Snout fluctuations of Gangotri and Kafani Glaciers (Uttrakhand Himalaya) from Satellite and GPS Observations During 1976-2009

Rajesh **Kumar**[1] and Ramesh P. **Singh**[2],
[1]*Remote Sensing Division, Birla Institute of Technology Extension Centre Jaipur, 27, Malviya Industrial Area, Jaipur- 302 017, Rajasthan, INDIA*
(e-mail: rajeshbhu@yahoo.com, Phone: +91-99288 60642)
[2]*Department of Physics, Computational Science and Engineering, Schmid College of Science, Chapman University, One University Drive, Orange, CA 92866, USA*
(e-mail: rsingh@chapman.edu)

The Himalayas cover approximately 33,000 sq km of glacierised area, snow and glaciers are the sources of water for more than 1.3 billion people. During the last few decades, changes in climate and local weather have impacted the world's glaciers in terms of length, width, area and volume. These changes of the glaciers are among the directly visible signals of global warming and being used for the climate system monitoring especially in areas where long term climate data is not available.

In the present work which is a joint research by BITEC, Jaipur and WWF-India, we will discuss the snout observations of Gangotri and Kafani glaciers of Uttrakhand Himalaya during 1976–2009 based on the satellite data and GPS observations. The comparisons of the satellite imageries clearly show the retreat of glaciers. The recent GPS observations during 2007–09 also support a small retreat of glaciers. During 1976-2009, the average retreat rate was found to be about 17.59 m/year, which has come down to 6.02 m/yr during 1999-2006. The recent GPS observations during 2006–09 show a retreat rate of 13.82 m/year which is found to be lower than overall average retreat rate (17.59 m/yr). Apart from the shifting of snout, the Gangotri glacier area is found to be reduced by 15.5 sq km during 1976-2006 with an average loss of 0.51 sq km per year. Similarly Kafani glacier has shown an average retreat rate of 15.7 m/year between 1976 and 2009 while the retreat rate has reduced to 10.61 m/year during 1990-99 and slightly increased to 12.99 m/year between 1999 and 2006. The GPS observations during 2006–09 show a retreat rate of 10.97 m/year which is still lower than the long term average retreat (15.7 m/yr). Apart from the snout retreat, the Kafani glacier has also lost a large ice volume from its glaciated catchments. The overall loss in the glaciated area of Kafani and its tributaries glaciers during 1976 to 1999 is 17.5% (main trunk), 29% (tributary 1) and 23% (tributary 2), respectively. The snout fluctuations and retreat of glaciers will also be discussed in view of the air, skin and tropospheric temperature derived from satellite data.

Keywords: Himalaya, Glacier, Snout retreat, climate change, global warming GPS, Gangotri, Kafani