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Modelling the impact of a GLOF scenario at Parón lake, Cordillera Blanca, Perú, using a novel multi-phase topographical and geological procedure

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The Cordillera Blanca is undergoing rapid deglaciation due to climatic warming, especially since the late 20th century. This process has resulted in the formation of new glacial lakes and an increase in the volume of existing lakes, some of which pose a risk in the form of Glacier Lake Outburst Floods (GLOF); such as Parón lake in the Cordillera Blanca, which represents a significant hazard to the Caraz city and smaller populations located in the Llullán-Parón sub-basin. Here, we model a potential dam breach and GLOF generation scenario at Parón lake using a novel numerical modelling procedure that, amongst other factors, considers the geological structure of the natural dam. Overall, this procedure includes four distinct phases: (1) estimation of the potential for ice avalanche impact on Parón lake sourced from surrounding glacial cirques; (2) modelling of subsequent impulsive wave generation and propagation; (3) analysis of the hydraulic parameters of a possible breach of the natural dam, considering the non-erodible material within empirical estimations of the hydrograph where the composition of the dam is interpreted based on surface geological mapping and drill sampling carried out in the area; and (4) simulation of a potential GLOF using the FLO-2D model with input data from the previous phases. Modelling results indicate that Parón lake is most at risk from ice avalanches that originate from the adjacent Hatunraju glacier and that such events have the potential to generate impulse waves that could initiate erosion and a subsequent breach of the natural dam. Considering a worst-case ice avalanche scenario, our results indicate the potential generation of a GLOF with average peaks flow of 25,264.22 m^3/s. This GLOF event would reach the urban area of the Caraz city in around 36 - 42 minutes with now rates and flood heights fluctuating between 11.2 m/s to 22.4 m/s and 9.9 m to 19.7 m, respectively.