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Rock avalanche occurrence in the San Juan province (Argentina): an analysis of their spatial distribution and main forcing factors

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Rock avalanches are frequent phenomena in the Argentinean Andes and a particular high concentration of these events is observed in the Northwest (∼25°S) and in the Central Andes from 30°S until the transition with the Patagonian Andes (∼38°S). Tectonic deformation and seismicity are generally proposed as main driving factors, with weather and lithologic conditions playing a subordinate role.
From 28°S to 33°S, the subhorizontal subduction of the Nazca plate drives higher shortening rates than in the surrounding areas, and an intense seismicity. Main morphotectonic units in this regions are the Cordillera and Precordillera, separated by the Barreal-Calingasta depression. In the southern central part of the flat subduction area (30°30'°-32°30'S), it is observed high valley incision and maximum local relief of 2900 m, while in the Precordillera main fluvial courses developed in the inter-thrust valleys, where local relief is up to 2400 m. In both mountain ranges, we recognized 34 rock avalanches deposits with volumes up to 0.3 km3. There is no apparent lithologic control on detachments, which involved sedimentary, volcanic and granite rocks, even though ∼20% of them were favored by layering orientation. However, about 50% of the inventoried rock avalanches with the greatest volumes, developed along tectonic structures or less than 1 km far from them.
The main objective of the present study is to explore the spatial distribution of rock avalanche deposits, and compare it with the instrumental seismicity and landscape conditions by means of statistical tools (e.g. exploratory data analyses, Ripley's K-function). Those analyses allow to highlight the spatial correlation between the geological events. Moreover, to visually display the detected cluster spatial patterns we elaborated kernel density maps. Our findings revealed that most of the rock avalanches show a high spatial aggregation mainly between 31°20'S-31°50'S. Main concentration of bedrock landslides spatially correlates with the area of greatest seismicity, coincident with an anomaly in the subducted plate due to the presence of the Juan Fernandez Ridge.