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Where Glaciers Melt, the Rivers Run Red

As the glaciers of South America retreat, the supply of freshwater is dwindling and its quality is getting worse.

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By Mitra Taj
Photographs and Video by Marco Garro

Dionisia Moreno, a 70-year-old Indigenous farmer, still remembers when Shallap River, nearly 13,000 feet up in the Cordillera Blanca, brought crystal clear water brimming with trout to her village, Jancu. “People and animals alike could drink the water without suffering,” she said. “Now the water is red. No one can drink it.”

At a glance the river looks like a casualty of mining pollution; Peru is a major producer of copper, silver and gold, and the waters near abandoned mines often run a shade of rust. But the culprit is climate change. The Cordillera Blanca mountain range harbors the world’s largest concentration of tropical glaciers, which are particularly sensitive to rising temperatures and are a major source of freshwater in Peru.

For thousands of years, the glaciers were replenished with ice in the winter. But they have shrunk by more than 40 percent since 1968, uncovering rocks that, when exposed to the elements, can trigger chemical reactions that leach toxic metals into the water and turn it acidic.

The process, known as acid rock drainage, “creates a cascade reaction that pollutes water sources,” said Raúl Loayza, a biologist at Peru’s Cayetano Heredia University who researches water quality in the Andes. “It’s a big problem and is getting worse and worse.”

Deglaciation above Lake Shallap, the headwaters of Shallap River, has exposed more than 380 acres of the Chicama Formation, which is rich in pyrite, an iron sulfide. As meltwater trickles across the rocks, the pyrite transforms into iron hydroxide and sulfuric acid, a corrosive chemical that releases heavy metals from the rock into the meltwater, Dr. Loayza said.

Pure water has a neutral pH of 7; Lake Shallap now has a pH of less than 4, nearly as acidic as vinegar. It also contains lead, manganese, iron and zinc at levels that surpass environmental quality standards, according to Peru’s National Institute of Glacier and Mountain Ecosystem Research, or Inaigem.

Health authorities have declared Shallap River and several other acidified streams off-limits for human consumption. But most villages continue to use it for crops, even though it does not meet water quality standards for agriculture. Farmers say it can cause some plants to wither.

Acid rock drainage can degrade ecosystems and corrode infrastructure. Juan Celestino, 75, the husband of Ms. Moreno, said that when the trout first disappeared from Shallap River, villagers thought that someone had dumped pollution into it. “We didn’t think that it was the river itself,” he said. That the

problem stemmed from shrinking glaciers was not reassuring. “What can we do?” he added. “Who can help us?”

To identify hot spots, Dr. Loayza and other scientists used satellite images to analyze the spectrum of sunlight reflected by glacial lakes. Their model has identified 60 lakes in the Cordillera Blanca that are highly acidic. Inaigem has confirmed acid rock drainage in five of the eight glacial gorges it has tested so far. “There are areas we’re aware of that are very affected and others where the process is just beginning,” said Yeidy Montano, a scientist with the institute.

Meltwaters are most acidified, and most laden with heavy metals, in the high Andes, where the glaciers are actively melting. Indigenous villages at these elevations are the most vulnerable, and, being small, tend to lack influence with authorities who might help secure access to cleaner alternatives.

“These places in the Cordillera Blanca are a time bomb for highland people, for their way of life, for ecosystems,” Dr. Loayza said.

With help from a local nonprofit, the village of Canrey Chico, which sits on the Rio Negro, another rust-red river, built a system of ponds and canals planted with native reeds to raise pH levels and reduce heavy metals in water drawn from the river. But provincial government officials abandoned an effort to expand it.

Vicente Salvador, the farmer who had promoted the effort, died of gastric cancer in 2021. “His main source of drinking water came from the river,” his son, Joel Salvador, 45, said. “On our land, we don’t have access to spring water.”

Springs have long been seen as cleaner sources of water than rivers in the Andes, but some are drying up, and others now contain heavy metals. “We suspect that groundwater will also be affected in the long term by acid rock drainage,” said Francisco Medina, a research director with Inaigem.
Video

Sixto León, 59, a farmer from the village Cacapaqui, said that in the past year the spring water that his family consumed started to taste sour. “A lot of us have been having stomachaches,” he said.

At first, the melting of the glaciers brought an abundance of water. But research has shown that watersheds in the Cordillera Blanca have since passed “peak water,” meaning that less water is now trickling down in the dry season.

The quality of the water that remains is increasingly threatened by acid rock drainage. In recent years, leaching has been detected on the rocks above Lake Palcacocha, the headwaters of the watershed that supplies drinking water for Huaraz, the regional capital. The lake has maintained an alkaline pH of around 7.5, but scientists say it will probably turn acidic as the glaciers above it continue to retreat.

The two other watersheds that flow into the city were already turning acidic. EPS Chavin, the utility company that provides water for Huaraz, stopped drawing on one of them in 2006 after manganese, a metal that can be toxic to the nervous system, was detected. But with water in shorter supply, the company plans to build a $10 million treatment plant to process acidified waters with heavy metals.

“It’s more complicated to treat, and more expensive,” said María Marchena, a manager at the company. “But the situation is very critical and will become more so every year.”

By 2030, Inaigem anticipates that glaciers in the Cordillera Blanca below 16,000 feet will have disappeared. “That is going to leave a large surface of minerals exposed,” Ms. Montano said.

One peak, Pastoruri, has already shed so much of its ice that it no longer qualifies as a glacier. Tourists once flocked to the mountain to ski, camp and climb its slopes. Today, meltwater gathers there in reddish pools that resemble open wounds.

Ms. Moreno said she longed for the abundance of her youth, when trout could be plucked from the river, thick snow and ice covered the peaks, springs gushed from the mountainside and grasses for grazing livestock grew waist-high.

Sometimes, she said, she thinks that the evangelical Christians who have spoken to her about the end of the world may be right. “They say the glaciers will disappear, and the rivers will run red,” she said. “That’s coming true.”