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Tracing the impact of climate change since 1960s on the south slope of Mt Everest (central southern Himalaya) on glaciers, lakes and river disharge

Gianni Tartari (1,3), Franco Salerno (1,3), Sudeep Thakuri (1,4), Nicolas Guyennon (2), Gaetano Viviano (1), and Claudio Smiraglia (4)

(1) National Research Council, Water Research Institute, Brugherio (IRSA -CNR), Italy, (2) National Research Council, Water Research Institute, Roma (IRSA-CNR), Italy, (3) Ev-K2-CNR Commitee, Bergamo, Italy , (4) Department of Earth Sciences "Ardito Desio", University of Milan, Italy

We contribute to the debate on the impact of climate change in Himalaya by analyzing the glaciers, lakes and river discharge in southern slopes of Mt. Everest. We present here a complete analysis from ‘60s to todays using all available optical satellite imagery and a discharge time series monitored by the Nepali Department of Hydrology and Meteorology (DHM).

We found an overall surface area shrinkage of 13.0±3%, an upward shift of the Snow Line Altitude (SLA) of 182±9 m, a terminus retreat of 403±9 m, and an increase of the debris coverage of 17.6±3%. The recession process of glaciers has been relentlessly continuous over the past fifty years. Furthermore, since the early 1990s, we have observed an acceleration of the surface area shrinkage, which resulted in a median annual rate double that of the previous three decades (an increase from 0.27% a-1 to 0.46% a-1). Comparing the SLA over the same periods, it shifts upward with a velocity almost three times greater (from 2.2±0.5 m a-1 to 6.1±0.9 m a-1), which points to a worsening of the already negative mass balance of these glaciers. However, the increased recession rate has only significantly affected the glaciers with the largest sizes, which are located at higher altitudes and along the preferable south-oriented direction of the monsoons. Moreover, these glaciers present median upward shifts of the SLA that are double the others; this finding leads to the hypothesis that the Mt. Everest glaciers are shrinking, beyond that due to warming temperatures, as a result of the weakening Asian monsoon registered over the last decades. However the shrinkage of these glaciers is less than that of others in the Himalayan range. Their high elevations have surely reduced the impact of warming, have not been able to exclude these glaciers from a relentlessly continuous and slow recession process over the past fifty years.

As regards the glacial lakes, using the same satellite imagery considered for glacier surfaces, we have analysed even the lakes behavior. We observed that since ‘90s more and more lakes, without glacier surfaces in their basin, are appearing over 5200 m a.s.l., unmistakable signal of permafrost melting.

Concerning the impact on river hydrology, we find for the 1964-2011 period a non-significant increased flow the Dud Koshi River (3000 km2) during the summer and a decreased trend in winter. The winter decrease may be due to reduced precipitation, while the summer increase is not congruent with a decrease in precipitation. So to offset this lower input must match a meteoric rise in the summer glacial melt, even if as has been highlighted in the study of climate trends, it should not be due to the increase of summer temperatures (radiation?). We also observed that the flow rate shows from the ‘60s to today, and the most obvious way from the ‘90s, the creation of a second peak in the monsoon period. This evidence is also confirmed by the analysis of other discharge series located in the region.