

Palcacocha icefalls demonstrate hazard vulnerabilities in Peru

June 13 2017, by Ben Orlove



Glacier front subject to calving, Lake Palcacocha. Credit: Jeff Kargel

In the last week, calving events at Lake Palcacocha in the Peruvian Andes released masses of ice from a glacier on Mount Pucaranra. The ice fell into the lake, sending waves across the lake that destroyed

infrastructure designed to prevent dangerous outburst floods. Fortunately, the waves were not high enough to overtop the moraine dam and send floodwaters downstream, where they could have taken many lives and damaged urban infrastructure. A glacial lake outburst flood from Palcacocha devastated Huaraz, the largest city in the region, in 1941, killing about 5,000 people. Other, more recent, glacier floods in the region have also been very destructive.

Marco Zapata, the director of glacier research at INAIGEM, the Peruvian National Institute of Research on Glaciers and Mountain Ecosystems, spoke about the events recently in a press conference reported in the Peruvian daily El Comercio. A Spanish-language video of the full press conference is available [online](#).

Zapata indicated that the calving event occurred around 8 p.m. on May 31. The resulting waves, three meters in height, were strong enough to move and damage ten large pipes, rendering them inoperable. These pipes, known locally as "syphons," are designed to draw water from the lake at times when its level is high; in this way, they were thought to reduce flood risk significantly. They had been a point of local pride, seen as a successful application of modern technology to protect against the dangers to which the region has long been subject.

Zapata mentioned that the waves also destroyed several gauges and a sensor which measures lake levels. And the event was not an isolated one, at least according to a regional newspaper, which [reported](#) a second calving event at 5:40 a.m. on June 2.

Representatives of INAIGEM and two other organizations, the National Water Authority and the local municipality of Independencia, visited the lake a few days later. They found that the workers on Pucathe site had restored two of the drainage pipes. These officials anticipated that the other eight will soon be functional. Zapata and the other authorities

called for increased investment in infrastructure at the lake to reduce the risks of a flood. They estimated that an expenditure of US \$6 million would prevent about \$2.5 billion in potential damages, including a hydroelectric plant and irrigation facilities on Peru's desert coast; it would also protect the lives of the 50,000 people who live in the potential flood zone.



Pucaranra Glacier, Lake Palcacocha, and syphons at the moraine. Credit: INDECI

The Causes of the Calving Events

These events were not entirely unexpected. Marcelo Somos Valenzuela, a postdoctoral fellow at the Northeast Climate Science Center at the University of Massachusetts, is the lead author of a study, published last year in the journal *Hydrology and Earth System Sciences*, which concluded "there is consensus among local authorities, scientists and specialists that Lake Palcacocha represents a glacier lake outburst flood hazard with potentially high destructive impact on Huaraz." This paper also stated that a "small avalanche" like the ones that recently occurred are "the highest likelihood event" and that they would "produce significantly less inundation." Somos Valenzuela wrote to GlacierHub, "There are empirical models and hydrodynamic models which provide estimates of the height of the wave in the lake... In this case, it seems that the ice-fall was small, and 3 meters is a reasonable estimate of the wave height."

Moreover, several sources indicated high risks at this time of year. Noah Walker-Crawford, an anthropologist at the University of Manchester, spoke recently with the workers at the drainage site at the lake. He wrote to GlacierHub, "According to the people who work at the lake, the icefalls were likely due to unusually strong fluctuations between cold nights and warm days." He mentioned that they said "there is a block of ice that is ready to fall, but we hope that that won't happen."

Jeff Kargel, a planetary scientist at the University of Arizona, told GlacierHub that both calving events and avalanches at Palcacocha "dump energy into the lake, and if they are large and sudden enough, a big wave can form. As with other more classical tsunamis, the shoaling in Palcacocha toward the south end of the lake— where the syphons are— can cause a relatively small displacement wave to build up to a much larger size when it nears the shore. Avalanches and calving events are frequent occurrences at this lake, and both should be especially active in the late May-July period, which tends to be the dry season, hence mainly sunny, thus allowing high solar radiation. The air temperature doesn't

vary much throughout the year, this being deep into the tropics, so variations in sunny versus cloudy days are the main seasons."

The weather data indicate some warm days in May at Palcacocha. The data also demonstrate that May had less rain than usual, particularly toward the end of the month. Such dry weather is typically associated with less cloud cover, supporting Kargel's suggestion and a report in a regional newspaper, *Ancash Noticias*, which stated that "intense solar radiation" in recent weeks had been the cause of the calving events. The data also support the observations of the local residents about the temperature fluctuations between day and night, since cloudless nights in this region are colder than ones with overcast skies.



Weather data at Palcacocha, May 2017. Credit: INAIGEM

Responses to the Calving Events

What can be done to protect Huaraz and neighboring communities from floods, now that the syphons are damaged? Mark Carey gave a long-term view to this question. "Palcacocha has its history of death, destruction, and near misses," he wrote to GlacierHub. "The issue is partially one of climate change and ever-shrinking glaciers that have caused the lake to

expand and fill with more water, creating a hazard waiting to morph into a disaster if Palcacocha's dam ruptures. Avalanches provide the trigger to help destroy dams." Referring to Peruvian activities, starting in the 1940s, to lower the lake level and to reinforce the moraine, he added, "The story is also one of engineering and technology. Since the 1990s, funds and political support for actual glacial [lake](#) engineering projects have been extremely limited. Now we have regular declarations of states of emergency at Palcacocha, but no engineering projects to provide a more long-term solution." He also pointed to the need for "an early warning system, and... educational programs to train the population how to respond in the event of an outburst flood or alarm system."

It might be thought that the damage to the syphons would generate support for such solutions. However, obstacles still limit effective responses. Barbara Frazer, a journalist based in Peru for many years, offered a note of concern, linking these events with other disasters in Peru. She told GlacierHub, "Peru's response to natural disasters is improving, but the country still clearly lags in prevention. The most recent flooding on the coast was an extreme reminder, but every year, there are also landslides on the Central Highway, and children die of pneumonia during the cold snaps high in the Andes. And every year, there's an emergency response, but little or no long-range planning. Part of that is due to the way responsibilities and budgets are divided among the various levels of government, part to turnover of government staff, and part simply to a lack of a culture of prevention and planning."

A recent online exchange in Huaraz shows awareness in the region of these issues raised by Carey and Frazer. Most discussants call for greater investment in infrastructure to protect the areas below Palcacocha. However, others suggest that self-interested government agencies play up the risk in order to increase their budgets, which they will divert to personal ends. A scientist, Sonfia González, commented that the regional government lacks the skills needed to manage risks. Others expressed a

concern that publicizing the risks would harm the region by reducing tourism. These disagreements point to a lack of confidence, at least on the part of some local residents, in the agencies whose task it is to protect them from natural hazards.

The calving events confirmed scientific research in the area. They also showed the weakness of the existing infrastructure, designed to protect the region from floods. And the discussions in Huaraz show a second, equally serious deficit: the limits of the trust between society, experts, and public agencies, even in ones of the areas of the world most familiar with glacier risks.

More information: Marcelo A. Somos-Valenzuela et al. Modeling a glacial lake outburst flood process chain: the case of Lake Palcacocha and Huaraz, Peru, *Hydrology and Earth System Sciences* (2016). [DOI: 10.5194/hess-20-2519-2016](https://doi.org/10.5194/hess-20-2519-2016)

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