore, the general lack of evidence based understanding on ecosystem services and conservation aspects of HAWs has lead to a complete ignorance on management of these important and climate sensitive ecosystems.

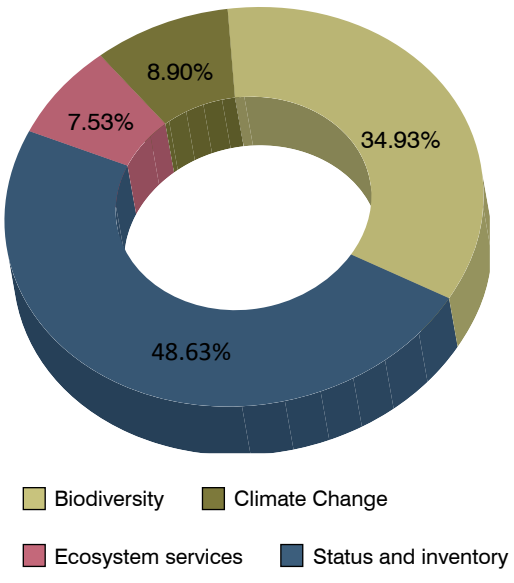

Fig. 5. Analysis of studies available (in %) on different aspects of HAWs in Indian Himalaya

BOX 6

Biodiversity in HAWs and Wetland Complexes

- Home to unique mountain biodiversity and endemic species
- Important breeding ground for continental migratory birds and low altitude migrants of Indian sub-continent

KEY ISSUES:

- Most groups of biodiversity either not studied or poorly studied
- Habitat degradation continues due to anthropogenic activities and impacts of climate change and
- Lack of specific measure for conservation of wetland complexes as unique habitats.

While analysing the studies on biodiversity aspects, occurrence of a considerable number of endemic plant species around wetlands of Ladakh region has been reported. Among nearly 700 plant species recorded there, 285 are in use for the traditional Tibetan medicine system[22]. The wetlands of Jammu & Kashmir, especially in Ladakh region are reported to be the best breeding grounds for endangered black-necked crane *(Grus nigricollis)*. These wetlands provide habitats for over 90 birds and 12 mammals. An assessment of 62 plant species from a sacred HAW in Uttarakhand (Devikund) reveals the occurrence of 14 species falling in different threat categories of IUCN and are being used, with other species, by local people for various purposes[23]. One new species *(Saxifraga minutissima)* has been added to the science with two small populations in wetland complex of Vasuki Tal in Uttarakhand[24]. In Arunachal Pradesh, 29 birds including sacred migratory bird of Buddhism; 78 plants and 21 medicinal plants have been recorded in the HAWs[25,26,27].

Among the lower plant groups, algae from Sikkim (15 taxa; including one new record for the country[28]), 52 species from Arunachal Pradesh, phytoplankton (23 taxa) of lake and periphytic community (34 taxa) in the stream from Ladakh[29], and cynobacterial species from Himachal Pradesh[30] have been recorded. Bacterial exploration from a glacial lake and nearby glacier soil in Uttarakhand reveals that lake soil was different from the glacier soil and the biogeochemical properties affected the diversity of microbial communities[31].

Out of 2104 lakes found in J&K at an altitude of >3000 m, most studied lakes are Pangong Tso, Tso Moriri, Tso Kar. These lakes are found in the area having very low rainfall (100 mm) and lake water is having high pH value, concentration of total dissolved solids (TDS), total hardness (TH), chloride (Cl), calcium (Ca), magnesium (Mg) was also high, so the water of these lakes may be treated as brackish water[32].

4.2. Conservation values of HAWs

HAWs and their complexes are known as the breeding ground for migratory birds of Indian sub-continent, particularly during summer season. But more importantly, as reflected earlier, these wetlands are the only breeding ground (outside China) for globally threatened (Vulnerable, IUCN Category) Black-naked crane whose population is less than 7000 in the world. Also, they provide breeding ground for Bar-headed goose *(Anser indicus)* in India.

Ruddy shelduck *(Tadorna ferruginea)* at Shungester lake, Tawang, Arunachal Pradesh

Aconitum fletcheranum a rare and endemic species of Eastern Himalaya

Pasturland of Chandra Tal, Himachal Pradesh

Wetland landscapes are also home for big animals that include many Scheduled I species (Indian Wildlife Protection Act 1972) and species listed in CITES. Some examples of unique mountain ungulates depending on HAW complexes include- near threatened (Argali, Ovis ammon hodgsoni, population is decreasing), vulnerable (Urial, Ovis orientalis vignei, population is decreasing), least concern (Bharal, *Pseudois nayaur*, abundant population), and least concern (Wild Ass, *Equus kiang*, population stable). The big cat of high mountains, Snow leopard *(Panthera uncia)* that falls under vulnerable (decreasing population) category of IUCN also enjoys services of wetland complexes. Himalayan Ibex *(Capra ibex sibirica)* is another common ungulate that uses wetland complexes. HAWs and their complexes can prove home for many other unique biodiversity elements, which - are yet to be explored. However, ongoing changes in the wetlands landscape and lack of targeted conservations efforts remain the major issue (Box 6).

4.3. Conservation Challenges and Priorities for HAWs

The high mountain ranges of Himalaya are home to traditional pastoralist communities and important biodiversity elements such as the snow leopard. Therefore, conflicts between these two are frequent.

Considering the higher coccurrance of species of conservation importance, high altitudes of the Indian Himalayan (Greater and Trans Himalayan) house several protected areas (PA). However, conservation has mostly remained nominal inside these PAs[33] due to various reasons, i.e., inadequate infrastructure and staff, improper delineation of boundaries, settlements inside, disputed international boundaries[34], etc. This has caused poor implementation of park rules. The conservation effectiveness of these high altitude wetlands in IHR, w.r.t. wetland ecosytems they encompass, is yet to be understood.

In recent decades, many large HAWs and their surroundings have emerged as center of attraction for scores of tourists thereby exposing these landscapes to a range of pressures caused by unregulated tourist activities. Generation of solid waste and garbage is one major issue[35]. Further, changing economic interests and aspirations of indigenous communities, who have traditionally depended on pastures and wetland ecosystems of High altitude areas, is yet another challange.

More importantly, the projected trends of warming in higher Himalaya and its likely implications for wetlands are more threatening. However, lack of empirical evidences and adequate resources remains major bottleneck for comprehensing climate change vulnerabilty assessment of HAWs. As a result, approrpriate conservation and management plans, which accommodate impacts under changing climate scenario, are not available. This calls for an urgent attention in terms of conservation priorities and addressing specific challenges using scientific evidenances.

Meconopsis merakensis var. *merakensis* (Papaveraceae) a new record for India from HAW of Tawang, Arunachal Pradesh

BOX 7

Status of Wetlands in Ladakh Region

Despite being referred as cold desert region, Ladakh is rich in wetland ecosystems, which include lakes and marshes with several characteristics that make them unique in terms of their biodiversity value in addition to their hydrological importance. The region harbours a large number of wetlands and lakes; some of the large lakes include Pangong Tso, Tso Moriri and Tso Kar. As documented in National Wetland Atlas of India, there are 968 lakes in Ladakh region (Leh and Kargil district) covering an area about 1,03,603 ha. A striking feature of this area is barren steep slopes with an undulating landscape, where snowmelt streams flow into lakes and ultimately into the Indus River. Many lakes and wetlands do not have outlets and thus became brackish. Ladakh has one Ramsar site (site of International Importance) – Tso Moriri wetland designated in August 2002 with an area of 18,900 ha.

Wetlands in Ladakh region have largely remained unexplored. Scientific explorations, if any, have confined to few larger wetlands only. Singh et al., (2008) found a very high concentration pH, TDS, Total Hardness, Chloride, Calcium, Magnesium in Tso Moriri and Tsokar lakes, attributed to prevailing cold desert type of climate having very low rainfall in the order of 100 mm. Study also revealed that the Tso Moriri is eutrophic in nature and Tso Kar is under hyper-eutrophic condition. Pangong Tso represents cold monomictic group of lakes and is highly alkaline (pH ≤ 9.0) with high conductivity (≥ 1639 µS) and nutrients (NH4-N ≥ 54 µg/L; NO3-N ≥ 299 µg/L; TP ≥ 464 µg/L). The studies in biodiversity aspects revealed that considerable number of endemic plant species occur in around wetlands of Ladakh region. About 700 plant species have been recorded from there, and 285 are being used in the traditional Tibetan medicine system.

Significant mammals, dependant on wetland ecosystems, include snow leopard *(Uncia uncia)*, the blue sheep or bharal *(Pseudois nayaur nayaur),* Siberian or Himalayan ibex *(Capra ibex),* Ladakh urial or shapu *(Ovis vignei),* Tibetan argali *(Ovis ammon hodgsoni),* Tibetan antelope *(Pantholops hodgsoni),* Tibetan gazelle *(Procapra picticaudata),* kiang *(Equus kiang),* and Tibetan wolf *(Canis lupus chanku)*. About 225 species of birds have been identified. These sites are key staging posts on the migratory routes of various waterfowl. The high altitude lakes in Ladakh are the only breeding grounds for migratory bird species like the Black-necked Crane and Bar-headed Goose in India. Local communities living in the region are dependent upon the lakes for their livelihood.

In recent decades, due to lack of facilities and clear regulations, these fragile ecosystems have been suddenly exposed to pressure from the outside world, with consequent impacts on local resources. Poorly organized tourism is a major threat to the wetland areas as the numbers of tourists visiting the area are increasing every year. The other major threats are degradation of the catchment area, increasing human–wildlife conflicts, unplanned development, and tremendous grazing pressure. Further, climate change induced rising level of glacial fed high altitude lakes, such as Tso Moriri in Ladakh, has submerged important breeding islands in the lake where endangered migratory birds like the Black-necked Crane and Barheaded Goose would breed. A long-term wetland conservation programme is therefore needed in order to conserve and better manage wetlands in Ladakh.

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4.4. HAWs -Maintenance of water and land resources

Natural wetlands support human activities by providing the fertile and moist soils, constantly renewed supplies of water, and by regulating the flow of nutrients and contaminants, resulting in water purification[36]. However, for the maintenance of water quality and regular supplies, integrated approach to societal and water management is required along with understanding the interconnectedness of wetland and their catchment[37]. Their intrinsic hydrological processes act as a buffer against extremes such as drought and floods. During monsoons, wetlands absorb water and thereby reduce flooding and in dry seasons they gradually release water and thus ensure its availability to nearby and downstream areas. Ecological processes are affected by biogeochemical variables, hydrogeomorphic and limnological characteristics and responses to land-use disturbances which are directly related to areas where different lakes, streams and other landscape elements are situated in the wetland complexes (Box 8). This can be understood by an example of lakes which are situated within a hydrologic flow system. Lakes at high positions tend to be hydrologically dominated by precipitation and, thus, have lower base cation concentrations compared to lakes at lower positions that have greater contributions from groundwater and surface water sources to their water budgets[38,39].

In case of Indian Himalaya interaction of snowmelt and glacial melt waters, and runoff generated from rainfall are the major hydrological processes, which control the wetland formation in high altitudes. Relative contribution of glaciers and snow melts increases with altitudes in comparison to rainfall-runoff, especially in North-western Himalaya. Bookhagen[40] reported that across the high altitude areas number and extent of wetlands increases from east to west extent of Himalaya.

Under changing climatic conditions, more lake formation on account of the melting of nearby glaciers is expected. Rashid and Majeed[41] while investigating spatiotemporal changes during 1971 to 2017 in the snout area of Drang Drung glacier in Zanskar Himalaya observed the formation and expansion of proglacial lake at the snout of the glacier which was confirmed through satellite data. This lake is expanding continuously resulting in accelerated melt of the frontal part of the glacier. The lake has expanded to 16.62 ha in 2017 amassing a water volume of 2.69 Mm^3 with a potential peak discharge of 2667 m^3/s. Srivastava et al[42] studied 13 high altitude lakes of Himalaya–Karakoram region, out of which 10 lakes had shown trend of increasing water level (mean rate 0.173 m/y) while 3 lakes had shown decreasing trend (mean rate -0.056 m/y) and suggested that the variation might be due to the fluctuations in climatic conditions.

Himachal Pradesh has three "Ramsar Sites - Wetlands of International Importance" namely, Chandertal (Lahual & Spiti), Pong dam (Kangra) and Renuka (Sirmour). Out of these, Chandertal and Pong dam come under high altitude wetlands (HAWs). Singh et al[43], had studied water quality of Chandertal and observed that the water is alkaline and disequilibrium of P_{CO2} between lake water and atmosphere and proposed open system weathering in the lake.

BOX 8

Water and land resources in HAWs

- Regulate water through groundwater-surface water interactions
- Regulate water quality through removal of suspended particulates and excess nutrients
- Regulate erosion through retention of soil and sediments
- Regulate weather through control of flood and protection of storm

KEY ISSUES:

- The stochastic water input to wetlands from intense rainfall events in high altitude areas may lead to increased duration of wetland dryness and increased sediment flow
- Insufficient water reaching wetlands due to obstruction of storage and/or diversion of water is the major cause of their loss and degradation.

In Uttarakhand, major water and sediment sources are glaciers. Gangotri glacier is the most studied glacier among all. Many glacier-fed lakes or glacial lakes are present above an altitude of > 3000 m amsl, but most of these HAWs are less explored. Sharma and Kumar[44] studied the water quality of Satopanth Lake (glacial lake), located at an altitude of 4600 m above sea level in Garhwal Himalaya of Uttarakhand and observed the water quality Index (WQI: 28.50) at an excellent level. Sharma and Singh[45] have correlated physico-chemical properties of water of Dodi Tal with the diversity of phytoplankton and observed its positive correlation with temperature, nitrogen and phosphorus content of water and also estimated it's water quality index[46].

Only few recent reports are available on different HAWs in Sikkim. Most of the work is either related to Remote Sensing-based inventory of glacial lakes[47] or about the hazard potential of the HAL or GLOF monitoring[48,49,50,51]. Very few reports are available based on on-site work in HAWs of Sikkim. District-wise analysis of Arunachal Pradesh has shown the presence of high-altitude wetlands in 10 districts. Dibang, Lohit and Tawang are the major high-altitude lake districts. Tawang and West Kamang are the only two districts having HAWs in the altitudinal range of >5000 m. Dibang has highest number of lakes in the altitudinal range of 3000-4000 and 4000-5000 m [National Wetland Inventory and Assessment report on High Altitude Lakes (HAL), 2011]. But very few details are available on HAWs of Arunachal Pradesh.

Therefore, given the ecological and developmental importance, Himalayan HAWs need to be explored more intensively to ensure sustainable management of these ecosystems. Further,

for the maintenance of water quality and regular supplies, an integrated approach of management is required that takes into consideration the interconnectedness of wetlands and their catchments[52].

4.5. Human interface with HAWs

Human interaction with the wetlands is complex in nature both on spatial and temporal scale. This interaction may be broadly understood as – (i) ecosystem services provide by the wetlands, and (ii) direct or indirect use of wetlands by the humans. However, the ecosystem services in the higher Himalaya are poorly understood and rarely accounted for[53]. Therefore, the need to identify ecosystem services used by people locally and beyond is often highlighted. In one such attempt in the landscape of Lahaul & Spiti, pepole recognized following services - provisioning (90% of respondents), regulatory services (5.4%), and cultural services (4.8%)[54].

Since long, different resources are being provided by wetland ecosystems for the welfare of humankind in the form of food, drinking and irrigation water, fuel wood, timber, medicinal herbs, and non-wood forest products[55].

Role of Himalayan alpine meadows are very significant for the existence of high altitude wetlands. The wetland ecosystems directly contribute to the ecology of alpine meadows. These meadows occupy significantly large area in the high altitude Himalaya. They are the repository of medicinal, rare-endangered, wild relatives of crop plants and endemic species. These meadows also provide food for wildlife and support a large livestock population maintained by migratory grazers. The Himalayan alpine meadows form habitats for variety of mammals, birds, reptiles and amphibians including endemic and rare-endangered species. Plant resources of alpine meadows are utilized by the local people in different forms, as medicine, food (edible), religious and various other purposes. For sustainable utilzation of such resources in Tsomoriri wetland area, Korzok homestays were established with the help of World-wide fund (WWF) for Nature which shows the integration of community development with conservation goals[56].

Tsongmo Lake, Sikkim

Tso Moriri wetland, Ladakh

BOX 9

Landscape of HAWs and human interaction

- Livelihood for rural people living in high altitude region
- Extended seasonal activities of tourists
- Expanding infrastructure for developmental and security needs
- Areas of conflicts between countries

KEY ISSUES:

- Over-grazing in some areas
- Unmanaged tourism and its cascading effects
- Land use change and habitat alternation
- Habitat degradation due to overuse of resources
- Sedimentation, solid waste generation, and socio-cultural pollution

The alpine meadows have been subject to grazing both by the wild animals and livestock associated with transhumance i.e., horses, sheep's and goats of the inhabitants of adjacent lower valleys during snow free period. Due to unplanned grazing, ecology of the alpine meadows has been seriously affected across the Himalaya. The alpine meadows have also been subject to trampling due to the human and animal activities. Trampling affects the successional progression of the plant community, its composition, structure, and soil characteristics. There are a number of species grazed by the sheep's & horses but some of them are highly preferred by these animals. As a result, such species fail to attain maximum growth in these areas therby affecting the ecology of alpine meadows.

In the present context of HAWs, habitat degradation in alpine ecosystems emerges as the major concern. The extensive use of the natural resources of alpine and sub-alpine areas leads to the depletion of natural resources and causes habitat degradation. Activities like intensive agricultural practice,

A Brokpa family (Pastoral community of Tawang) with Yaks near Bhagajang wetland

grazing of livestock, temporary corrals for seasonal stay of cattle's, unsustainable removal of biodiversity resources by overharvesting or unscientific removal like uprooting, depleting regenerating stock, etc., are the major factors of the habitat degradation. Over-stocking of livestock is reported as a major cause of degradation, and a major concern for the health and sustainability of pasturelands in the Himalayan landscapes. Degradation of pastures not only affects wild herbivores but also the productivity of livestock. Wetlands, as part of pasture ecosystem complexes, are adversely affected by these unsustainable pastoral practices. Bhagajang High altitude wetland complex (HAWC) in western Arunachal Pradesh is a good example of biodiversity and its association with communities residing in that area[57], but proper management planning is required with the involvement of local communities and other stakeholders as unplanned road construction and unregulated tourism and its associated issues are creating problems in Himalayan wetlands.

Recent growth of tourism has further created problem of solid waste management in high altitude wetland complexes. Trekkers deposit self generated waste in open ditches close to a lake and most of it is non-biodegrdable[58]. This is one of the fast emerging concerns for sustenance of HAWs in the Himalaya.

Solid waste problem in Indian Himalayan Wetlands

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5. THE WORKSHOP - CONSERVATION & MANAGEMENT HAWs IN THE INDIAN HIMALAYA

As discussed in preceding chapters, Himalayan high-altitude wetlands (HAWs) are amongst the most iconic and hydrologically dynamic ecosystems in South and Central Asia . Yet, very little is known about their ecological, socio-cultural and economic values. Hence, their management has largely remained unattended. In the Indian context, at an event ''National Policy Framework for Wetlands Conservation and Wise Use'' (MoEF&CC, January 2019) it was endorsed that the High Altitude Wetlands (HAWs) are least investigated and most sensitive to changes, and therefore, deserve greater atention. With this realization, need for a special brainstoring on Conservation and Management of HAWs of Indian Himalaya was emphasized. Considering this, G. B. Pant National Institute of Himalayan Environment, under the guidance of MoEF&CC, organized a one day Brainstorming-cum-Workshop on "Conservation & Management of High Altitude Wetlands (HAWs) in the Indian Himalaya" on May 8th, 2019 at its Headquarters, Kosi-Katarmal, Almora, Uttarakhand. The detailed programme of the event is placed (Annexure – II).

5.1. The event

In view of the cocerns, the brainstorming-cum-workshop targated on stock taking of high altitude wetlands and wetland complexes. As its broad goal, event envisaged to build a common understanding on status, significance, and sensitivity of HAWs. Towards realizing this goal, discussion revolved around the following specific objectives- (i) to take stock of knowledge base on HAWs of IHR, and identifying gaps therein, (ii) to reflect on Conservation and Management challenges and Opportunities, (iii) to analyze Institutional framework and policy support available, and gaps therein, and (iv) to suggest way forward for ensuring effective conservation and management of HAWs in IHR. To focus the discussions three concurrent groups (Science, Policy, and Practice) were formed among the participants to address the designated issues so the outcome of the workshop may inform policy and planning process at National level. It is also envisaged that a 'Discussion Paper' on Conservation & Management of HAWs in IHR needs to be prepared considering the inputs received after this consultation and synthesis, which will feed to a 'Policy Brief' and a strategic Planning Document on HAWs.

5.2. Participants: Spectrum of Stakeholders

The workshop was attened by around 36 particpants of 20 organizations located in five Indian Himalayan states (Arunachal Pradesh, Sikkim, Himachal Pradesh, Uttarakhand, and Jammu & Kashmir). Representation at Joint Secretary and Senior Consultant level from the Ministry of Environment, Forest & Climate Change (MoEF&CC) was also there. Participants also represented State Wetland Authorities of two Himalayan states (Himachal Pradesh and Uttarakhand). Participation included other than the governemnt organizations were UNDP, Wetland International, WWF, and Himalayan Universities. Beside the official participants, young researchers of the G. B. Pant Institute of Himalayan Environment also participated for learning. Details of participants are placed in Annexure – III.

5.3. Setting the Stage

The event began with the inaugural session Chaired by Ms Manju Pandey, Joint Secretary, GoI, MoEF&CC. Director GBPNIHE, Dr. R.S. Rawal, welcomed all the participants and expressed gratitude for their participation in the workshop. He gave a brief overview on the vision, objectives and activities of the Institute. Emphasising the uniqueness importance and usefulness of HAWs, Dr. Rawal mentioned that the MoEF&CC entrusted the job of organizing this event to the Institute. Highlighting that very limited research and development work has been done on IHR HAWs, he stressed the need of science based interventions to address science-policy-practice issues of HAWs. Dr. Subrat Sharma, Scientist, GBPNIHE gave the base presentation of the workshop. He informed that the broad goal of the event is to take stock of High Altitude Wetlands (HAWs) in the Indian Himalayan Region. The event has been envisaged to build a common understanding on status, significance,

and sensitivity of HAWs in the region. The specific objectives include: (i) to take stock of knowledge base on HAWs of IHR, and identifying gaps therein; (ii) to reflect on their Conservation and Management challenges and Opportunities, (iii) to analyze Institutional framework and policy support available, and gaps therein, and (iv) to suggest way forward for ensuring effective conservation and management of HAWs in the Indian Himalayan region (IHR).

Dr. Ritesh Kumar, Director, Wetland International (South Asia), informed that HAWs require special treatment due to their fragile and climate sensitive attributes. He further added that presently, fresh water ecosystems and species are declining at a very fast pace therefore HAWs need their own space for policy level interventions. Dr. Kumar also emphasized on the need for creation of regional umbrella network for capacity building and knowledge sharing on HAWs. Dr. Lalit Kapur, Former Advisor, MoEF&CC recalled the discussion held during wetland workshop in January, 2019 at New Delhi. He underlined that the data gaps on HAWs and special conservation and management measures for HAWs were realized during deliberations of the said workshop. At present, HAWs are under diverse anthropogenic pressures such as grazing, tourism, fuel wood extraction, NTFP collection, dredging, infrastructure development etc., he mentioned. Dr. Kapur suggested that one large co-ordinated project can be submitted by the interested organizations under Ministry's ambitious National Mission on Himalayan Studies (NMHS) for consideration of funding.

Dr. Rajendra Dobhal, Director General, UCOST recommended creation of a centre of excellence for wetland research and conservation. He also primarily suggested to develop an integrated HAWs monitoring system, conduct of quality research work, on ground/field based data collection, establishment of virtual working station within MoEF&CC for data sharing, creation of a single authority for lake management/monitoring, etc. Dr. Dobhal welcomed GBPNIHE to formulate a joint research project with UCOST for implementation in identified HAWs of Uttarakhand.

While concluding the inaugural session, the Chairperson, Ms. Manju Pandey, appreciated the efforts of GBPNIHE in organizing the event as per the requirement expressed by the MoEF&CC. She expressed happiness in participation of representatives of all Himalayan states having HAWs. Chairperson stressed the need for holistic understating about the role and functions of HAWs. She mentioned despite the State wetland authorities have been constituted in various states, these authorities are not properly functioning for conservation of wetlands. She further highlighted that water and land both are state issues, therefore, respective State Govts., should take proactively action for conservation and wise use of wetlands, particularly HAWs in their respective states. Ms. Pandey underlined the need of synthesis of HAWs related information/studies to fill the existing knowledge gaps for formulation of requisite SOPs/ rules.

5.4. Science, Policy & Practice:

Focussed interactions on research, development, conservation and management issues of HAWs were conducted in groups, to synthesize issues on three domains viz., Science, Policy, and Practice. Thereafter, focussed group discussion took place. These groups were led by Prof. R.C. Sharma - Science, Dr. R.S. Rawal - Practice and Shri Lalit Kapur - Policy.

5.4.1. The Science Group took stock of different aspects of HAWs addressed by the researches and identified gap areas. It was realized that inventorization of aquatic /terrestrial biodiversity, mapping (particularly high resolution for small wetlands), characterization (Origin, geology, and Hydrology) of HAWs and Wetland Complexes, and assessment of Goods and Services provided by HAWs (including highland-Lowlan interactions) of Indian Himalayan Region have not been addressed properly, and small HAWs (< 2 ha) and the wetland complexes have not been adequately mapped. There is a need to ensure availability of systematic data and its synthesized knowledge products to support conservation practices by analysing drivers of changes (Anthropogenic/Natural) contributing towards the degradation of landscape/wetland complexes/high altitude wetlands and developing indicators for monitoring.

Recommendations:

(i) Promote networking of institutions/experts interested on wetlands to bring them on a single platform
(ii) Facilitate co-ordinated multidisciplinary & multi-institutional collaborative research
(iii) Create a dedicated web portal on HAW

5.4.2. The Practice Group deliberated on need of evidences required for planning, management, and cultural practices adopted by peoples. Deliberations included scientific or proxy evidences landscape approach that include ecosystem (biodiversity, disaster, hydrology, climate change) and community, indicators of vulnerability (climatically sensitive, ongoing natural processes, anthropogenic pressure, etc.), and uniqueness (important/threatened biodiversity, support to livelihood, etc.) to prioritize practices for effective conservation and further monitoring of wetlands and wetland complexes. Use of spiritual values, drivers of changes, linear infrastructure, and available bioengineering measures for immediate interventions were emphasized. Need for formulations of management plans, based on the vulnerability and sensitivity of wetlands, was realized to mitigate impacts of drivers. Emphasis was also given on systematic monitoring of HAWs by following globally accepted protocols across all the disciplines, integration of datasets through proper institutional mechanism, creation of centralized data management agency (with subset at state level) and possibility of exploration of resource allocation for monitoring purposes. For management of HAWs, need of development of specialized training modules for stakeholders were identified by mapping actual stake holders. The module should be based on target-oriented awareness and exposure program. Necessity of development of this module in multiple

languages were also identified and discussed. In nutshell, discussion focused on landscape and integrated approach which is supported by scientific evidences, indicators for selection and prioritization of HAWs and Complexes for conservation, management, and monitoring, boundary (natural) delineation for targeted landscape and wetland complexes, and documentation of good practices (including religious) in wetland/landscape management for replication in the areas where scientific evidences are not available.

Recommendations:

(i) While practicing conservation and management of HAWs there is a need to follow the landscape and integrated approach, which is supported by scientific evidences, and it should also include smaller wetlands
(ii) Delineate boundary of the target landscape, wetland complexes, and identify indicators for the selection of wetlands for conservation (i.e., climate sensitivity indicators, livelihood promotion indicators, etc.) and monitor them
(iii) Promote existing indigenous knowledge and practices for conservation and management of wetlands, especially when scientific evidences are lacking
(iv) Formulate management plans following vulnerability and sensitivity of wetlands to mitigate impact of drivers of change, such as development of linear infrastructure in high altitude
(v) Adopt bio-engineering measures for immediate interventions in critical areas
(vi) Formulate multilingual training modules for diverse stakeholders
(vii) Ensure long term monitoring of HAWs following globally accepted protocols.

5.4.3. The Policy Group analysed various policy aspect related to HAWs dealt. For example, effectiveness of State Wetland Authorities in managing HAWs and their complexes, and scenario after implementation of Wetlands (Conservation & Management) Rules, 2017, particularly on aspects of notification, management plans and setting regulatory benchmarks; Proper documentation of HAWs, and execution level at sub-state level, e.g., District Wetland Authorities to implement ground level activities; Local communities which are harnessing benefits from HAW or Wetland Complex deserve provisions of tangible benefits in lieu of restriction imposed to make conservation effective and in building pro-attitude towards conserved entity; Carrying capacity of vulnerable/ prioritized HAWs to formulize management plan of a HAWs; Adoption of a wetland for maintenance and management of wetlands through capable communities or organizations including corporate sector; PPP mode as new model of conservation for encouragement; Effective tourism policy to address the range of challenged posed by a large number of tourists; Awareness and sensitization programmes targeting local populations, religious institutions and different media.

Recommendations:

(i) Formulate wetlands management plans as per WCM Rule 2017
(ii) Demonstrate exemplary wetlands management plans as motivating factor for state wetlands authorities
(iii) Formulate district level wetlands authorities to execute field implementation of activities effectively
(iv) Facilitate adoption of wetlands by community/ organizations /corporate body
(v) Involve dependent communities in decision making and make provisions for tangible benefits in lieu of imposed restrictions
(vi) Assess carrying capacity of wetlands having high anthropogenic exposure
(vii) Demarcate zone of influence and regulate tourism activities
(viii) Launch special campaigns for awareness and sensitization of masses on HAWs

5.4.4. Action points for the Institute emerged as the follow-up of the event:

- Documentation of best conservation and management practices in HAWs areas across Himalayan states.
- Discussion paper on HAWs to provide key inputs to science-policy-practice people.
- Functioning as a hub/centre of HAWs research and development in India.

6. SUM UP

Undoubtedly the wetlands, with 5-10% of global surface cover, are important for survival of life's diversity and human well-being. However, they are amongst the most vulnerable but less understood ecosystems in the world. The value of wetlands mostly remains unrecognized. All this has resulted in fast depletion and degradation of wetlands across the globe.

With a coverage of nearly 5% of countries' surface area, wetlands in India support diverse and unique habitats, and provide diverse ecosystem services. Yet, these ecosystems have grossly remained less investigated, and unattended from conservation and management point of view.

The Govt. of India, has, however, attached wetlands with high priority for their conservation and management. Therefore, continuous efforts are on to find-out the best possible ways of conservation and sustainable use of these ecosystems.

The Himalayan wetlands in India, as in most of Hindu Kush Himalaya (HKH) region[60], are facing steady decline and degradation thereby exerting substantial impacts on ecosystem services, biodiversity and the livelihoods of local communities. Especially the wetlands in higher altitudes (i.e., HAWs), which are well known for diverse ecosystem services including their spiritual and sacredness significance, have remained poorly investigated and understood for their contributions to nature and society. With this gross neglect the need for the protection and management of HAWs has not been articulated and appreciated in justified manner.

In view of above, the common broad goals identified are (i) to build a common understanding on status, significance, and sensitivity of High Altitude Wetlands, and (ii) to develop a roadmap for interventions in science, practice and policy domains for conservation and management of these HAWs. The snapshot of recommendations for HAWs, as emerged during the brainstorming cum workshop, under domains of Science, Policy and Practice are given below:

SNAPSHOT OF RECOMMENDATIONS

SCIENCE

- Promote networking of institutions/experts interested on wetlands to bring them on a single platform
- Facilitate co-ordinated multidisciplinary & multi-institutional collaborative research
- Create a dedicated web portal on HAWs

PRACTICE

- Follow the landscape and integrated approach supported by scientific evidences while practicing conservation and management of HAWs (including smaller wetlands)
- Dlineate boundary of the target landscape, wetland complexes, and identify and monitor the indicators for the selection of wetlands for conservation (i.e., climate sensitivity indicators, livelihood promotion indicators, etc.)
- Promote existing indigenous knowledge and practices for conservation and management of wetlands, especially when scientific evidences are lacking
- Formulate management plans following vulnerability and sensitivity of wetlands to mitigate impact of drivers of change
- Adopt bio-engineering measures for immediate interventions in critical areas
- Formulate multilingual training modules for diverse stakeholders
- Ensure long term monitoring of HAWs following globally accepted protocols

POLICY

- Formulate wetlands management plans as per WCM Rule 2017
- Demonstrate exemplary wetlands management plans as motivating factor for state wetlands authorities
- Formulate district level wetlands authorities to execute field implementation of activities effectively
- Facilitate adoption of wetlands by community/organizations/corporate body, etc.
- Involve dependent communities in decision making and make provisions for tangible benefits in lieu of imposed restrictions
- Assess carrying capacity of wetlands having high anthropogenic exposure
- Demarcate zone of influence and regulate tourism activities
- Launch special campaigns for awareness and sensitization of masses on HAWs

BOX 10

To conclude

- HAWs in Himalaya have significant cultural, spiritual, religious, economic and hydrological significance.
- In the present context of HAWs, habitat degradation in alpine ecosystems emerges as the major concern.
- Climate change impact on HAWs can be visualized as the most pressing challenge as they provide numerous ecological services, and support unique biodiversity.
- Some of HAWs can be taken-up as frontiers of regional cooperation, as many HAWs are transboundary in nature.
- They are important buffer zones for minimizing flood hazards.
- There is a need to strike balance between livelihood benefits to dependent populace and degradation of habitats due to over activities.
- While practicing conservation and management of HAWs, there is a need to follow an integrated landscape approach supported by scientific evidences, and include smaller wetlands as part of larger wetland complexes.

Tso Moriri, Ladakh

Pangong Tso or Pangong Lake, Ladakh

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ANNEXURE I

RAMSAR WETLANDS SITES IN INDIA

Sr. No.	Name of the Wetlands	Date	State/UT	Area (in ha)	Coordinates
RAMSAR SITES IN INDIAN HIMALAYAN REGION					
1	ASAN CONSERVATION RESERVE	21-07-2020	UTTARAKHAND	444	30°26'N 77°40'E
2	CHANDERTAL WETLAND	08-11-2005	HIMACHAL PRADESH	49	32°28'N 77°36'E
3	PONG DAM LAKE	19-08-2002	HIMACHAL PRADESH	15662	32°01'N 76°04'E
4	RENUKA WETLAND	08-11-2005	HIMACHAL PRADESH	20	31°37'N 77°27'E
5	SURINSAR-MANSAR LAKES	08-11-2005	JAMMU & KASHMIR	350	32°45'N 75°12'E
6	WULAR LAKE	23-03-1990	JAMMU & KASHMIR	18900	34°16'N 74°33'E
7	HOKERA WETLAND	08-11-2005	JAMMU & KASHMIR	1375	34°04'N 74°42'E
8	TSO MORIRI	19-08-2002	LADAKH	12000	32°54'N 78°18'E
9	TSO KAR WETLAND COMPLEX	17-11-2020	LADAKH	9577	33°17'N 78°00'E
10	LOKTAK LAKE	23-03-1990	MANIPUR	26600	24°25'N 93°49'E
11	RUDRASAGAR LAKE	08-11-2005	TRIPURA	240	23°28'N 91°16'E
RAMSAR SITES IN NON-HIMALAYAN STATES					
12	ASHTAMUDI WETLAND	19-08-2002	KERALA	6140	08°57'N 76°34'E
13	SASTHAMKOTTA LAKE	19-08-2002	KERALA	373	09°01'N 76°37'E
14	VEMBANAD-KOL WETLAND	19-08-2002	KERALA	151250	09°49'N 76°45'E
15	BEAS CONSERVATION RESERVE	26-09-2019	PUNJAB	6429	31°23'N 75°11'E
16	HARIKE LAKE	23-03-1990	PUNJAB	4100	31°13'N 75°12'E
17	KANJLI	22-01-2002	PUNJAB	183	31°25'N 75°22'E
18	KESHOPUR-MIANI COMMUNITY RESERVE	26-09-2019	PUNJAB	344	32°05'N 75°23'E
19	NANGAL WILDLIFE SANCTUARY	26-09-2019	PUNJAB	116	31°23'N 76°22'E

20	ROPAR	22-01-2002	PUNJAB	1365	31°01'N 76°30'E
21	BHITARKANIKA RESERVE	19-08-2002	ODISHA	65000	20°39'N 86°54'E
22	CHILIKA LAKE	01-10-1981	ODISHA	116500	19°42'N 85°21'E
23	BHOJ WETLAND	19-08-2002	MADHYA PRADESH	3201	23°13'N 77°19'E
24	DEEPOR BEEL	19-08-2002	ASSAM	4000	26°07'N 91°39'E
25	EAST CALCUTTA WETLANDS	19-08-2002	WEST BENGAL	12500	22°27'N 88°27'E
26	SUNDARBAR WETLAND	30-01-2019	WEST BENGAL	423000	21°46'N 88°42'E
27	KABARTAL WETLAND	21-07-2020	BIHAR	2620	25°37'N 86°08'E
28	KEOLADEO NATIONAL PARK	01-10-1981	RAJASTHAN	2873	27°13'N 77°31'E
29	SAMBHAR LAKE	23-03-1990	RAJASTHAN	24000	27°00'N 75°00'E
30	KOLLERU LAKE	19-08-2002	ANDHRA PRADESH	90100	16°37'N 81°12'E
31	LONAR LAKE	22-07-2020	MAHARASHTRA	427	19°58'N 76°30'E
32	NANDUR MADHAMESHWAR	21-06-2019	MAHARASHTRA	1437	20°01'N 74°06'E
33	NALSAROVAR	24-09-2012	GUJARAT	12000	22°46'N 72°02'E
34	NAWABGANJ BIRD SANCTUARY	19-09-2019	UTTAR PRADESH	225	26°36'N 80°39'E
35	PARVATI ARGA BIRD SANCTUARY	02-12-2019	UTTAR PRADESH	722	26°56'N 82°09'E
36	SAMAN BIRD SANCTUARY	02-12-2019	UTTAR PRADESH	526	27°00'N 79°10'E
37	SAMASPUR BIRD SANCTUARY	03-10-2019	UTTAR PRADESH	799	25°59'N 81°23'E
38	SANDI BIRD SANCTUARY	26-09-2019	UTTAR PRADESH	309	27°18'N 79°58'E
39	SARSAI NAWAR JHEEL	19-09-2019	UTTAR PRADESH	161	26°58'N 79°15'E
40	SUR SAROVAR	21-08-2020	UTTAR PRADESH	431	27°15'N 77°50'E
41	UPPER GANGA RIVER	08-11-2005	UTTAR PRADESH	26590	28°33'N 78°12'E
42	POINT CALIMERE WILDLIFE AND BIRD SANCTUARY	19-08-2002	TAMIL NADU	38500	10°19'N 79°37'E

(Source: https://www.ramsar.org/)

ANNEXURE II

BRAIN STORMING CUM WORKSHOP

CONSERVATION & MANAGEMENT OF HIGH-ALTITUDE WETLANDS IN THE INDIAN HIMALAYA

8th MAY 2019

SEMINAR HALL, ADMINISTRATIVE BLOCK, GBPNIHESD, KOSI-KATARMAL, ALMORA

PROGRAMME

10.00-11.00 hrs		**Introductory Session**
Deep Prajavalan	:	Dignitaries
Welcome	:	Director, *GBPNIHESD*
About the Event (Base Presentation)		
Remarks from the Dais	:	Ritesh Kumar, Wetland International Lalit Kapur, MoEF&CC Manju Pande, MoEF&CC Rajendra Dobhal, UCOST
Felicitation of Guests		
11.00-11.30 hrs		**Tea/Coffee Break & Group Photograph**
11.30-12.15 hrs		**Setting the Stage**
State Perspective on HAWs (Each State 5 minutes)	:	Arunachal Pradesh, Sikkim, Uttarakhand, Himachal Pradesh, Jammu & Kashmir
Approach for HAW Conservation	:	Ritesh Kumar, Wetland International
12.15-13.30 hrs		**HAWs - Brainstorming**
Science	:	Chair: R.C. Sharma, HNB Garhwal University Rapporteurs: K.S. Kanwal and S.C. Arya
Practice	:	Chair: R.S. Rawal, GBPNIHESD Rapporteurs: V.E. Gosavi and V. Agnihotri
Policy	:	Chair: Lalit Kapur, MoEF&CC Rapporteurs: D. Kumar and S. Sharma
13.30-14.15 hrs		**Lunch Break**
14.15-16.30 hrs		**Concluding Session**
Group Presentation & Discussion Action Plan & Strategy Way Forward	:	Chair: Manju Pandey, MoEF&CC Co-Chair- Ritesh Kumar, Wetland International Rapporteurs: K.S. Kanwal and V.E. Gosavi
CLOSE		

ANNEXURE III

LIST OF PARTICIPANTS

Sr. No.	NAME	ORGANIZATION
1.	Dr.Rajendra Dobhal	Director General, UCOST, Dehradun
2.	Ms. Manju Pandey	Joint Secretary, MoEF&CC, New Delhi
3.	Dr R.S. Rawal	Director, GBPNIHE, Almora
4.	Shri Lalit Kapur	MoEF&CC, New Delhi
5.	Dr. Ritesh Kumar	Director, Wetlands International South Asia, A-25, 2nd Floor, Defence Colony, New Delhi 110024
6.	Dr. Bhupen Mili	State Climate Change Cell, Department of Environment & Forests, Itanagar
7.	Dr. Bikramjit Sinha	Scientist-D & Head of Office, Arunachal Pradesh Regional Centre, Zoological survey of India, Itanagar
8.	Dr. Rajib Gogoi	Scientist E & Head of Office, BSI,Sikkim Himalayan Regional Centre, Gangtok
9.	Shri G.C. Khanal	Additional Director, Land Revenue & Disaster Management Department, Gangtok, Sikkim
10.	Shri D.G. Shrestha	Additional Director (State Remote Sensing App. Centre) & Climate Change Cell, Department of Science, Technology & Climate Change, Gangtok, Sikkim
11.	Shri Neeraj Mahar	WII, Dehradun
12.	Dr. Ramesh Chandra Sharma	Professor & Head, Department of Environmental Sciences, HNB Garhwal University, Srinagar, Uttarakhand
13.	Shri Kuber Bisht	Divisional Forest Officer, Almora
14.	Shri Amit Dubey	Associate Director, Wetlands WWF India Office, New Delhi
15.	Dr. Pankaj Chandan	Team Leader, Western Himalayas, WWF India Office, New Delhi
16.	Ms Arti Gupta	Coordinator, Shimla Field Office, WWF India Office, New Delhi
17.	Dr. Santosh Kumar	Scientist-D, Zoological Survey of India Headquarters, Kolkata
18.	Dr. Pottakkal George Jose	Scientist 'D' and Scientist-in-Charge, Western Himalayan Regional Centre, National Institute of Hydrology, Jammu, Jammu and Kashmir
19.	Dr. D.R. Thakur	Professor, Department of Bio-Sciences, Himachal Pradesh University, Shimla
20.	Shri Ravi Sharma	Himachal Pradesh State Wetlands Authority (HPSWA), Shimla
21.	Prof. M.K. Seth	Guest Faculty, Department of Bio-Sciences Himachal Pradesh University, Shimla
22.	Dr. Pankaj Bharali	Scientist-B, Centre of Excellence in Bioresources and Sustainable Development, APSCS&T, Itanagar
23.	Dr. Abhishek Ghoshal	Conservation Ecologist, SECURE Himalaya UNDP India

24.	Shri Kapil Joshi	APCCF (Administration) UKFD, Dehradun, Uttarakhand
25.	Er. Kireet Kumar	Centre Head, CLWRM, GBPNIHE, Almora
26.	Dr. R.C. Sundriyal	Centre Head, CSED, GBPNIHE, Almora
27.	Dr. Anita Pandey	Centre Head, CEA&CC, GBPNIHE, Almora
28.	Dr. G.C.S. Negi	Centre Head, CBCM, GBPNIHE, Almora
29.	Dr. J.C. Kuniyal	Scientist, CEA&CC, GBPNIHE, Almora
30.	Dr. Subrat Sharma	Scientist, CEA&CC, GBPNIHE, Almora
31.	Dr. Paromita Ghosh	Scientist, CSED, GBPNIHE, Almora
32.	Shri Ranjan Joshi	Scientist, CLWRM, GBPNIHE, Almora
33.	Dr. K.C. Sekar	Scientist, CBCM, GBPNIHE, Almora
34.	Dr. S.C. Arya	Scientist, CSED, GBPNIHE, Almora
35.	Dr. Vasudha Agnihotri	Scientist, CLWRM, GBPNIHE, Almora
36.	Dr. Mithilesh Singh	Scientist, CEA&CC, GBPNIHE, Almora
37.	Dr. V.S. Negi	Scientist, CBCM, GBPNIHE, Almora
38.	Er. Ashutosh Tiwari	Scientist, CLWRM, GBPNIHE, Almora
39.	Dr. K.S. Kanwal	Scientist, NE Regional Centre, GBPNIHE, Itanagar
40.	Dr. Devendra Kumar	Scientist, Sikkim Regional Centre, GBPNIHE, Pangthang
41.	Er. Vaibhav E. Gosavi	Scientist, Himachal Regional Centre, GBPNIHE, Kullu
42.	Dr. Harshit Pant	Scientist, CSED, GBPNIHE, Almora
43.	Dr. M.S. Majla	Tech IV (4) CSED, GBPNIHE, Almora
44.	Dr. Subodh Airi	Tech IV (4) CBCM, GBPNIHE, Almora
	Researchers	GBPNIHE, Almora

ABOUT THE INSTITUTE

G. B. PANT 'NATIONAL INSTITUTE OF HIMALAYAN ENVIRONMENT' (NIHE)

G. B. Pant National Institute of Himalayan Environment (NIHE) was established in 1988-89, during the birth centenary year of Bharat Ratna Pt. Govind Ballabh Pant, as an autonomous Institute of the Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India. The Institute is a focal agency to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound development in the entire Indian Himalayan Region (IHR). The Institute attempts to maintain a balance of intricate linkages between socio-cultural, ecological, economic and physical systems that could lead to sustainability in the IHR. To achieve this, the Institute follows a multidisciplinary and holistic approach in all its Research and Development programmes with emphasis on interlinking natural and social sciences. In this effort, particular attention is given to the preservation of fragile mountain ecosystems, indigenous knowledge systems and sustainable use of natural resources. A conscious effort is made to ensure participation of local inhabitants for long-term acceptance and success of various programmes. Training, environmental education and awareness to different stakeholders are essential components of all the R&D programmes of the Institute.

The Institute functions under a Society, guided by a Governing Body and a Science Advisory Committee. It has a decentralized set-up, with its headquarters at Kosi-Katarmal, Almora and at present six other Regional Centres (RCs) operational at Srinagar (Garhwal RC), Mohal – Kullu (Himachal RC), Pangthang-Gangatok (Sikkim RC), Itanagar (North-East RC), Leh (Ladakh RC) and Mountain Division (at MoEF&CC, New Delhi).

Further Information:

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