Impact of Climate Change on Himalayan Glaciers and Glacier lakes

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ABSTRACT

One of the major global warming related issues of the 21st century directly concerns to more than half a billion people across five countries sharing Hindu Kush-Himalaya is the fast receding Himalayan glaciers which is threatening their agriculture and habitats. IPCC fourth assessment report published in 2007 has predicted that global mean temperature is expected to increase between 1.4 and 5.8 degrees Celsius over the next hundred years. However, the recent studies by Ramanathan et al (2007) published in nature issue of 2nd August have found that Atmospheric Brown Clouds (ABC) on Indian Ocean and south Asia is contributing as much as the recent increase by humans and their green house gases. The total warming on southern flank of Hindu Kush-Himalaya is already around 1.2 degree Celsius which is perhaps the main cause of accelerated recession in Himalayan glaciers.

Snow cover dynamics varies from western to eastern Himalaya and determine the hydrological regimes of the rivers. In western Himalaya, the monsoon rainfall component is less as compared to snowmelt component. Therefore, deglaciation has a profound impact on the water resources of the western Himalayan rivers. However, in central and eastern Himalaya the seasonal snow cover melt peaks by last week of June, whereas monsoon rains between July and mid-September sustain the flows in the rivers. Hence, a time series of snow-cover extent in Himalaya and discharge patterns are important component for evaluating the future of snow and glacier resources in Himalaya. Database of snowfall distribution, river flows and climate parameters are not available since independence as no system was in place for collecting such basic information. Basic data on climate variables and stream and river flows usually collected by the state or local authorities all over the world and made available to universities and researchers for analysis. Unfortunately, this culture was not established in India as the state and central level organization dealing in water, climate and environment are headed by the babu’s of Indian administrative service: a class not aware about the importance of time series.

The direct implication of green house gas emission and resultant global warming on the glacier environment is melting. Moreover, deglaciation has far reaching implications on both biological and ecological systems. There are different reasons for ice melting. Its repercussions are also different, depending on regional and climatic variables. Flood, sea level rise, fresh water scarcity, threat to fauna and flora are major security implications of deglaciation.

The Himalayan glaciers feed seven of the great rivers of Asia (the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Hu) and ensure a year-round water supply to one billion people. In today’s times, the rivers have shown 3-4% surplus Water due to 10% increase in the melting of the glaciers of the western Himalaya, and the 30% increase in the eastern Himalayan glaciers.

Many glacier lakes dammed by moraines have been created on a glacier terminus in the eastern and central Himalaya where they are nourished by SW monsoon. As a consequence of global and regional warming by ABC, Moraines were formed during the latest neo-glaciation period which happened between 16th and 19th century and are not yet consolidated. Since the moraine is remarkably unstable, a moraine dam is easily destroyed by some disturbance. This abrupt release of lake water generates heavy and sudden floods which cause serious damage, along the river channel downstream. This phenomena is called a glacier lake outburst floods (GLOF). Therefore, an inventory of wetlands across Indian Himalaya should be taken on priority basis and potentially dangerous lakes be identified.

INTRODUCTION

With 59x10^3 km^2 of glacierized area (out of a world total area of mountain glaciers of 540 x 10^3 km^2 (Dyurgerov and Meier, 2005)), the Hindu Kush-Himalaya (HKH) region (including Himalaya, Karakoram and Hindu Kush) is the biggest mountain range on Earth, and the largest ice mass outside of the polar regions. Taking into account that the HKH region is the most populated on Earth (about 50-60% of the world’s population), it is potentially one of the most critical part of the world while considering the social and economical impacts of glacier shrinkage (Barnett and others, 2005). Monitoring the evolution of HKH glaciers is therefore a key issue as their melting may (i) negatively affect regional water supply in the next decade (Barnett and others, 2005), (ii) significantly contribute to ongoing sea level rise (Kaser and others, 2006), and (iii) increase natural hazards linked to glaciers (especially glacial lakes outburst floods) (Mool and others, 2001a and 2001b).

Mountain glaciers are also widely recognized to be sensitive climatic indicators (IPCC, 2001 and 2007). Measuring glacier evolution gives insights into the regional climate change in high and remote places where meteorological measurements are difficult and rare. This is of particular interest in the western Himalaya because the region is influenced...
by two major climatic systems (the mid-latitude westerlies and the south Asian summer monsoon) still poorly known due to logistical difficulties in maintaining observational networks at high elevation. Besides, the occurrence of global warming in this part of the world is still under debate (Yadav and others, 2004; Roy and Balling, 2005).

Observed global average surface temperature trends

The Himalaya is the largest mountain range (33 x10^3 km^2) of the HKH region, but its glaciers are very poorly sampled in the field. One of the most recent and comprehensive global inventories includes only 8 glaciers in India and 3 in Nepal with mass balances measured for at least one year (Dyurgerov and Meier, 2005). Over these 12 glaciers, 4 are smaller than 2 km^2 and the time series are short: 3 glaciers have only one single year of mass balance. Furthermore, the longest series (11 years) is for Langtang glacier (Nepal, 75 km^2) whose mass balance is not surveyed directly in the field but modelled from temperatures and precipitations measured in Kathmandu, 60 km away (Tangborn and Rana, 2000). Consequently, measured mass balance series are shorter than 9 years in India and 4 years in Nepal (WGMS, 2001). Furthermore, the time series are usually old (8 ended before 1990) and no mass balance measurements have been reported since 2000 (Dyurgerov and Meier, 2005). In conclusion, no long-term glacier monitoring network has ever been sustained despite the efforts of the local and international scientific communities (Young, 1993) and this situation is even worse since 2000.

Satellite imagery is now a suitable tool to obtain a comprehensive and more frequent sampling of glacier evolution (e.g. Bishop and others, 2000; Kulkarni and others, 2007) and some remote sensing studies even address the question of glacier mass balance over a few years (e.g. Berthier and others, 2007). Nevertheless, ground measurements are still needed as a calibration and a validation, and because the seasonal and annual mass balances cannot be measured from space. Given the crucial interest of Himalayan glaciers in terms of future water supply, sea level rise and regional climate change, and given the lack of data, starting a long-term monitoring program on a glacier was an urgent need.

Glacier Lakes

The rain and meltwater routing through the glacier system, occasionally, as a result of landslides or movement of a glacier blocks the natural flow-passage of the glacial discharge and impounds water, thereby causing the temporary storage (Ageta, et. al. 2000). With the time the size of the lake may increase. A small seismic activity, landslide, ice calving, snow and rock avalanches result in sudden release of huge amount of water in the stream causing a flash flood downstream. It causes serious damages to infrastructure, to the inhabitants and also to ecosystem and environment in Himalayan region. This phenomenon is known as Glacial Lake Outburst Flood (GLOF), a common geo-hazard in the Himalaya. The formation of such lakes has accelerated in recent years (Yamada T., 1998). The glacier lake inventory of the Nepal and Bhutan Himalaya prepared by the (ICIMOD and UNEP 2000) shows 2315 glacial lakes covering about 5322 km^2 area in Nepal and Bhutan region. Some of these have been formed in the last 50 years and many others in the last decade only. In Garhwal Himalaya, the formation of moraine dammed lake at the glacier snout has been noticed at the Dokriani glacier snout. The lake was first noticed in 2000 and is at the initial stage of taking a threatening shape. The other such GLOF potential sites are at Dhauliganga, Ganga headwater.

Effects of Deglaciation on Water Resources

In the Himalayas, glacier and snow-melt form an important source of water for North Indian rivers. However, this source of water is not permanent as glacial dimensions change with climate. Mass balance was estimated during 2001 and 2002 for 19 glaciers in the basin, suggesting overall specific mass balance value of – 90 and – 78 cm, respectively. The research suggests a loss of 0.2347 km^3 of glacial ice in the last two years. This is likely to pose a serious problem of availability of water to many villages located in the Baspa basin, India. The Himalayan glaciers that feed three of the great river systems of India (the Ganga, Indus, Brahmaputra) and ensure a year-round water supply to more than 500 million people are retreating at a startlingly fast rate. A typical example of glacial retreat is the Gangotri glacier at the head of the River Ganges, which is retreating at a rate of 23 meters per year (Hasnain, et.al.,2004).
Consequent to enhanced retreating and melting of glaciers, water discharge in Garhwal Himalayan rivers is expected to increase by Hasnain, et.al.,2004. to 30% in the subsequent 2 decades, thereafter reducing to approximately ~50% by decade 6 (SAGARMATHA, 2004). Considering, such a grave scenario of deglaciation processes at Garhwal Himalaya and associated future water availability scenarios, the water resource development schemes like interlinking of river channels need to be formulated with due care.

CONCLUSIONS

The Himalaya with its high altitude, unique geographical features, rich wildlife and water resources, plays a major role in the monsoon system of India. The Garhwal Himalaya being the headwater of such important rivers as Bhagirathi, Alaknanda and Yamuna are important in the wake of raising population and growing fresh water demands. But the recent growth in number and size of glacial lakes is believed to be visual evidence of the global warming and consequent enhancement of deglaciation in the region. Such lakes may also pose serious threat to immediate community by generating catastrophic glacier lake outburst floods (GLOF’s), which is a major natural hazard. If current glacier down-wasting trend continues, more potentially dangerous Glacier-snout lakes can be expected to develop. Also, the formation of pools beneath the Gangotri glacier need to be validated as it may lead to sudden dump of the glacier and associated hazards. Hence, it is the need of time to identify the potential GLOF sites in the Garhwal Himalaya, so that necessary action can be taken prior to occurrence of any calamity. Also, it is of urgent need to establish a National Glacier Monitoring Authority to continue to strengthen the research activities on Himalayan glaciers.

REFERENCES