

Need for strengthening mountain-specific research*

Among global mountains, the Himalaya holds a special position. It is massive, vast, complex and highly variable in space and time, and therefore, difficult to understand and characterize even with the best scientific efforts. The situation gets worse when the capacity to undertake research is limited. Remoteness, difficult terrain, lack of resources and poor infrastructure, are some inherent difficulties that hamper the extent and quality of research in the region. More importantly, continuous decline in the number of motivated and sincere field researchers is causing a grave situation. This calls for urgent attention from all concerned. Recognizing this urgency, especially considering the sensitivity of the region under global change scenario, a two-day workshop was recently organized. The purpose of the workshop was to bring together different scientific and educational institutions and experts/researchers in the Himalayan region to debate on issues pertaining to promotion of field research as a culture. The idea of this workshop was borne out of the concerns of Indian National Science Academy (INSA), New Delhi for region-specific research. The workshop mainly targeted (i) taking stock of the present state of research, and associated gaps and discrepancies; (ii) attracting young researchers and developing strategies to promote field research culture in general, and in the context of the Himalaya in particular; (iii) identifying thrust areas of research for the next decade or so; (iv) conducting coordinated ecosystem-based long-term studies through collaboration and networking; (v) developing research networks and data-sharing mechanisms with

Himalayan countries, and finding out mechanisms for saving data; (vi) establishing a connect between science, policy and practice, and (vii) taking measures to improve research publications on diverse issues from the Himalayan region.

Convener of the workshop, P. P. Dhyani, Director, GBPIHED, while welcoming the dignitaries and participants highlighted that in recent years the Himalaya has drawn global attention because of vulnerability of the region to climate change (CC). He mentioned that the Government of India (GoI), through its National Action Plan on Climate Change (NAPCC), has shown its commitment for the Himalayan region by way of a National Mission on Sustaining Himalayan Ecosystems (NMSHE). Furthermore, the recently established Mountain Division, as the fifth unit of GBPIHED, by the Ministry of Environment and Forests (MoEF), GoI is indicative of the fact that GoI is giving special attention to mountains, especially the Indian Himalayan Region (IHR).

Coordinator of the workshop, S. P. Singh (FRI, Dehradun) in his keynote address, 'Mountain-specific research: How to strengthen the culture of field research', explained the need of such a workshop and acknowledged INSA President, Krishan Lal for supporting the idea of this workshop. Citing historical example of Troup's world-famous volumes on *Silviculture of Indian Trees* in 1922, Singh mentioned that this classic work was based on extensive fieldwork in the Himalaya, when the rest of the developing world had hardly any idea about relating research to forests. He expressed grave concern that in spite of substantial efforts put together by various universities across the IHR during 1980s, the field research culture is declining in the region. India's three major centres in ecology (viz. Kashmir University, J&K; Kumaun University, Nainital and North-Eastern Hill University, Shillong), developed in the Himalaya and made their presence felt across the globe through landmark publications, are now not contributing significantly. Inadequate expertise, lack of uniform methodology and instrumentation and data collection

and syntheses protocols, were underlined as major causes that affect the quality of research outcome. Networking and extensive collaboration was emphasized as key for raising good research questions and hypotheses. Singh suggested measures to improve the situation that included: (i) incentivization, e.g. better field research facilities and systems of rewards; (ii) system-based research facilities to learn and conduct research and establishment of long-term ecological monitoring sites to collect datasets, (iii) provisions for short courses on field research and writing of papers by mentors, and (iv) publishing a mountain-specific research journal.

The Chief Guest, S. S. Garbyal (MoEF, GoI), while appreciating the people's beliefs and reverence to the sacred mountainscape, felt that extensive research in these landscapes will help understand the value of this belief system. David Molden (ICIMOD, Nepal) presented a framework on how to bring science in policy and practice through comprehensive assessment and answering relevant questions from different disciplines such as drivers of change, enhance livelihood, security and adaptation in the Himalayan region. The Guests of Honour Furquan Quamar (Central University, Kangra, HP) and V. K. Jain (Doon University, Dehradun) emphasized upon the need to build on interdisciplinary science keeping food, water and energy security at the centre stage. B. M. S. Rathore (MoEF, GoI), underlined the issue of the missing multidisciplinary network to pursue quality research and highlighted a need for collaboration and networking with all the stakeholders. In his presidential remarks, Krishan Lal (INSA) felt a need for sustained efforts for this kind to foster quality research in the region.

In the introductory session four lead lectures were delivered for taking stock on: (i) State of knowledge on biological/ecological research (Eklabya Sharma, ICIMOD); (ii) State of knowledge on physical research (V. P. Dimri, NGRI, Hyderabad); (iii) State of knowledge on socio-economic research (T. S. Papola, GIRI Institute of Developmental Studies,

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Lucknow); and (iv) Science, policy and practice connect (B. M. S. Rathore). Sharma pointed out that major drivers of change in the region are climate change, infrastructure development and hydro-projects that have transboundary ramifications. Dimri suggested research on geothermal energy and geothermal heat pumps for space heating as an alternative source of energy in the Himalaya. Papola spoke about the importance and role of social scientists and economists to build sound socio-economic database for developmental planning. Rathore stressed the need for a better connect among policy, science and practice. He presented 'Landscape yatra's – journeys through identified landscape' as a tool to learning the ground realities and foster such a connect.

The first panel discussion (Research Motivation) was chaired by J. S. Singh, who had established the Ecology Centre at Kumaun University, Nainital way back in the early 1980s. He dwelt upon the process that energizes the knowledge and skills and helps focus on the most important goals and sustains action over time. He explained about extrinsic motivation (such as fellowships, arduous allowances, awards and other recognitions and enhanced job opportunities) and intrinsic motivation that consists of altruistic reasons and intrinsic satisfaction to do a task with dedication. Thus, the main motivators of research include: (i) a research environment with a wide variety of researchers working on cognate topics, strong links with other disciplines in a cross-disciplinary setting, cross-fertilization of ideas from external researchers, and access to appropriate facilities; (ii) well-structured career perspectives for progression, including posts outside academia and (iii) strong funding and facilitating processes. He stressed upon the need to raise good research questions or hypotheses that focus on a study, narrow the research topic area to a meaningful and manageable size, and address issues of theoretical and practical significance. The panelist in this session, H. Y. Mohan Ram, emphasized upon the three guiding principles to pursue quality research, viz. motivation, dedication and discipline. G. S. Rawat felt the need for short courses on natural history and mountain environment to appraise young researchers about local culture and society and inculcate a sense of belonging to the research area/community under mentorship and

guidance from elders and role-models. R. S. Tolia was concerned about the pathetic state of research for want of basic facilities, and also for not making use of good research.

In the second session (Quality Research on Mountain Issues), chaired by Molden, it was emphasized that the issues of immediate societal importance and scientific value need to be taken up for research. However, to steer such applied research limited availability of mentors and research supervisors in the remote areas is a problem. On the issue of the need for a devoted journal (e.g. Mountain Environment and Development proposed by Central Himalayan Environment Association (CHEA), Nainital), it was emphasized that to establish a journal of repute, an extremely dedicated band of academicians would be required that will motivate researchers and strengthen research culture in the Himalaya.

While chairing the third panel discussion session (Multi-Site Long-Term Research), S. P. Singh felt the need to take up research under the long-term ecological research sites (LTER) such as (i) change in glacial melt with CC; (ii) detecting refuge value of the Himalayan ecosystem for sheltering the march of species; (iii) timber line communities flux and tracing movement of species; (iv) phenological network to monitor changes in plants in response of CC; (v) estimation of carbon stock and sequestration; and (vi) eco-hydrology of the Himalayan landscape. G. V. Subrahmanyam indicated that MoEF through its NNRMS Division is supporting multi-site research in the form of All-India Co-ordinated Projects (AICP). However, there is a need to analyse the past data collected properly. C. P. Singh informed about the ongoing Himalayan Alpine Dynamics Research Initiative (HIMADRI) as one of the multi-site research initiatives. P. P. Bhojvaid emphasized the importance of ecotones to collect and analyse data. J. S. Singh pointed out that a set of hypotheses and minimum database by making working groups on 2–4 topics (sites/Pis/research questions) to collect verifiable database and draw valid conclusions need to be chalked out. R. S. Tripathi submitted that in ecological research over 5 years data are not enough for deciphering ecosystem function and processes. Thus project cycle should be designed for more than 5 years

duration. Rawal suggested that latitude, longitude, altitude and aspect should be kept in mind while selecting LTER and the usefulness of the three existing opportunities – NMSHE, NNRMS-BR, ICIMOD – transboundary landscape projects in forging partnerships. R. R. Rao mentioned that the Western Ghats should also be included in the LTER network. G. S. Rawat stressed the need to base these LTER on a broad and interacting framework of cryosphere, atmosphere, ecology and hydrology. R. D. Singh (NIH) felt a need for advanced instrumentation for collection of data.

While chairing the fourth panel discussion session (Research for Development), R. S. Tolia indicated that social face of the research is a must to contribute to sustainable development process of the Himalayan mountains. H. C. Pokhariyal dwelt upon the importance of considering inaccessibility, fragility and marginality of mountains and the need of horizontal (sectors and sections of society) and vertical (spatial scale of village, block and district) integration in micro-planning process.

In special session-I (Role of INSA in Promoting Science in the Himalaya), the INSA Fellows recommended that (i) INSA should take the lead in strengthening interaction among the other academic institutions of the region; (ii) Himalaya-specific lecture workshops and 2–4-week fieldwork training exposure to a group of UG and PG students on methods in the field biology need to be organized and (iii) government agencies such as DST, MoEF must be motivated to establish Chairs for Himalayan Research in leading academic institutions in the mountain region of India.

In special session-II on 'Voice of Himalayan Researchers', some of the main issues discussed were: (i) need for digitization of past data/publications and devise data-sharing mechanisms; (ii) need for collaboration among universities and research institutions establishing an Association of Mountain Researchers; (iii) devise suitable mechanisms to overcome difficulties faced by PIs in getting good JRFs and delays in project funds, and (iv) need for capacity building of researchers, particularly in paper writing for quality publications.

The way forward and concluding session chaired by B. M. S. Rathore summed up with following conclusions: (i) need to strengthen interdisciplinarity

and multidisciplinary to foster quality research and to generate comparable dataset so as to improve the image of data-deficient Himalayan region among the world community; (ii) overcoming the dearth of dedicated researchers to pursue research and need to devise strong incentive mechanism to boost the scenario; (iii) shift in approach to collect meaningful data through participatory research utilizing the force of students and other stakeholders; (iv) promote applied and

demand-driven research so that job opportunities of the researchers are ensured and (v) mountain-specific courses need to be designed and run in the institutions.

The workshop was attended by over 80 participants from 50 organizations consisting of eminent academicians, heads of leading research institutions, active researchers from universities, policy makers, NGOs, etc. actively engaged in mountain-specific research in the Himalayan region. The officials of MoEF and

DST took keen interest in the proceedings of the workshop and contributed immensely in terms of their intellectual inputs. This is a positive sign for improving research quality in the Himalayas.

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Mars Orbiter Mission prepared to photograph Mars: some results from Earth Imaging Experiment

Mars Orbiter Mission (MOM), the interplanetary mission of ISRO, launched on 5 November 2013, is a maiden attempt towards sending orbiters to other planets of our solar system. It has many laurels to its credit in terms of cost-effectiveness, weight-budget, short period of realization, miniaturization of five heterogeneous science payloads, textbook precision of launch and post-launch manoeuvres. Mars Colour Camera (MCC) on-board MOM is among the five science payloads, having 16 different modes of exposure, aimed at imaging the surface of the Mars with moderate objectives like morphological/structural mapping, imaging dynamic events, viz. dust devils, polar ice cap variations and other opportunistic imaging.

Earth Imaging Experiments (EIEs) were conducted during the Earth Orbit



Figure 1. First image of the Earth taken by Mars Colour Camera on 19 November 2013.

Phase (EOP) in order to assess the application potential of MCC vis-à-vis the objectives envisaged. Three imaging sessions on two different dates, viz. two sessions on 19 November and one session on 23 November 2013 were conducted. These included imaging from varying altitudes, spatial resolution, illumination conditions, taking multiple snapshots of a given area of interest in order to view physiographic, morphologic and other geological details of our planet, so as to ascertain the expected results from highly elliptical Mars orbit. The imaging sessions were chosen to get favourable sun angle/spacecraft yaw axis/phase angle combination

The four major objectives of EIE are as follows:

- (i) To image India for outreach purpose.
- (ii) To image Earth from Mars apoaxis equivalent (about 60,000–70,000 km).
- (iii) To image from geo-stationary equivalent altitude (36,000 km).
- (iv) To image at a resolution of 1 km.

The altitude, spatial resolution and exposure mode required for selected science targets on Mars have been assessed, qualified and ascertained in terrestrial orbit.

The first photograph was taken on 19 November 2013 (0820 UT) from an altitude of 67,975 km with 3.5 km spatial resolution (Figure 1). It was the first MCC image showing parts of Asia and Africa, including India. The swath of the

image was about 7240 km and it was taken using 0.133 ms integration time. Three snapshots at one second interval were taken.

Most of the India could be covered with minimal cloud cover. The four major physiographic zones of India, viz. Himalayan range (white colour), the Indo-Gangetic Plain (grayish colour), the Thar desert (beige colour) and the southern peninsula (dark colour) were picked up distinctly with textbook precision by the maiden image taken by MCC. The *Helen* cyclone, off the eastern coast of India was picked up before its landfall. Additionally, the dispersal pattern of the suspended sediments discharged by rivers into the Gulf of Khambhat and Gulf of Kachchh is seen in light blue colour off the Gujarat coast. Lake Manas Sarovar is also visible amidst the Himalayan snow peaks. Other features in the image show parts of Sahara and Arabian deserts (bright colour), Trans-Himalayan Tibetan Plateau, fertile Indus Valley and a variety of cloud patterns.

The experiment has been successfully conducted and it has yielded fruitful results. MCC is expected to provide images of desired quality during rest of the mission. MCC on-board MOM is fully prepared to image Mars and send the first ever photograph of taken by an Indian payload in the Mars orbit.

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