Centre for Himalayan Study in Uttarakhand

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The Minister for Finance, Government of India, while presenting the budget for 2014 has announced the setting up a Centre for Himalayan Study (CHiMS) in Uttarakhand. It is a welcome move, and rightful aspiration of the country and people of Uttarakhand in particular[1,2]. It became necessary after the devastating disaster symbolized by the Kedarnath tragedy in June 2013 to explore and understand the interactions of various natural agencies for sustainable growth and progress. There is a lack of assessment of the optimal extent of loss of life and property during this tragedy. This highlights the limitation of our understanding of the natural systems, leading to insufficient policy and programme implementation and lack of coordination among various stakeholders aspiring to reach the same goal, i.e. welfare of people of the country or region.

The Uttarakhand region receives a large number of pilgrims from different parts of the country during summer as the religious shrines normally remain inaccessible during winter. Besides pilgrims, nature lovers and adventure enthusiasts arrive in large numbers from India and abroad. These visitors are an important source of revenue and provide employment to the inhabitants to sustain the local micro economy. The growing population and aspiration for development have led to the resource exploitation. This cycle has an adverse effect on the local biodiversity and exposes the rocks and soil to the most potent gradational agent of nature, i.e. rain and snow. We are aware that the Himalaya is a theatre of active interaction of geological, geomorphic, climatic and biotic heterogeneities and diversity for the past several million years. The June 2013 disaster was a recent event that exposed the limitation of our scientific understanding of the earth processes and the way various factors interact with each other in the region[3–5]. This throws up challenges for better exploration of the natural processes to understand ways for sustainable human–nature interaction in the mountainous region. We briefly discuss these factors to analyse a few related to earth processes that act in cause and effect relationship during such disasters.

Earthquakes: The Himalaya, in general, and Uttarakhand, in particular, lies in zone 5 of the seismic zoning map of India and the region lies in the central seismic gap of the Himalaya, which did not experience any great earthquakes in the past century. The last great earthquake occurred in 1803 when many townships, including Srinagar Garhwal were completely destroyed. In recent past, Uttarakhand experienced a few large earthquakes, namely Dharchula (1964, *M* 6.2), Uttarkashi (1991, *M* 6.9) and Chamoli (1999, *M* 6.6), and over a dozen 5–6 magnitude and a large number of 4 and below magnitude earthquakes. These recurrent earthquakes of varying sizes suggest that the region is tectonically active and accumulating strain along mid-crustal décollement. This is a cause of great concern, because the strain that is building up may get released during a large earthquake event in future with rupture along large intra-crustal thrusts. These large intra-crustal structures have built the spectacular topography of the Himalaya during the past several million years by exhuming the deeper crustal rocks and the geodynamic process is still continuing. The distribution of these intra-crustal thrusts on ground has been mapped[6], but their subsurface geometry, lateral variability and the locking zone are yet a matter of conjecture. To carry out source characterization and monitoring of earthquake events for precursor studies and their modelling to develop refined crustal structures, there is a serious need of installation of dense seismic network and carrying out the palaeoseismic studies[7,8] to understand the past earthquake history and seismic hazard potential of the region.

Geomorphic landform mapping: The movement along the thrusts during recurrent earthquakes causes strong ground motion that shatters the near-surface rocks on a large scale and pulverizes them along the thrust zone. These shattered and pulverized rocks provide debris to the gradational agents, which involves weathering and erosion of higher ground and filling of the material in the lower plains. The glaciers and rivers, which are the most potent gradational agents of nature, interact at these weak zones and rocks to produce debris and characteristic erosional and depositional landforms that evolve through time. It is essential to understand these natural processes with special reference to topography, which is the most critical element in hilly terrain. For example, most of the causality, loss of property and destruction to infrastructure during the June 2013 disaster occurred in the upper reaches of the Himalaya between ~2600 and ~4000 m asl. This region is exposed by the last glacial retreat[9] and has several lakes formed due to temporary impounding by glacial moraines and landslides. The glacial moraines and landslide debris was washed downslope in the form of debris flow with the flood[10]. Most of the large devastating landslides, debris flow and flash floods in Uttarakhand in the recent past, namely, 1970 Gohana Tal-Belakuchi flood[4,5], 1978 Dabrani and 1998 Malpa slide occurred in this zone, which is also characterized by large diurnal temperature variation, sudden high rainfall and very steep slopes. The gentler landforms close to the riverbed are best suited for agriculture, but are most vulnerable as they lie in the flood ways and have suffered devastation during the June 2013 disaster. It has been variously suggested after the 2013 Uttarakhand disaster[11] that there should be a concerted effort to provide a better connect between policy, science and practice using tools such as ‘Landscape Yatra’s – journeys through identified landscape’. The basic data on landscape for such integrated approach is not yet available in usable form. It is of immense importance to have the distribution of topography, drainage, landforms, landslides, critical lakes (including both glacial and landslide lakes), land-use/land-cover pattern, the communication network, including roads, distress/emergency centres in integrated usable format. As it was observed during the 2013 disaster, ground data were not available in usable format for safe rescue, relief and rehabilitation operations. There is a serious need for mapping and characterization of landforms with an aim to assess their suitability for habitation, relocation and infrastructural development. India is a leading nation in space technology and

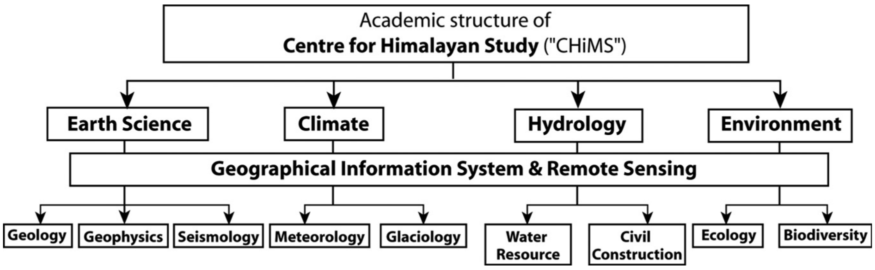

Figure 1.

remote sensing. The high-resolution satellite images are critical for the Himalayan region, which largely remains inaccessible. The data generated from various sources have to be put in Geographic Information System (GIS), which plays a pivotal role in data integration, analysis, decision-making and dissemination.

Micro-climate, incessant rain and cloud bursts: The only and most important anomaly that brought about the 2013 Uttarakhand disaster was the incessant rain[3–5]. The interaction of a mid-troposphere westerly with the low-troposphere summer monsoon[12] led to the growth of a transient cloud front causing extreme rainfall event[13] with an unprecedented large spatial coverage[10,12]. The incessant rainfall/cloud burst events in Uttarakhand are common; they are of short duration and low spatial coverage. The post-event climate modelling using satellite data and data from isolated weather stations in the region yielded similar result, but are only useful for short-term prediction if analysed in real time together to validate the simulations. The validation of simulations is most critical and requires dense weather station network deployment in the region[10]. It is vital to invest a meagre fraction of the state's resources in such deployment.

Amongst the increasing level of natural resource exploitation to cater to national growth, water resource exploitation is most common in the Himalayan belt. Several mega, large and small infrastructural projects are being built. These require stream diversion, large-scale excavation by blasting, tunnelling and dumping loose rock debris/soil, creating unstable landforms prone to slope instability. They also lead to deforestation of indigenous plants. Aforestation with non-native plant species deemed suitable for slope stability and soil conservation has not been adequate and helpful. The anomalous sediment supply and change in natural fluvial discharge to the downstream regions often cause disturbance in the ecosystem. These clearly demonstrate that the geodynamic system is at the core of all the natural disasters, biodiversity, ecological, social and economic changes in Himalayan terrain of Uttarakhand and adjoining regions and hence needs to be understood in detail.

The announcement of setting up CHiMS has demonstrated the seriousness of the policy makers and proactive initiative. With this note our effort is to bring to the notice of the Government the outlook of a large community of earth and atmospheric science, which intends to participate in the scientific endeavour of the nation. It would be prudent to have the earth science studies at the core of the proposed CHiMS as it is coming in the backdrop of the June 2013 natural disaster in Uttarakhand. It should house and integrate the applied disciplines, which have bearing on understanding of natural disasters like earthquakes, cloud burst, landslides and flooding, and their effect on ecosystem and biodiversity. The Centre should act as a repository for the various databases that can be accessed for planning for sustainable development of the region. It is prudent that CHiMS should have the divisions as shown in Figure 1, which generate, integrate and interpret multi-disciplinary dataset of the following disciplines, though the list can be amended.

Further, it is important to note that there are several institutions actively involved in research related to natural resource and disaster in the Himalayan region, e.g. CSIR-NGRI, Hyderabad; Wadia Institute of Himalayan Geology, Dehradun; G.B. Pant institute of Himalayan Environment and Development, Almora along with several academic institutions/universities. But the theme 'mountain hydro-resource' has a small component of the mandate of all these institutions. It is expected that CHiMS intends to build capacity and expertise in this core area of natural disaster and mountain water resource management involving various disciplines.

1. Tribune, Go for safer routes to avoid death, damage in natural disasters, 2013; http://www.tribuneindia.com/2013/2013-0807/dun.htm
2. Tribune, Prof. Dimri welcomes proposed centre for Himalayan studies, 2014; http://www.tribuneindia.com/2014/2014-0715/dun.htm
3. Dimri, V. P., Monsoon c(o)urse changed Uttarakhand. *The Hindu*, 24 June 2013.
4. Dimri, V. P., *Curr. Sci.*, 2013, **105**(2), 152.
5. Dimri, V. P., Extreme events in Uttarakhand, India. In American Geophysical Union Fall Meeting, San Francisco, 2013, 1, 05.
6. Valdiya, K. S., *Geology of Kumaun Lesser Himalaya*, WIHG, Dehradun, 1980.
7. Kumar, S., Wesnousky, S. G., Rockwell, T. K., Briggs, R. W., Thakur, V. C. and Jayangondaperumal, R., *J. Geophys. Res*., 2006, **111**, B03304; doi:10.1029/2004JB003309.
8. Pandey, P., Kumar, R., Suresh, N., Sangode, S. J. and Pandey, A. K., *J. Geol.*, 2009, **117**, 200–209.
9. Pandey, A. K., Pandey, P., Singh, G. D. and Juyal, N., *Curr. Sci.*, 2014, **106**(2), 245–253.
10. Dobhal, D. P., Gupta, A. K., Mehta, M. and Khandelwal, D. D., *Curr. Sci.*, 2013, **105**(2), 171–174.
11. Negi, G. C. S., Rawal, R. S., Sharma, S., Kumar, K. and Dhyani, P. P., *Curr. Sci.*, 2014, **106**(5), 659–661.
12. Kotal, S. D., Roy, S. S. and Bhowmik, S. K. R., *Curr. Sci.*, 2014, **107**(2), 234–245.
13. Mishra, A. and Srinivasan, J. S., *Curr. Sci.*, 2013, **105**(10), 1351–1352.

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