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Monitoring the glaciers of Peru

BY JEFFREY MCKENZIE

HUARAZ, Peru – I am in the Café Andino in Huaraz, Peru on a day off due to a general strike that has disabled all local transportation. Although Peru is a major coffee producer, most people drink instant coffee. This café is one of two places in the city that have 'proper' coffee and wireless Internet access. I have been in Peru since mid-July studying the hydrology associated with Andean glaciers in the Cordillera Blanca mountain range. Globally, mountain glaciers are undergoing rapid and widespread retreat, with potentially devastating effects for water resources. Tropical glaciers in the Andes and the Himalayas are particularly important because they are at the headwaters of hydrologic systems that provide water for much of the world's population.

Water and glaciers are a critical component of daily life in this region which has the highest density of glaciers in the tropics. Here water is not only used for domestic purposes but also for agriculture and hydroelectric power generation, and the glaciers are a major tourist destination. But glaciers also loom as a danger and potential hazard. From the balcony of our café we can see Huascarán, Peru's highest peak. In 1970, an earthquake triggered a massive avalanche that obliterated the town of Yungay, killing more than 18,000 people.

Jeffrey McKenzie talking on the walkie-talkie while hiking up to the Yanamarey glacier.
JEFF BURY

Our research this year, funded in part by a Natural Sciences and Engineering Research Council grant, is focused on answering many critical questions. For example, how much water do glaciers provide to local and regional hydrological systems; what will be the future impact of glacier recession on these systems; and what is the potential storage or transfer of groundwater to surface water in near glacier valleys? My primary collaborator is Prof. Bryan Mark from The Ohio State University; we have worked together for many years on issues related to tropical glaciers, both in Peru and Kilimanjaro, Tanzania.

Working in a remote area such as the Cordillera Blanca presents a number of challenges, including the lack of historical data and difficulties in establishing monitoring networks. Weather and hydrologic stations are often targets of vandalism or fall into disrepair, and historical data (such as the volume of water flowing in a stream or river) is discontinuous or records are lost.

We use water chemistry to identify and quantify different sources of water (such as glacial melt) combined with synoptic sampling, a method where samples are taken from a wide range of locations over a very short time span, to essentially capturing a snapshot of water chemistry variability. Our previous research has shown that as much as 40 percent of dry season runoff comes from glacial melt water, and that the amount of glacial melt water is increasing.

When collecting water samples, we also measure stream discharge (when possible) with a flow meter that measures water velocity. Over the past four years, it has been my job to dangle from bridges or to pull on hip-waders to wade in glacial streams to make discharge measurements. This year, I even had to wade without the hip-waders into a cold (just 5 C) glacial stream to install instrumentation.

A local woman corrals one of the researchers' wayward steeds loaded with their luggage.

Because the Peruvian Andes are at very high altitude, working here presents a whole set of physical challenges. The potential side effects of extremely high altitude can include death. Luckily, the elevations at which we spend most of our time usually leads to significantly less worrisome side effects such as shortness of breath, headaches and difficulty sleeping. During this trip, we had occasion to sleep at 5,200 meters above sea level, which borders on extremely high, and left me feeling nauseous and unable to eat for about 24 hours. Other than that, and getting winded doing simple things like brushing my teeth or eating dinner on my first few days at elevation, this hasn't really been a problem.

We are also studying the interaction and connection between surface water and groundwater in high elevation pampas — grass plains that are often former lakes dammed by glacial deposits that have been in-filled with sediments. To study these systems we measure discharge (the volume of water flowing in a stream or river per time) and temperature profiles of streambeds, while also taking soil cores.

Even in these remote areas there are still a surprising number of people, both tourists trekking and farmers pasturing their animals. In order to keep our equipment from getting stolen, we use many small data logging devices that can be hidden. For example, our temperature sensors are self-contained units the size of watch batteries that we embed in wooden dowels and push into the streambed. Usually the biggest challenge is finding our instruments for data retrieval when we return. This year, it took us only 15 minutes to recover a set of temperature data-loggers that, miraculously, survived an entire year buried in a streambed.

Every year we visit the Yanamarey glacier, one of the smaller glaciers in the range, and every year the trip is very similar – the hike to the hut where we stay is exhausting, it always snows as we arrive, and it is always depressing to observe the rapid glacier retreat. The hike can take between four and five hours and it is often a challenge to get to the hut by nightfall. As has often been the case in past expeditions, this year we had to hurry through the most grueling stretch of the hike up the final, steepest part of the ascent (the hut is at 4,600 meters above sea level) in order to beat nightfall. In addition to noting that the glacier had retreated 48 meters from November of last year, we also found two new small lakes have appeared in front of the ice and there was a landside (likely from a newly exposed rock surface) that spilled across one section of the ice.

Ever since my first trip to Ethiopia in 1993, I have a mantra that I repeat to myself over the course of the day whenever I am working overseas; "Every day is an adventure." With our fieldwork in Peru few things go according to plan and we now actually schedule one day per week for unforeseen events. Last week we had scheduled a 5 p.m. meeting with the people from a community a few kilometers from the end of the Quilcayhuanca valley. However, in order to make the meeting and complete our work we had to hike through the afternoon without stopping. This was difficult as we were almost trampled by a small stampede of horses. We were further delayed because we had to commiserate with a colleague who lost her camera, all the while worrying about our guide who had disappeared with our donkeys and our bags.

We were too far behind schedule to likely make the meeting on foot, but were lucky to find a minivan on a remote part of the road, and purchased a ride to the community, where we found our guide calmly waiting for us roadside with our bags. We then spent the next 30 minutes listening to roll call for approximately 200 people and 'listened' to a discussion about upcoming religious festivals before we gave a brief presentation about our research. Of course, we were now once again without a ride, and it was almost nightfall. We were again lucky to get picked up by a private pickup truck, and we rode in the open-air on top of our bags down to town. The disarray of this day is surprisingly common throughout our fieldwork and there are two ways to deal with the circumstances – be frustrated or enjoy the adventure. I chose the latter.

The view from the top of the Llanganuco Valley looking down at the winding road and treacherous

In many ways Andean field research is a somewhat spiritual experience. In the mountains, it gets dark every night at 7:00 p.m. and the temperature becomes frigid. The result is long nights stuck in one's sleeping bag, with far too much time to think about life. On nights when we camp at high elevations even sleep is difficult and often filled with vivid bizarre dreams. There are many disturbingly fast drives, including this year's near-death experience on a dirt switchback road during a night drive in which only a rare dirt embankment kept us from plunging over the side of a steep mountain after our driver lost control. Combined with far fewer distractions from my regular 'connected' world, the trip can be very reflective about life.

Dr. Jeffrey McKenzie joined McGill in 2006 as an Assistant Professor of Hydrogeology in the Department of Earth and Planetary Sciences and he teaches hydrogeology and courses in McGill's new Earth System Science program. McKenzie came to McGill from the Byrd Polar Research Center at The Ohio State University where he was a post-doctoral research fellow studying the impact of tropical glacial recession on water resources. McKenzie's doctoral research at Syracuse University focused on creating a numerical model of heat transport in hydrogeologic systems that includes freezing and studying how heat moves through northern peatlands. McKenzie was an undergraduate student at McGill (B.Sc. Honours, 1997) and he is excited to be back in Montreal.

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