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The satellite observed glacier mass changes over the Upper Indus Basin during 2000–2012

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Decadal glacier thickness changes over the Upper Indus Basin in the Jammu and Kashmir Himalaya were estimated using the TanDEM-X and SRTM-C Digital Elevation Models (DEMs) from 2000 to 2012. In the study area 12,243 glaciers having $19,727 \pm 1,054 \text{ km}^2$ area have thinned on an average of $-0.35 \pm 0.33 \text{ m a}^{-1}$ during the observation period. The highest thinning of $-1.69 \pm 0.60 \text{ m a}^{-1}$ was observed in the Pir Panjal while as the marginal thinning of $-0.11 \pm 0.32 \text{ m a}^{-1}$ was observed for the glaciers in the Karakoram. The observed glacier thickness changes indicated a strong influence of the topographic parameters. Higher thickness reduction was observed on the glaciers situated at lower altitudes ($-1.40 \pm 0.53 \text{ m a}^{-1}$) and with shallower slopes ($-1.52 \pm 0.40 \text{ m a}^{-1}$). Significantly higher negative thickness changes were observed from the glaciers situated on the southern slopes ($-0.55 \pm 0.37 \text{ m a}^{-1}$). The thickness loss was higher on the debris-covered glaciers ($-0.50 \pm 0.38 \text{ m a}^{-1}$) than on the clean glaciers ($-0.32 \pm 0.33 \text{ m a}^{-1}$). The cumulative glacier mass loss of $-70.32 \pm 66.69 \text{ Gt}$ was observed during the observation period, which, if continued, would significantly affect the sustainability of water resources in the basin.