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History and current safety measures at Laguna Palcacocha, Huaraz, Peru

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Laguna Palcacocha is a large glacier lake in the Cordillera Blanca, Peru, located in the Quillcay catchment, above the city of Huaraz, the local capital. On 13 December 1941, the moraine dam lake collapsed, probably after having been impacted by a large ice avalanche, and triggered a major outburst flood. This GLOF destroyed about a third of the city of Huaraz, causing about 2,000 casualties and is therefore one of the deadliest glacier lake outbursts known in history.

In 1974, the Glaciology Unit of Peru, responsible for the studying, monitoring and mitigation works related to glacier hazards installed a reinforcement of the natural moraine dam of the newly filled Laguna Palcacocha, with an artificial drainage channel at 7 m below the crest of the reinforced dam. At that time, the lake had an area of 66,800 m^2 and a volume of 0.5 x 10^6 m^3.

During the past decades, in the course of continued glacier retreat, Laguna Palcacocha has undergone an extreme growth. In February 2016, the lake had an area of 514,000 m^2 (7.7 times the area of 1974) and a volume of more than 17 x 10^6 m^3 (more than 34 times the volume of 1974). At the same time, the city of Huaraz, located 20 km downstream of the lake, grew significantly after its almost complete destruction by the 1970 earthquake. Today, about 120,000 people are living in the city. Due to the persisting possibility for large ice avalanches directly above the Palcacocha lake, this constitutes a high-risk situation, requiring new hazard and risk mitigation measures.

As an immediate temporal measure, in order to bridge the time until the realization of a more permanent measure, a syphoning system has been installed in 2011, using about ten 700-m pipes with a 10-inch (25.4 cm) diameter. The aim of this syphoning attempt is to lower the lake level by about 7 m, and therefore reduce the lake volume on the one hand, and also reach a higher dam freeboard. However, the system is less effective than assumed, currently the lake level can be reduced by about 4 m below the artificial draining tunnel during the dry season (austral winter, June, July, August), but during the wet season (austral summer, December, January, February), the lake refills to the level of the drainage tunnel. Preparation works and preparatory studies for a more permanent construction are currently ongoing, since 2015 a 12-km access road to Laguna Palcacocha is being built to make the site accessible for construction machines.

These structural measures are complemented by non-structural risk reduction measures. A communication system between the lake and the city has been established by radio and satellite phone, and six persons are permanently located at the lake site in order to maintain communication and the syphoning system. In parallel, efforts are currently undertaken to design and implement a technical early warning system, complementing this human monitoring system.