Submitted Abstract

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Abstract

This work is focused on the impact of climate change on slope stability by analysing a dataset of 392 slope instability events documented from 2000 to 2020 at high elevation (above 1500 m asl) in the Italian Alps (doi.org/10.1594/PANGAEA.931824). At present, this is the most comprehensive dataset of slope failures occurred at high elevation in the Italian Alps in the last two decades. For this work, we analysed the dataset with the aim of 1) recognizing trends of slope failure occurrence; 2) highlighting the different susceptibility to instability of slopes with specific geomorphological characteristics and 3) investigating how climate change may have affected the occurrence of slope instability at high altitude. To address these questions, spatial and temporal analyses were performed using GIS and statistical software. We applied inferential statistic tests such as Man-Kendall test and Pettit test (in comparison with other non-parametric tests).

Interestingly, spatial and temporal analyses highlighted a positive linear trend both in the annual frequency of slope instability events throughout the Italian Alps for the considered period, with a break point in the series in 2011, and in the annual temperature series, especially minimum temperatures. North-facing slopes over 2000 m asl resulted to be more susceptible to instability. In addition, the seasonality of slope failure occurrence depends on the altitude. Between 1500 and 2000 m asl, two maxima were detected respectively in May and October, while at higher altitudes a single maximum was observed in August. Finally, there was a clear trend towards an increase in instability events on slopes in permafrost conditions, compared to a substantial stationarity in the number of events for slopes without permafrost: in particular, the increase is more rapid in the period 2011-2020 compared to the period 2000-2010, with a break point in the series in 2012.

The outcomes of the present work provided further evidence that climate change is causing an increase in the frequency of instability events on high-altitude slopes. Further studies, including the implementation of the dataset of events and the test of new data analysis methods, are needed to deepen the knowledge on the processes that cause the instability of high altitude slopes and on the role of predisposing and triggering factors, and in particular of climate change, allowing to define hazard scenarios.