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Effect of Climate Change on Himalayan Glaciers

Imtiyaz Jahangir Khan[1]* and Nahal Zahra[2]

[1]*Assistant Professor (SG), Division of Environmental Sciences, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India*

[2]*Research Scholar, Division of Environmental Sciences, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India*

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***Corresponding author:** Imtiyaz Jahangir Khan, Assistant Professor (SG), Division of Environmental Sciences, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar-190025, India, Email ID: ijk_786@rdiffmail.com

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Introduction

The Himalayan region, which spans eight Asian countries, is home to some of the world's largest and most magnificent glaciers, with an estimated 15,000 in total. Each summer, the meltwater created by these glaciers enriches the region's rivers and streams, including some of Asia's largest river systems such as the Indus, Ganges, and Brahmaputra, which provide water to about 500 million people.

Climate change poses significant challenges to the Himalayan glaciers, which are crucial freshwater sources for millions of people in Asia.

Since the industrial revolution, carbon dioxide and other greenhouse gas emissions have boosted temperatures, particularly in the poles, and as a result, glaciers are rapidly melting, calving into the sea and retreating on land.

In recent years, climate change has caused glaciers to shrink and retreat, as well as an increase in the size and quantity of glacial lakes, hence increasing the frequency of GLOFs. These climate changes will eventually affect the lives and property of mountain people.

Impacts on Himalayan Glaciers

Hydrological changes

Climate change alters precipitation patterns, leading to shifts in the timing and amount of snowfall and rainfall in the Himalayas. Warmer temperatures cause earlier snowmelt, affecting river discharge and water availability downstream. Changes in glacier meltwater contributions impact seasonal water availability for agriculture, hydropower generation, and ecosystems.

Glacial retreat

Rising temperatures accelerate the retreat of Himalayan glaciers, with significant variations across regions. Glacial melt rates have increased in recent decades, contributing to sea-level rise and altering river flow dynamics. The loss of glacier mass reduces water storage capacity, affecting river flow patterns and sediment transport downstream.

Glacial retreat in India

Previous investigation on a few glaciers in the Indian Himalaya shows that the majority of the glaciers have been retreating irregularly since the end of the glacial era. Of these, Vohra [1] found that the Siachen and Pindari Glaciers receded at rates of 31.5 and 23.5 meters year, respectively. The Gangotri Glacier (Figure 1) is receding 18 meters a year on an average. Based on their observations of the Milam Glacier in the Kumaon Himalaya, Shukla & Siddiqui [2] estimated that between 1901 and 1997, the ice receded at an average annual rate of 9.1 meters. It is observed that the Dokriani Bamak Glacier's moving snout in the Garhwal Himalaya recorded a 586-meter retreat from 1962 to 1997.

Annually, the average retreat was 16.5 meters. Matny [3] discovered that Dokriani Bamak Glacier had receded by 20 meters in 1998 as opposed to 16.5 meters on average during the preceding 35 years.

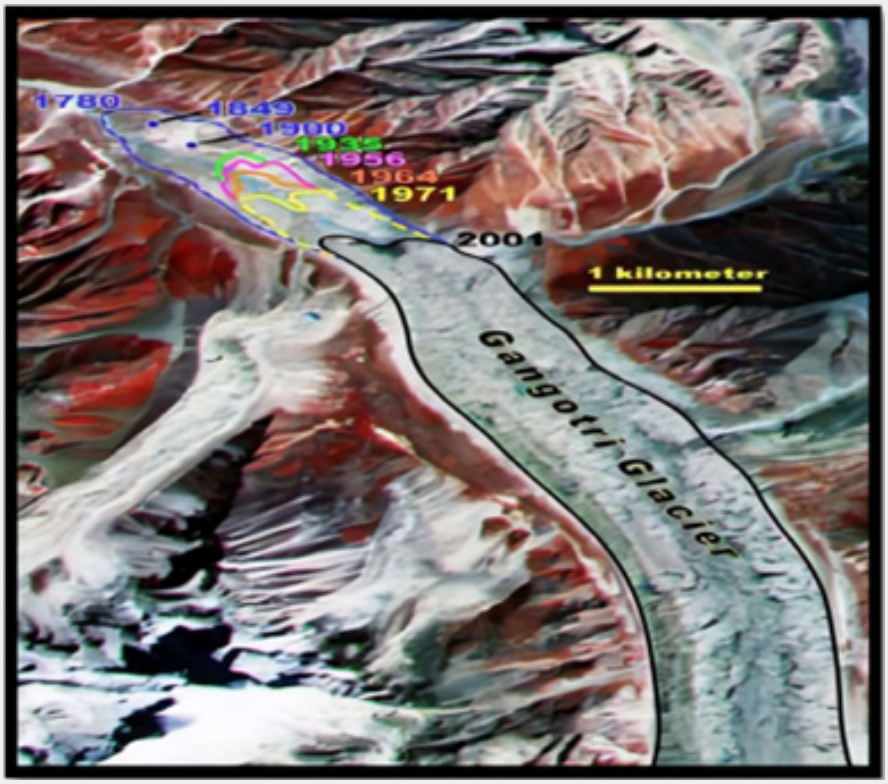

Figure 1: Retreat of the Gangotri Glacier snout during the last 220 years (Source: Jeff Kargel, USGS).

The Gara, Gor Garang, Shaune Garang, Nagpo Tokpo, and Geological Survey of India [1] studied the glaciers in the Satluj River Basin and found an average retreat of 4.22-6.8m/year. In the Chenab River Basin, the glaciers Bara Shigri, Chhota Shigri, Miyar, Hamtah, Nagpo Tokpo, Triloknath, and Sonapani receded between 6.81 and 29.78m/year. The Bara Shigri Glacier and the Chhota Shigri Glacier experienced the greatest and lowest retreat, respectively.

Kulkarni and associates discovered that between 1963 and 1997, Janapa Glacier receded by 696 meters, Jaya Garang by 425 meters, Naradu Garang by 550 meters, Bilare Bange by 90 meters, Karu Garang by 800 meters, and Baspa Bamak by 380 meters (Figure 2). Furthermore, they noted that from 1962 to 2000, the Parbati Glacier in the Kullu District experienced a massive 6.8km (178m/year) glacial retreat. In the last 39 years, they found that, overall, 19% of the glaciated area and 23% of the glacier volume had receded.

Contrary to the 1962 topographic map produced by the Survey of India, which placed the snout of Shaune Garang Glacier at an altitude of 4360masl, the 1999 field survey determined the snout to be at an elevation of 4460masl. This indicates a 100-meter vertical shift and a 1500-meter horizontal shift over 37 years. These findings also imply that the Himalayan snow-glacier melt and runoff pattern have been impacted by global warming. One of the best illustrations of glacier retreat is seen in Gangotri Glacier, where the Gangotri Glacier's nose has continuously moved upward by roughly 2 km between 1780 and 2001.

Downstream implications

The impacts of glacier retreat extend beyond the mountains, affecting communities dependent on glacial meltwater. Changes in river flow variability can lead to water scarcity or flooding, impacting agriculture, urban settlements and biodiversity. Hydroelectric power generation, reliant on consistent water flow, faces challenges due to fluctuating water availability.

Socioeconomic and environmental consequences

Communities relying on glacier-fed rivers face socioeconomic vulnerabilities due to uncertain water availability and changing river dynamics. Shifts in agricultural practices, loss of biodiversity and increased risk of natural disasters (e.g., glacial lake outburst floods) pose challenges to sustainable development in the region.

Adaptation and mitigation strategies

Efforts to mitigate climate change and adapt to its impacts are crucial for Himalayan communities. Adaptation strategies include improving water management practices, enhancing early warning systems for natural hazards, promoting climate-resilient agriculture, and investing in renewable energy to reduce carbon emissions [4,5].

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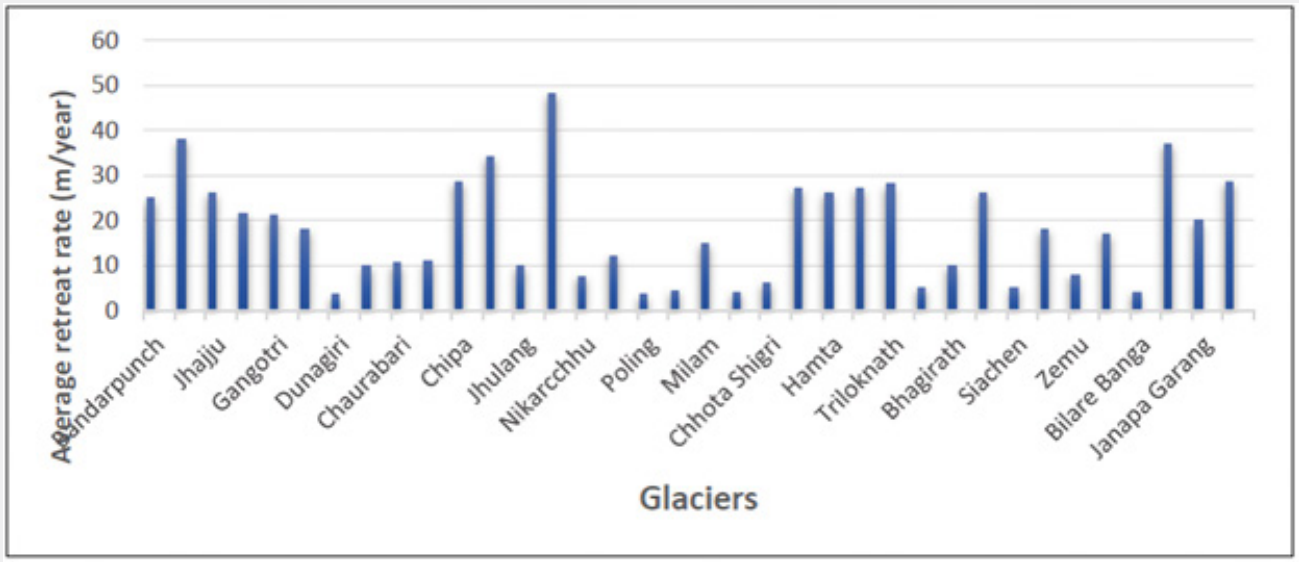

Figure 2: Graph representing the average retreat rate of some important Himalayan glaciers.

Conclusion

During the last 30 years there has been a **5.5%** shrinkage in volume of glaciers in China and similar results are also shown in Nepal, India and Bhutan. Valley Glaciers and small glaciers are retreating faster. The impacts of climate change on Himalayan glaciers are profound and wide-ranging, affecting water resources, ecosystems and human livelihoods. Urgent global action is needed to mitigate climate change and support adaptation efforts in vulnerable mountain regions. Understanding these impacts is essential for developing effective strategies to safeguard the Himalayan glaciers and the communities that depend on them.

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