Preface

National Mission on Himalayan Studies

In the wake of increasing climate changes and anthropogenic impacts, the Indian Himalaya deserves special attention towards conserving and preserving its resources and services bestowed upon humankind in the form of water resources, biodiversity and dependent livelihood options among other key ecosystem services. A Special Section in this volume of *Current Science* showcases dedicated studies conducted under the National Mission on Himalayan Studies – a Central Sector Grant-in-Aid Scheme, implemented by the Ministry of Environment, Forest and Climate Change, Government of India along with G.B. Pant National Institute of Himalayan Environment in and for the Indian Himalayan Region (IHR).

The special section presents timely assessment of climatic and anthropogenic impacts observed on the various important domains like water, biodiversity, livelihood, integrated natural resource management, etc. in the IHR, affecting upstream and downstream dependent communities. Consistently increasing number of footsteps in the Indian Himalaya has demanded attention in terms of new studies and demonstrations on resolving anthropogenic interferences behind interventions like handling hazardous substances, mitigating disaster risks, adapting to climate change impacts, etc.

Observing water-related issues in the recent past decades, 'water security' in the IHR has gained momentum after due scientific assessment and successful demonstrative interventions. Taking this further, Dimri *et al*. (**page 774**) review both observational and modelling studies showing warming trends, although with different rates, along different elevations and diverse regions distinctly across the IHR. Furthermore, a review of the current state of knowledge on the IHR, focusing on climate (i.e. temperature and precipitation), and other components of the cryosphere (i.e. glaciers, snow cover and permafrost) is presented. The study also concentrates on glacial lake flood outbursts (GLOFs), landslides, hydrological changes, and briefly on agriculture, ecosystem and livelihood options in the target region. Dass *et al*. (**page 791**) bring forth field observation and reference data towards springshed development through hydrological monitoring in the IHR. The study highlights the best management practices through hydrological monitoring and modelling in the selected watersheds of Uttarakhand. The data and information generated through the study will also help assess the impacts of LULC (land use land cover) and climate change on key ecosystem functions, particularly water availability and other services of selected watersheds in the IHR. Bal *et al*. (**page 800**) examine the price and income elasticity of water through a case study of Darjeeling town in West Bengal. The overall implication of the study is that rising price of water per litre has compelled the residents to compromise on the quality of drinking water. The study recommends that the objective of inter-generational equity for water should be followed in the long run. Addressing the urgent need to purify the contaminated water, Kumar *et al*. (**page 809**) suggest a novel, cost-effective, nano-fibre based membrane technology for water purification and biomineralization, which can be implemented as a replicable model across the IHR.

Towards enhancing the livelihood options and income-generation, Garg *et al*. (**page 818**) present a set of transformative demonstrative models by way of converting eight wild edibles into 19 high-value products, encouraging community participation and women empowerment. The study also addresses the key issues of declining agro-biodiversity and deteriorating traditional mountain food systems, which further helps in mitigating environment degradation and climate change impacts. Bringing forth a sustainable approach towards livelihood improvement in the Central Himalaya, Chauhan *et al*. (**page 825**) present a demonstrative, integrated natural resource management model suitable for the IHR. Some of the key activities that can bring transformation in the lives of the hill communities, particularly the youth and women in the IHR, are also summarized in the study as a replicable model.

Mitigating household carbon emission along with forest conservation, Lal Singh *et al*. (**page 835**) highlight a cost-effective and technically efficient system for fuelwood consumption with innovative solar water heating technique as a clean energy solution to the mountain households. In addition, this technique also provides employment opportunities by way of skill-building in locally fabricated solar water-heating systems. The initiative, presented in the study in the selected hilly areas of Mandi and Kullu districts of Himachal Pradesh, has the potential to be replicated in other parts of the Indian Himalaya, resulting in significant environmental, social and economic benefits to the local hill communities. Sharma and Sharma (**page 841**) address some of the critical issues due to challenging forest waste, i.e. pine needles in the IHR, and suggest bioconversion of pine needles into the second generation of biofuels. The study highlights the most efficient hypercellulase- and xylanase-producing microorganisms from the soil for the production of bioethanol, which is the most promising alternative for gasoline. The study also recommends that such hydrolytic enzymes will be further utilized for the conversion of pine needles to fermentable sugars, which is a feasible process and offers potential to reduce use of fossil fuels as well as environmental pollution.

Dash *et al*. (**page 850**) present first-hand information on quantitative assessments of different vegetation layers, viz. tree, sapling, seedling, shrub and herb, collected from 57 permanent plots established for long-term monitoring of biodiversity and other functional aspects in the Namdapha National Park of Arunachal Pradesh in the Eastern Himalayan region. The findings of the study indicate good regeneration with *Dipterocarpus retusus* Blume as the dominant tree in the target areas. Singh *et al*. (**page 859**) enumerate the research findings on the Indian Himalayan timberline ecotone with a focus on three sites in Kashmir, Uttarakhand and Sikkim. Identifying *Betula*, *Abies*, *Rhododendron* and *Juniperus* as important treeline genera and representing the highest treeline (*Juniperus tibetica*, at 4900 m amsl) and the widest elevational range (>1700 m amsl), the study recommends that economic interventions are required to reduce the high dependence of people on timberline. The findings of this study reveal that the tree-ring chronology indicates winter warming, favouring *Abies spectabilis*, and that snowmelt increases the growth period and richness of the species along the upward advancement of treeline, particularly *Rhododendron campanulatum* (a krummholz species), depleting further alpine meadows with changing and warming climate in the target regions of the IHR. Dasila *et al*. (**page 872**) assess the sub-alpine forests in Hamta Pass area of Himachal Pradesh in the Northwestern Indian Himalaya, focusing on *Betula utilis* and D. Don populations. The study highlights that the continued anthropogenic activities, climate change and other factors have affected the species population adversely in the area, but through proper propagation of seedling and sapling, the species can be conserved and can continue to grow in the target areas.

Taking pollination as one of the pivotal ecosystem services in natural and managed ecosystems, Mona Chauhan *et al*. (**page 883**) present the preliminary assessment and conservation of insect pollinators through community participation in Lahaul and Spiti districts of Himachal Pradesh. Stressing on diversification of agriculture and prioritizing pollinators' conservation efforts, the study recommends a variety of crops over the homogenization of crops due to monoculture practices, besides restricting the inappropriate use of pesticides and insecticides. The study also highlights that overgrazing of natural habitats affects the nesting, foraging and breeding sites of pollinators, which will have a direct impact on the food, nutrition and socio-economic patterns in the Trans Himalayan Region.

Kuniyal *et al*. (**page 888**) assess the anthropogenic impacts and suggest capacity building as a mitigative measure in the wake of climate change, particularly in the glacier- and non-glacier-fed ecosystems of the IHR. The study takes into account the people's perceptions across five water basins (with 25 villages having 994 households) on identified climatic indices and recommends adaptive strategies based upon the target region of the IHR. According to the perception-based studies, the findings reveal greater change in land-use patterns, adverse impacts on forest and human health, overall reduction in harvest, etc. with increasing temperature and changing climate. The study recommends adequate capacity-building programmes on climate change mitigation and adaptive measures as the most effective strategy involving the local inhabitants towards combating the climate change impacts.

Overall, comprehensive and solution-oriented mitigation and adaptative strategies are covered under the specific thematic areas like water, biodiversity, livelihood, disaster risk reduction, handling of hazardous substances, etc. in this special section towards combating climatic impacts and anthropogenic changes felt all across the Indian Himalaya.

Considering the immense coverage of data, information, measures and recommendations herein, we hope that this special section will assist in addressing the critical concerns in the IHR and prove to be a suitable ready-reckoner/appropriate reference material while seeking solutions with new resolutions for conserving and sustainably developing the region.

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– Guest Editors