



Thermal and morphological characteristics and spatial distribution of rock glaciers in the Cordillera Chila, southern Peru

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Climate change generates important impacts in high mountain regions, and tropical glaciers are particularly affected due to their high sensitivity to climatic changes. Peru hosts 71% of the tropical glaciers worldwide, and glacier changes are well documented in the country. Information on rock glaciers, however, is very scarce and hardly any research in this field exists, and no systematic overview of characteristics of rock glaciers in Peru has been produced so far. Nevertheless, in southern Peru, rock glaciers represent important landscape elements and valuable indicators of permafrost.

The Cordillera Chila is part of the high mountain ranges in the southern region of Peru, in the administrative region of Arequipa, bordering the provinces of Castilla and Caylloma (extending from S 15°39'41.36" to S 15°09'29.37" and from W 72°24'10.03" to W 71°27'13.20"). For this study we applied Geographic Information System and satellite remote sensing, including Sentinel 2 images, and further images from GoogleEarth, ALOS Palsar corrected DEM data (12.5m), the SRTM DEM (90m) and WorldClim data (1970-2000) at 1 km².

Our mapping indicates 0.19 km² of glacier and 3.0 km² of rock glacier area. Preliminary results further indicate that the rock glaciers are located in thermal ranges between -1.31°C and 2.5°C, indicating that 75% of the rock glaciers are in a thermal range of -1.31°C and 1°C, with an average elevation of 4734 m asl to 5479 m asl, and an average slope between 25° and 57°. The aspect is predominantly SE to S. Morphologically, the rock glaciers show lobate-like forms, tongue shaped and piedmont type rock glacier. Furthermore we classified the rock glaciers into active, non-active and fossil ones.

This first systematic rock glacier study represents an initial but important basis for permafrost research, a widely unexplored field of research in Peru: it provides indications for the spatial distribution including the lower elevation of permafrost in southern Peru which also serves to better constrain permafrost models and assessments for e.g. slope stability problems and hazards. Furthermore, rock glaciers contain substantial ice and thus water reserves which may represent a source of water in arid regions such as in southern Peru with very low surface water runoff. Further research on rock glaciers and permafrost are planned in Peru in national and international programmes.