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A new rock glacier inventory of the Lombardy, Central Alps, Italy

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The Lombardy Alps, with a surface of 2148 km^2 above 2000 m a.s.l. (9% of the total) represents an important portion of the southern side of the orogen. For encompassing a variety of tectonic and climatic regimes, they represent an interesting area to examine environmental controls on periglacial processes. Today, technological developments in remote sensing techniques allow us to study periglacial landforms with increasing detail. We present a new inventory for the whole Lombardy Alps in which we identify and classify rock glaciers and protalus ramparts. The inventory has been conducted by combining a number of remotely-sensed images with field traverses. Specifically, the interpretation of high-resolution (0.5 x 0.5 m) digital aerial photos (2000, 2003, 2007) and a 2 m*2 m Digital Surface Model that cover the whole region has allowed inventorying a greater number of relevant landforms when compared to prior regional efforts. Measurements and photographs taken during fieldwork provided critical ground control for the validation of data extracted from remotely-based analysis. Rock glaciers have been mapped in GIS polygons. The inventory follows the specifics detailed by Scapozza and Mari (2010), with some additional information adapted from the PermaNET evidences guidelines (Cremonese et al., 2011). Landform attributes include, geographic coordinates, mountain sector, type, activity, area, elevation (min, max and mean), slope gradient, slope aspect, dominant lithology, vegetation at the front, and upstream presence/absence of a glacier.
In total, we identify 1734 periglacial landforms covering a surface of 81,5 km^2 (0,34% of the region). In terms of activity, the inventory includes 673 (39%) intact classified and 1061 (61%) relict landforms. The most common landform typology is the talus-lobate (931, 54%) followed by talus tongue-shaped (436, 25%) and protalus ramparts (232, 13%). Minimum elevation, often considered a good approximation of discontinuous permafrost lower limit, sets respectively at 2590 m a.s.l. and 2200 m a.s.l. for intact and relict types. The majority of the inventoried landforms sits within the 2000-2500 m (53 %) and 2500-3000 m (39%) elevations belts. In order to explore potential lithologic controls on rock glacier abundance, we calculate surface ratios across major lithological categories. This attribute for a given lithology is the ratio between the combined surface of the inventoried landforms and the relevant terrain surface over the 1460 m a.s.l. (i.e. minimum elevation of the lowest relict rock glacier).
Higher rock glacier densities are found in intrusive (0.032) and metamorphic (0.031) rocks, followed by extrusive (0.017) and sedimentary ones (0.012).

This inventory represents a necessary preliminary step for modelling the spatial distribution of permafrost at the regional scale. We believe the inventory integrates well with prior and ongoing research on the cryosphere of the Alps. In particular, our research effort fills a strategic geographic gap in the context of the PermaNET initiative.

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