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Current and future glacier and lake assessment in the deglaciating Vilcanota-Urubamba basin, Peruvian Andes

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Abstract

Glacier shrinkage is a strong driver of change for mountain hydrology and landscape development and bears multiple risks as well as new options for human livelihoods. In the tropical Andes, current rates of glacier loss are investigated to some point but associated future extent of both vanishing glacier and forming lake areas and volumes are poorly explored. This study combines an analysis of current (1988–2016) and future (2050/2100) glacier and lake development in the Vilcanota-Urubamba basin (Cusco, Southern Peru). Total glacier area (volume) decreased by 37.3% (20.5%) from 226.1 km2 (8.122 km3) in 1988 to 141.7 km2 (6.457 km3) in 2016. Adjacent lakes increased in area (number) by 15.5% (18.3%) from 23.3 km2 (460 lakes) in 1988 to 26.9 km2 (544 lakes) in 2016 while corresponding lake volume has grown by 9.7% from 0.637 km3 to 0.699 km3, respectively. High spatiotemporal variability can be observed in the basin, with strongest glacier shrinkage in the lower lying northwest (Cordilleras Urubamba and Vilcabamba) and highest growth and lake extent in the Altiplano region of the southeast (Cordillera Vilcanota and Quelccaya ice cap). Future glacier areas could substantially decrease between 40.7% (RCP2.6) and 44.9% (RCP8.5) within the next decades (2031–2060) and between 41.4% and 92.7%, respectively, within this century (2071–2100). Hence, Andean landscapes would transform into mostly glacier-free areas with some remaining ice-covered summits over ~6000 m asl. and this would imply a loss of permanently stored water of several km3. Until the end of this century, important future lake areas could develop and continue to grow between 3.2% (RCP 2.6) and 6.0% (RCP8.5) with an associated volume increase of 0.032 km3 (4.6%) and 0.041 km3 (5.9%), respectively. Our current baseline and future projections suggest that a decrease of glacier shrinkage is also followed by a slowdown in lake formation and particularly volume growth which might have already developed or occur in the near-future. Under the depicted scenarios of change, strong emphasis needs to be promptly put on feasible water management and storage options as robust adaptation measures tackling high uncertainties, risks and complex hydroclimatic and socioenvironmental intertwining.