Climate in the Peruvian Andes: From early humans to modern challenges

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In Chuqibamba, ancient Inca terraces have been repurposed to grow alfalfa for cattle. Before the arrival of the Spaniards, the Inca grew native varieties of corn and potatoes.

(Phys.org) —Twice humans have witnessed the wasting of snow and ice from Peru's tallest volcano, Nevado Coropuna—In the waning of the last ice age, some 12,000 years ago, and today, as industrial carbon dioxide in the air raises temperatures again. As in the past, Coropuna's retreating glaciers figure prominently in the lives of people below.

In an ongoing project, scientists at Columba University's Lamont-Doherty Earth Observatory and partner institutions are reconstructing the ebb and flow of ice on Coropuna since the last ice age to understand how the tropics influence the global climate system, how ice-loss and a warmer climate will impact farming in the region, and what adaptation measures might help people survive in this hotter, drier world.

In 2012, Gordon Bromley, a scientist with joint appointments at Lamont and University of Maine, spent his eighth field season in Peru camped near a high-altitude bog in the Pucuncho Basin below Coropuna. Over five weeks, he and his field assistant, Peter Strand, chiseled flakes of rock from boulders dragged down the mountain during the last ice age when temperatures were significantly colder.

In a technique called surface exposure dating, scientists can pinpoint when the ice receded by measuring the amount of cosmogenic isotopes in the rock. The isotopes are formed when the ice pulls back, like a blanket, exposing the rocks to cosmogenic rays from space. In quartz rocks, like those found in the European Alps or Himalayas, scientists measure beryllium isotope levels to get an age for the glacier retreats; in volcanic rocks, like those found in the Andes up and down South America, including in Peru, they measure helium isotopes.

During breaks from sampling moraines, Bromley collected bags of dirt from a stream embankment near camp. Back in a lab, he planned to analyze the grains of sand and gravel to see how stream flow has varied with climate over the past 10,000 years or so—information that can be used today to anticipate future stream flows as Coropuna's ice continues to shrink. Over several days, Peruvian glaciologists Tomas Quispe and Edinson Barreto with the non-profit sustainability group, La Asociación Especializada para el Desarrollo Sostenible (AEDES), joined Bromley and Strand, a graduate student at University of Maine, to collect samples.

One day, they hiked several hours to Coropuna's snowfield to scope out a location for a weather station. Their feet crunched over blades of ice, or penitentes, formed as the glacier vaporizes into the dry air.

While they worked, Bromley's colleague at the University of Maine, archeologist Kurt Rademaker, was lining up government permits to begin excavating a rock shelter he believes was occupied about 12,000 years ago by Peru's earliest settlers. For seven years, Rademaker and Bromley have collaborated to understand how climate has shaped human occupation in this part of the Andes. After years of searching the Pucuncho Basin for human settlements, Rademaker in 2007 stumbled across this rock shelter. Animal bones littered the floor, including those of vicuña, a wild camelid closely related to the domesticated alpaca. It looked as if the cave's inhabitants had moved out in a hurry after a raucous barbeque. The partly caved in ceiling was stained black by what looked like cooking smoke. "It was obviously in a prime location, north facing, warm, great river, lots of vicuña, beautiful vista" he said, gazing at the grasslands below the shelter last summer.

Each summer since then, Rademaker has discovered more fishtail hunting points, animal bones and other artifacts that radiocarbon dating has placed at 12,000 years old. The Cuncaicha rock shelter may be the highest ice-age archeological site discovered yet. At an elevation of nearly 15,000 feet—almost three miles high—the shelter suggests that Peru's first people had powerful lungs to survive on the thin air, and most likely a hearty constitution to brave the cold. By 12,000 years ago, Bromley's work suggests, Coropuna's glaciers had retreated far enough that climate would have been tolerable for these early hunter and gatherers. In his continuing fieldwork, Rademaker hopes to understand why the early Andean people came here. Was Cuncaicha a seasonal hunting lodge or did people live here year-round? Was it occupied continuously for 12,000 years or did climate change and other factors lead to its abandonment and resettlement over time? "This basin is a case

study," he said. "Are there huge shifts in climate, hydrology and human settlement or is it a story of stability and resilience?"

This question resonates today as the region warms. "Tens of millions of people rely on water from these glaciers," said Gisela Winckler, a geochemist at Lamont-Doherty who runs the noble gas lab where Coropuna's moraines will be analyzed. "Simulating what's going to happen in the future is really crucial."

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