Chapter 3
Understanding Glacial Retreat in the Indian Himalaya: Historical Trends and Field Studies from a Large Glacier

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ABSTRACT

One of the most important and visible indicators of global climate change is the recession of glaciers in many parts of the world. The findings of the IPCC Assessment Report (2007) suggest that there has been a significant decline in mountain glaciers and snow cover, which has contributed to the increased sea levels and water flow changes in river basins. In the latter half of 20th century, an increase in the rate of retreat has been observed in Himalayan Glaciers since advent of industrialization. The paper attempts to present a critical review and understanding of the recent changes in retreat of selected Himalayan glaciers from potential climate change. The study explores scientific evidence and analysis of observed data from a large and a small glacier in the Indian Himalaya. This will help in understanding the vulnerability of retreat of the glaciers based on their size. The larger glaciers are unlikely to disappear in the near future, due to its large mass balance and large response time due to climatic changes. Future adaptation needs, research and action for downstream communities, ecosystems and impacts on power sector are discussed.

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INTRODUCTION

The Cryosphere plays a major role in the Earth's climate system by impacting on the surface energy budget, the water cycle, sea level etc. and has control on the physical, biological and social environment over a major portion on the Earth. The cryosphere is most sensitive to temperature change hence capable of providing the most visible signatures of climate change. There are many indicators of climate change like changes in surface temperature, precipitation, extreme weather events, glaciers, ocean and land ice and sea level. Icesheets and glaciers changes are closely related with the global sea level changes impacting the global ocean circulation and marine ecosystems. The warming trend has been reported in the vertical profiles of temperature measured through the entire thickness of mountain glaciers, or through ice sheets climate over recent decades (Lüthi and Funk, 2001; Hoelzle *et al*., 2011). The loss of glaciers and snow cover near populated areas have direct impacts on the livelihood of the local communities in terms of water resources for drinking, agriculture, hydropower etc.

Over the last few decades, changes in climate and local weather conditions have impacted the world's glaciers both in terms of structure and characteristics, reflected in the form of advancement or retreat of glacial snouts (IPCC, 2007; UNEP, 2007). The changes in the length, width, area, volume and mass balance of the glaciers are among the most directly visible signals of global warming and these changes are the primary reasons why glacial observations have been used for climate system monitoring for many years (Haeberli, 1990; Wood, 1990), especially in areas where time series data on climate (mainly temperature and precipitation) is difficult to get and where climate change signals are not yet clear (Yadav et al., 2004; Roy and Balling, 2005). Thirty reference glaciers that have been studied in detail since 1975 show an average annual mass loss of 0.58 metres (m) water equivalent in the past decade, which is four times the rate for the period 1976-85 (UNEP, 2007).The IPCC, 2013 report (The physical science basis) clearly reflects the warming trend on the planet and state that "The last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 while in the Northern Hemisphere, 1983–2012 was likely the warmest 30-year period of the last 1400 years (medium confidence)". Unnatural rates of glacial melting, related to the changing climate, can have serious implications on the hydrology of the associated river systems and consequently on the livelihoods of millions of people who are dependent on these rivers and their ecosystems.(Stern,2007). Overexploitation of water resources and changes in hydrological cycle could be vital to future developmental strategies of the fertile belt of Northern India where agricultural productivity, irrigation etc.is to a large extent dependent on availability of freshwater resources (Mall et al, 2006).

The right approach, thus, in addressing these impacts is to have a better scientific understanding through long-term observations and analysis of the interactions of the different components of the mountain ecosystems with their climate. Then the lager data can be helpful in predicting the future scenarios and utilizing the information to formulate effective adaptation and management strategies. There is also a pressing need for disaster management and rehabilitation policies in areas affected by the glacial retreat, particularly focusing on agriculture, meadows and other livelihood support structures of the local people.

A growing body of scientific knowledge solidly indicates that carbon concentrations are changing the global climate and that there would still be significant changes to the global climate even if emissions would drastically reduce and fall to zero. The world is anticipating a 2°C warming above the pre-industrial level, and this will result in some unavoidable changes, the effects of which need to be understood, especially in fragile and endangered ecosystems. Generating a deeper understanding of the climate impacts on critical indicators such as glaciers are needed as there is inadequate documented scientific evidence

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