EGU21-11598
https://doi.org/10.5194/egusphere-egu21-11598
EGU General Assembly 2021


# Interrelationships among mass balance, meteorology, discharge, and surface velocity on Chhota Shigri Glacier over 2002-2019 using in-situ measurements

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Interrelationships among mass balance, meteorology, discharge, and surface velocity on Chhota Shigri Glacier over 2002-2019 using in-situ measurements

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The Himalayan glaciers contribute significantly to regional water resources. However, limited field observations restrict our understanding of glacier dynamics and behavior. Here, we investigated the long-term in-situ mass balance, meteorology, ice velocity, and discharge of the Chhota Shigri Glacier over the past two decades. With 17 years of uninterrupted glacier-wide mass balance datasets, Chhota Shigri Glacier is one of the most studied glaciers in the Hindu-Kush Himalayan region in terms of mass balance record. The mean annual glacier-wide mass balance was negative, -0.46±0.40 m w.e. $a^{-1}$ during 2002-2019 corresponding to a cumulative wastage of about -8 m w.e. Mean winter mass balance was 1.15 m w.e. $a^{-1}$ and summer mass balance was -1.35 m w.e. $a^{-1}$ over 2009-2019. Surface ice velocity has decreased on average by 25-42% in the lower and middle ablation zone (below 4700 m a.s.l.) since 2003; however, no substantial change was observed at higher altitudes. The decrease in velocity suggests that the glacier is adjusting its flow in response to negative mass balance. The summer discharge begins to rise from May and peaks in July, with a contribution of 43%, followed by 38% and 19% in August and September, respectively. The discharge pattern closely follows the air temperature. The long-term observation on the Chhota Shigri — a benchmark — glacier, shows a mass wastage that corresponds to the

glacier’s slowdown in the past two decades.