Researchers study impact of melting glaciers in Peru

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In the context of modern anthropogenic climate change, many Peruvian societies are experiencing the brunt of abrupt climate change impacts. The Peruvian Andes are home to 70 percent of the world's tropical glaciers, which provide surrounding communities with water for drinking, agriculture and pastoralism, energy production and tourism.

Recent studies indicate that glacier coverage in the Cordillera Blanca—a mountain range in the Ancash region of Peru and part of the larger Andes range—has declined by more than 25 percent since 1970, which is twice the rate of the global average. In the last decade, rapidly receding glaciers in the range have resulted in an increase in heavy metals being exposed and washed downstream, degrading the region's water quality.

Though water quantity is an apparent and impending issue for the region, the overall quality of the water may be of greater concern.

Understanding how changes in climate influence tropical glaciers and glacially fed systems in the Andes, and how these changes influence land use, water availability and quality is the research focus of three Ph.D. students at the University of Maine. The researchers are working to monitor the use of the regions' essential grasslands and wetlands, which immobilize heavy metals naturally present in the valley's hydrologic system.

The project took shape in August 2014 when Kathryn Warner, Dulcinea Groff and Jessica Scheick traveled to Huaraz to speak with their local collaborators, The Mountain Institute (TMI). The nonprofit organization works to conserve mountain ecosystems, ensure sustainable economic development and offers support to local cultures.

TMI was instrumental in the selection of their research site and in guiding and developing their research questions to make them relevant to local populations.

The project, which ultimately resulted in two integrated projects, has seen many iterations since its inception aiming to address water availability. Since the initial trip, the larger project now includes an anthropologist, Ph.D. student Jamie Haverkamp, who is aiming to

inform sustainable adaptation policies in the region using anthropological approaches.

The graduate students are fellows in the Climate Change Institute's Adaptation to Abrupt Climate Change (A2C2) Integrated Graduate Education and Research Traineeship (IGERT), which provides funding to Ph.D. students for interdisciplinary research projects aimed at improving climate change adaption strategies.

"In interdisciplinary, applied work, it's important to go in with an open mind and be willing to learn and change your project as you go," says Scheick.

The purpose of UMaine's IGERT is to tackle the issue of adaptation to abrupt climate change, part of which involves forming teams from different disciplines to come up with a collaborative immersion project.

"I am often in awe of the opportunities we have in the Climate Change Institute, not only to work on important problems, but to also work with world-class leaders in climate change research," says Groff.

To the local population in the Cordillera Blanca—the world's highest tropical mountain range—their work will inform stakeholders about the climate history of the region and provide important information to guide decisions about current and future water management strategies.

"I feel that our project was developed in a fully collaborative way with TMI, which makes the project even more exciting, knowing that we are providing information and resources to an area of particular interest not only to TMI, but also to the local communities and the Huascaran National Park," says Warner, a trained limnologist—someone who studies inland waters—and economist.

Huascaran National Park, which comprises most of the Cordillera Blanca mountain range, aims to restore the wetlands of the region. One hypothesis about the declining water quality is a lack of wetland plants able to absorb heavy metals in the environment.

Removing grazing animals would be one strategy to improve water quality, but would have implications for the livelihood of pastoralists who have been in the valley for millennia.

"We may be able to shed light on the ecological resilience of this system and how it may influence the social system of local communities and decisions by the national park," says Groff.

As the project's paleoecologist, Groff uses information from the last 10,000 years to measure and understand climatic variability and how animals and plants vary in their composition in the region.

"While my research focuses on natural systems, the opportunity to inform and learn from other disciplines is very important because our work may influence rangeland management practices, conservation policy, restoration efforts, etc.," says Groff.

Plant species compositions relate directly to water availability and play an important role in soil and hydrological characteristics of landscapes. By understanding the natural variation of plant communities in response to past climate variability, Groff will be able to inform future management strategies.

Groff is processing samples from a lake sediment core, compiling previous studies of climate change and paleo-records from the region, and planning another trip to collect pollen from modern day plants as a reference for the pollen found in the lake sediment.

"My area of expertise provides baseline information for those looking to restore the environment, with the potential to provide information that may allow restoration ecologists to set realistic goals, conserve funding and understand the environment by looking back further in time," she says.

In order to figure out how water availability has changed in the recent past, glaciologist Scheick is using satellite imagery to look at changes in the size of the glaciers that supply meltwater to Quilcayhuanca Valley. Once established, these trends will be used to infer glacier mass balance to compare with local temperature and precipitation records.

"I wanted to be a part of the (IGERT) program because I wanted to be able to work with researchers across disciplines and really understand how my research is important in the broader context of human-natural systems," says Scheick. "I have learned a lot about effectively communicating my research and working in interdisciplinary groups."

As the project's economist, Warner assesses the value of the area grasslands using data and information gathered from TMI as well as researchers at Universidad Nacional Agraria La Molina (UNALM) near Lima, Peru. She is using cost-benefit analysis to interpret the effects of grazing on grasslands in the Quilcayhuanca Valley and the subsequent effects on water quality in the region. Using ecological and economic analysis, she aims to provide potential management and adaptation strategies that allow pastoralists to continue their way of living while improving water quality.

Calculating values of environmental goods and the resources and/or time people are willing to sacrifice to implement preventative and adaptive strategies is important to effectively create, modify and apply adaptation measures, Warner explains.

"It is important to first understand the climate history of the region and potential impacts of future climate changes on individuals before generating adaptation and management strategies."

Warner's other primary area of study is aquatic ecology, and she has been working with collaborators at Northern Illinois University and SUNY Fredonia to use diatoms—small algae with glass-like cell walls—preserved in the sediments of a core taken from Laguna Palcacocha to reconstruct lake level over the past two millennia. Changes in lake level aid in understanding water balance in the region over the past few thousand years.

The economic analysis is underway, and the data is being collaboratively collected with TMI and UNALM. During the next trip, the team plans to provide results from the natural science portions of the study and to collect more information for the economic and anthropological parts.

"The resources at UMaine have allowed us to be successful so far and various people and groups have assisted us with all stages of our project from logistics in planning and travel, to dating sediment cores, and providing valuable feedback on how and what steps to take next," says Warner.

"While four of us make up the core team, it has truly been an effort across many individuals."

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