APPLICATION OF GLABTOP MODEL ON FOUR NEPALESE GLACIER FOR ESTIMATING GLACIER ICE THICKNESS DISTRIBUTION AND BED TOPOGRAPHY, EVEREST REGION, NEPAL

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ABSTRACT

This paper provides the application of computer based software model for estimating the ice thickness, volume and bed topography of four Nepalese Himalayan glacier. Information of ice thickness and volume is essential for present glacier status, future water availability and glacier evolutions. Due to harsh topography, climatic condition, remoteness there is limited information on ice thickness and volume by direct glaciological and geophysical investigations. Generally area volume scaling approach based on empirical relation uses surface area and thickness to estimate ice reserves. Glacier bed Topography (GlabTop) Model applied in this study is a good approach, implemented in ESRI ArcGIS using Digital Elevation Model (DEM), glacier outline and branch lines relating with surface slope, elevation difference, shape factor and basal stress to estimate spatial ice thickness distribution, volume and approximation of bed topography. The GlabTop model is applied on Mera Glacier in Hinku Valley to estimated ice thickness and then compared with field data measured by ground penetrating radar which shows ± 25 % uncertainty in estimated ice thickness. The model is then applied on Imja, Khumbu and Ngozumpa Glaciers of the Everest region. The ice thickness spatially distributed in all studied glaciers is ~ 0 – 60 m at the glacier outline or moraine to ~ 509 m in the lower flat region of glacier valley at an elevation range of 4500 – 5500 m a.s.l., at higher altitude the estimated ice thickness is shallower. The bed topography reveals that there is no large over deepening or possible sites for the formation of large lakes after glacier retreats except in Ngozumpa Glacier, where as in Imja Glacier, existing glacier lake can further expand up to ~ 4 km in the Lhotse Shar Glacier and ~ 2.5 km in the Imja Glacier. More than 65 % of total ice is stored relatively on flat glacier valley. Sensitivity analysis is performed by modifying the two scaling parameters, shape factor by ± 0.1 and basal stress by ± 30 kPa. The model performed very well when shape factor is 0.8 and basal stress is 150 kPa (1.5 bar)

while comparing with field investigated ice thickness data. This GlabTop model though has an uncertainty of ± 20 - 30 %, it estimates ice thickness and approximates bed topography crudely in cost effective ways. This model thus proves to be very useful to fill the large data gap prevalent in ice thickness distribution and volume in the Himalayan region.

KEYWORDS: Glacier ice thickness, ArcGIS, GlabTop Model, Bed topography