Photo: TERI

Impact of melting glaciers in the Himalaya

The Himalayan region is not only tectonically active and ecologically fragile but it is also one of the most economically underdeveloped and most densely populated mountain ecosystems on the planet. These natural as well as human characteristics render the Himalayan region highly vulnerable to the impacts of climate change, in particular to those of melting of glaciers and changes in the patterns of precipitation.

The melting of glaciers seasonally releases melt water into tributaries of the Indus, Ganges and Brahmaputra Rivers, with glacial melt contributing up to 45 percent of the total river flow. Approximately 500 million people depend upon water from these three rivers to support agricultural and economic activities. The impacts of retreating glaciers on the ecosystems, human well-being, water availability and food security, are of broad societal concern. Since the 1970s, the glaciers have been melting at a staggering rate; in conjunction with a decrease in the summer monsoon rainfall in the Indo-Gangetic Plain the region has been facing major environmental problems, threatening both water and food security.

Professor Syed Iqbal Hasnain
The Energy and resources Institute – TERI
New Delhi, India
shasnain@teri.res.in

A widespread deglaciation is occurring in the Himalayan Tibetan region. This includes a 21 percent decrease in the area of 466 glaciers that were studied in the Indian region of the Himalaya. About 80 percent of the western Tibetan glaciers are retreating. The rate of melting of Himalayan glaciers (15 metres per year) is the highest in the world. The largest glaciers of the Himalaya are downwasting and forming moraine-dammed glacial lakes. These growing lakes invariably burst out, releasing huge amounts of water and debris. This phenomenon is known as glacial lake outburst floods (GLOF).

Increasing population pressure (and urban growth), land use changes and intensification, large-scale deforestation, mining and excessive grazing, coupled with climate change, has lead to a drastic change of the water regime in the Himalaya, i.e. the traditional resource-use structure has changed, disrupting the hydrological regime of the Himalayan watersheds. The causes of diminishing water resources and their depletion are rapid land use changes, over-exploitation not only of surface water but also groundwater resources, reduction in groundwater recharge, change in precipitation pattern and melting of glaciers. These hydrological imbalances impair the basic ecological services, such as drinking water and irrigation, thus undermining livelihoods and food security in large parts of the region, which is mainly dependent on subsistence agriculture. The resulting change in the Indian monsoon pattern leads to large rainfall variability, at some places with severe drought in the Himalayan region. In view of this, the regime of water resources in the Himalaya, both snow-fed and rainfed, is likely to change rapidly.

Impacts on watersheds

Due to global warming, the Indo-Gangetic basin of the Indian subcontinent, where water supply is dominated by melting snow and glacier ice, will be faced with severe environmental problems. Negative impacts, including seasonal shifts in water supply, flood risks and increased precipitation variability, will eventually offset benefits incurred by short-term increases in runoff from glacier melt. Tibetan ice-fields and glaciers are critical resources for one sixth of the world's population because they sustain dry-period low flows for major rivers, such as the Indus, Ganges and Brahmaputra Rivers, in the south western Himalaya. The Indus and Ganges Rivers currently have little outflow to the sea during the dry season and are in danger of becoming seasonal rivers due to climate change and increased water demand. The surface area of glaciers across the Tibetan Plateau is projected to decrease from 500,000 square kilometres measured in 1995 to 100,000 square kilometres in 2030, thereby threatening regional rivers and water resources. Himalayan glacier melt water surpluses which include high altitude thinning of ice fields in western Tibetan Plateau are likely to shrink much faster than currently predicted, with substantial consequences for approximately a billion people.

With glacial and snow retreat, many of the semi-arid mountains, inhabited by some 170 million people, will lose several of their local springs and streams, so essential to villages and livestock grazing. In addition, increasing flash floods and rockslides degrade roads and trails. The impacts are aggravated by the fact that some 94 percent of the energy demand is still met by traditional means as fuel wood and animal dung or biomass, such as in India, Pakistan, Bhutan, Nepal, Tibet, and most other regions in Asia. Most watersheds have experienced a substantial deforestation and overgrazing, making the hillsides much more vulnerable to landslides, either during peak snowmelt or in relation to tectonic activity. For an energy-constrained economy like India, the prospect of diminishing river flows in the future and the possibility that the energy potential from hydropower may not be achieved will have deep-seated consequences.

Action is needed

The Indian National Action Plan on Climate Change addresses the urgent and critical concerns of the country through a directional shift in the developmental pathways. It identifies measures which will promote developmental objectives while addressing issues relating to climate change efficiently and effectively. The Himalayan ecosystem is one of its eight missions with a long-term approach and well defined time-lines for achieving the goals of the Action Plan. The ecologically sensitive Himalayan mountain system is prone to adverse impacts of climate changes on account of anthropogenic emissions of Green House Gases and developmental activities of the region.

The Himalaya are referred to as the 'third pole' as they have a large area with perennial snow cover and the largest concentration of glaciers outside the Polar Regions. The glaciers provide around 8.6 x 10^6 cubic metres of water annually. There is global concern that glaciers are receding at faster rates on account of climate change and global warming. An initiative is needed to develop regional co-operation to quantify effects, assess vulnerability and tackle climate change impacts on glacial ecosystems to evolve mitigation and adaptation measures. Currently, several research institutions are engaged in a study of glaciers and ecosystems in the Himalaya on project mode. However, as long as the national mission does not offer an integrating platform, the research and monitoring

The Darang Durung glacier in India's Jammu and Kashmir. The Himalayan region has the largest concentration of glaciers outside the polar region.

activities may well remain sub-critical, disparate and isolated. The national mission would therefore focus on evolving a strategy to develop and integrate the ongoing efforts and initiate new ones enabling multi-disciplinary and multi-institutional participation on a nationwide basis. Such an effort is necessary to develop policy strategies and recommend action programmes for sustaining the ecosystem.

An Advisory Council of technical experts will be constituted for the National mission on sustaining the Himalayan ecosystem. This Council will play the role of a think tank and assist in monitoring progress of work under the mission. The national mission proposes to work with the existing knowledge institutions within the structure and practices of extra-Mural Research support employed by the Ministry of Science and Technology as well as the intra-Mural Research programme already undertaken in the domain area institutions under various ministries. Establishment of the National Centre for Himalayan Glaciology and special programmes for human capacity building on Himalayan ecosystem will be supported by the Department of Science and Technology (DST) under existing provisions. The data related to glaciological research generated through DST project funding will be processed and analysed at the National Centre for Glaciology.

Photo: TERI

The National Action Plan on Climate Change has included glacier research in the mission on the Himalayan ecosystem, with a rural road map envisaging that existing institutions will be further strengthened and research programmes will be funded through projects. However, this approach does not address the issues of water resources or the hazard potential of glaciers. Neither does it provide for valuable field studies, which would require scientists experienced in technical climbing, since the glaciers in the Himalaya are located at an altitude of 4,000 to 6,000 metres. Long-term monitoring of a benchmark/ index glacier in each climate setting could provide the critical foundations we need to develop an understanding of ongoing processes. The benchmark/ index glaciers could be measured in detail to define the seasonal mass-balance processes, meteorological environment and water runoff.

However, none of this can be achieved as long as funding by the Ministry of Science and Technology is provided in project mode, as planned. There is a clear need for an oversight body, which we could call the National Glacial Monitoring Authority. Such an authority would maintain a network of weather stations on the glaciers and in the nearby valleys, discharge stations close to the snout of the glaciers, a network of discharge stations downstream and measurements of mass balance with pits in the accumulation region. The scientists and technical staff operating the network ought to have skills in technical climbing and be physically fit to operate the system for six to eight months. Data would have to be fed into a common platform that could be called e.g. the National Centre for Himalayan Glaciology for detailed analysis, and it could be used by the agricultural scientists, hydrologists, etc.

Zusammenfassung

Die Himalaya-Region ist nicht nur tektonisch aktiv und ökologisch sensibel, sie ist auch eines der wirtschaftlich am wenigsten entwickelten und am dichtesten besiedelten Gebirgs-Ökosysteme des Planeten. Diese von der Natur und vom Menschen beeinflussten Merkmale machen die Himalaya-Region extrem verletzlich für die Folgen von Entwicklung, Degradierung und Klimawandel, insbesondere durch Gletscherschmelze und Veränderungen im Niederschlagsaufkommen.
Im Aktionsplan des indischen Staates zum Klimawandel (Indian National Action Plan on Climate Change) wird die Himalaya-Region besonders berücksichtigt. Das zunehmende Schmelzen des „ewigen Eises“ hat jedoch auch globale Auswirkungen. Um die Folgen der globalen Erwärmung hinreichend zu untersuchen, ist eine regionale und überregionale Zusammenarbeit erforderlich.

Resumen

La región del Himalaya no sólo se caracteriza por su actividad tectónica y por su fragilidad ecológica, sino que además es uno de los ecosistemas de montaña económicamente más subdesarrollados y más densamente poblados del planeta. Estos atributos naturales y humanos convierten a la región del Himalaya en un área muy vulnerable a los impactos del desarrollo, la degradación y el cambio climático, y en particular a los efectos del derretimiento de los glaciares y los cambios en los patrones de precipitación. La región del Himalaya ha sido incorporada en el Plan Nacional para el Cambio Climático de la India. Sin embargo, el aceleramiento en el deshielo de la capa de nieves perpetuas es un motivo de preocupación para el mundo entero. Es necesario llegar a una cooperación regional para evaluar los impactos del calentamiento global.

Such an arrangement would ensure a better understanding of the impacts that the melting of glaciers is having and facilitate the introduction of measures to protect water resources and maintain food security in the region.