Potential Impacts of Climate Change in the Uttarakhand Himalayas

by Prakash Rao, G.Areendran and Rajneesh Sareen

Global climate change has come to be seen as a major issue confronting the lives of millions of people around the world. Temperature data available since 1000 A.D. indicates that the 20th century was unusually warm and the decade of the 1990s was the hottest on record with six of the warmest years occurring in this last decade. Recent examples of erratic weather patterns have been experienced by humans on a regular basis across the world with the Indian subcontinent being no exception.

The rapid growth in industrialized nations which have followed a fossil fuel based economic developmental path over the past few decades has resulted in an exponential increase in GHG concentrations emitted into the atmosphere.

The recently released Fourth Assessment Reports of the Inter Governmental Panel on Climate Change (IPCC) state that there is now a higher confidence in evidence to show that the Earth has warmed even more since 1,750 because of anthropogenic activities. The IPCC also mentions that over the next century, average surface temperatures are expected to rise between 1-6.3 C depending on various emission scenarios with impacts on health, agriculture, forests, water resources, coastal areas, species and natural areas.

Impacts on high mountain systems including glacial retreat are amongst the most directly visible signals of global warming. One of the most important and visible indicators of climate change is the recession of glaciers in many parts of the World. On a time scale recent glaciations occurred around 20,000 years ago as part of the earth's paleoclimatic history. Although the recession of glaciers has been suggested by some scientists as a natural phenomena, in the later half of 20th century, an increase in the rate of retreat has been observed in most glaciers around the world including the Himalayas.

The Himalayan region has the largest concentration of glaciers outside the polar caps. With glacier coverage of 33,000 sq km, the region is aptly called the "Water Tower of Asia" as it provides around 86,000,000 cubic metres of water annually. These Himalayan glaciers feed seven of Asia's great rivers: the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho and ensure a year round water supply to about one billion people.

The changes in climate variability have led to a rapid retreat of mountain glacier systems which are considered the lifeline of river basins and ecosystems. Scientific studies have shown that 67 % of glaciers are retreating at a startling rate in the Himalayas as a result of various factors including climate change.

While there are no true estimates on the total number of glaciers in the Himalayas, inventories by various institutions including the Geological Survey of India suggest that there are well over 5,000-6,500 glaciers in the Indian part of the Himalayas. For example in the state of Uttarakhand, the four sub-basins of Ganga, Yamuna, Bhagirathi and Alaknanda together constitute nearly 900 glaciers. The Uttarakhand region of the Himalayas in India is a hill state with a rich and diverse natural resource base ranging from pristine deciduous and temperate forests to alpine ecosystems apart from several Himalayan rivers, many of which are glacial fed. The Bhagirathi basin in the State of Uttarakhand has around 238 glaciers which cover a glaciated area of 755 sq km and an

ice volume of 67 cubic km. Some of the important glaciers in the region include the Gangotri, Yamunotri, Dokriani, Pindari and Milam glaciers which form important components of the watershed.

Past work by glaciologists and climatologists have found that the accelerated rate of glacial melt in the some of the important glaciers in Uttarakhand will have serious consequences for the freshwater ecosystems of the Ganga basin, with long term impacts for biodversity, people and livelihoods as well as regional food security. This will not only mean repercussions on the region's agricultural productivity and industrial activity, but also on the Terai ecosystems and species like the Ganga river dolphin.

Case study of the Gangotri Glacier

The Gangotri glacier is the second largest of Indian glaciers and occurs in the Uttarkashi district of Uttarakhand at an altitude of about 4,000 metres. For thousands of pilgrims, the Gangotri Glacier is a sacred spot as a major source of freshwater to the Ganga which flows as the Bhagirathi in its purest form.

In recent times the 30 km long glacier has shown considerable recession (average retreat rate of 20-22 m per annum) which has been a cause of concern for both the scientific community as well as the common public. Recent advances in satellite technology have enabled scientists to monitor changes in glacial retreat patterns using a combination of Remote Sensing satellite imageries. Satellite data has shown that the rate of retreat in the last three decades has been found to be more than three times the rate during the earlier 200 years or so. The recession of the Gangotri glacier and potential impact from climate change has been a subject of much discussion by Indian scientists. Preliminary observations by WWF India using modern technological methods like Differential Global Positioning Systems (DGPS), indicates that the glacier continues to retreat from its earlier position. It is estimated that glacial melt water which has huge relevance to watersheds and catchments in Uttarakhand could affect future water and power generation scenarios.

Gangotri valley (G.Areendran)

Snout of the Gangotri Glacier, Uttarakhand (G.Areendran)

Impacts on water and agriculture

The fertile Ganga region in the Indian subcontinent is bestowed with several important rivers which form part of a larger Ganga basin which has both national and transboundary relevance. The presence of these highly complex river systems indicates the importance of glaciated mountains, which account for most of the glacial melt water. Both glacial

melt water and monsoonal precipitation provide a significant component of water resources for different parts of the country. While snow and glacier melt are the major factors in the western and central Himalayan region, rainfall patterns in the eastern part of India are responsible for the changing water regime.

Recent studies by scientists have tried to determine the impact of deglaciation on the water resources of the Himalayan region through development of a hydrological model which can depict how local water discharges can respond to future climate scenarios. Consequently, these studies have come out with conceptual models which show increased water availability in some river basins and decreased water supplies in other regions in the coming decades. The glacial fed rivers of Uttarakhand are an important resource for the Ganga basin with many rivers contributing to the irrigation potential of some of India's most densely populated states like Uttar Pradesh, Bihar Delhi, Haryana etc.

Impacts on Power

Most of the rivers which originate in Uttarakhand have their upper catchments in snow and glaciated areas and traverse through dense valleys and deep gorges. These perennial rivers are an important source for hydel power generation and also supply water to some of the largest irrigation networks of the world. Any changes in river discharge patterns can have profound impacts on the hydropower potential of this region. There are ambitious plans to exploit more hydel power through several micro and mini hydel projects including run-of-the-river power plants which are seen as environmentally friendly. Current estimates suggest that 194 hydropower plans are proposed in Uttarakhand with a planned power generation capacity of about 18,700 MW. This is in contrast to the existing operational capacity of 2,050 MW of power. Changes in the water regime as a consequence of climate change may lead to concerns about energy security due to investment in hydropower development across the state.

Policy Interventions

In the past few decades, continuous impact on the environmental landscape particularly in Uttarakhand in the form of land use practices (water diversions, deforestation, local agriculture practices, industrialisation etc.) have caused large scale impacts on the watersheds of the region. Climate change is expected to further accelerate the adverse impacts on these regions. There is a need to develop and implement local adaptation strategies in order to cope with the changing climate around us. These include alternate livelihood options, research and use of new and better cropping patterns, use of technology through development of early warning systems etc. Various stakeholders ranging from local communities, to academic institutions, civil society organisations and Government bodies and policy makers need to work in an integrated manner to make their regions "climate ready."

It is also important to mention here the impacts of climate change on water resources and deglaciation that will probably be felt most by local and vulnerable communities. Such impacts may drive the poor and the landless to move to urban areas for better employment opportunities imposing further stress on existing urban planning and development.

References

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WWF India is engaged in a multitude of activities for protection and conservation of the environment in the Indian context. Apart from climate change and energy issues, WWF India also carries out conservation work in areas like forests, freshwater and marine ecosystems as well as focusing on wildlife species of national concern through a participatory approach involving key stakeholders. Through its Environment Education Programme, it aims at strengthening individual and institutional capacity in nature conservation and environmental protection through widespread education and awareness.