

## Recession Rate of Gangotri and Its Tributary Glacier, Garhwal Himalaya, India through Kinematic GPS Survey and Satellite Data

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**Abstract :** In order to reconstruct past retreating rates, total area loss, volume change and shift in snout position were measured through multi-temporal satellite data from 1989 to 2016 and kinematic GPS survey from 2015 to 2016. The results obtained from satellite data indicate that in the last 27 years, Chaturangi glacier snout has retreated  $1172.57 \pm 38.3$  m (average  $45.07 \pm 4.31$  m/year) with a total area and volume loss of  $0.626 \pm 0.001$  sq. Km and  $0.139$  Km<sup>3</sup>, respectively. The field measurements through differential global positioning system survey revealed that the annual retreating rate was  $22.84 \pm 0.05$  m/year. The large variations in results derived from both the methods are probably because of higher difference in their accuracy. Snout monitoring of the Gangotri glacier during the ablation season (May to September) in the years 2005 and 2015 reveals that the retreating rate has been comparatively more declined than that shown by the earlier studies. The GPS dataset shows that the average recession rate is  $10.26 \pm 0.05$  m/year. In order to determine the possible causes of decreased retreating rate, a relationship between debris thickness and melt rate was also established by using ablation stakes. The present study concludes that remote sensing method is suitable for large area and long term study, while kinematic GPS is more appropriate for the annual monitoring of retreating rate of glacier snout. The present study also emphasizes on mapping of all the tributary glaciers in order to assess the overall changes in the main glacier system and its health.

**Keywords :** Chaturangi glacier, Gangotri glacier, glacier snout, kinematic global positioning system, retreat rate

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