

High Mountain Glacial Watershed Program

Quarterly Newsletter



Issue 3

Perceptions on Change in the High Mountains

A significant component of the High Mountain Glacial Watershed Program (HMGWP) is our consultation work with local communities. These consultations provide fascinating insights about the perceptions that high mountain people have regarding climate change and its impacts on their day-to-day life. These insights often agree with the formal, academic research results regarding changes in the high mountains. Changing freshwater supplies and emerging, glacier-related threats such as like glacial lake outburst floods are commonly discussed. However, the community perspective also provides a new understanding about the priorities of the people most directly impacted by climate change. It transforms the scientific, technical changes as reported by scientists into a personal, human context. As The Mountain Institute (TMI) Andes Program Director, Jorge Recharte, said, "We know about all of the tangible changes occurring in water resources, but what we want to find out through these consultations and interviews is what is the significance of these changes to the people who directly impacted?"

Our fieldwork in Nepal this past September sought to better understand these perspectives through a series of community consultations in three villages that are located downstream of Imja Lake: Phakding, Namche Bazar, and Dingboche. During the consultations, community members discussed the changes they saw as a result of climate change, assessed their resources and assets, identified their vulnerabilities due to climate and non-climate stressors, and brainstormed potential solutions to more effectively adapt to the changes occurring. The topic of the new threat from emerging glacial lakes, like Imja, and potential energy production from hydropower dominated the conversations with the communities in the region.



Community consultations in Nepal. Photo by Chris Rainier.

Similarly, we launched a series of risk perception studies in Peru that attempted to identify the various concerns that high mountain communities in the Cordillera Blanca have in relation to changes in climate. Through a series of open-question interviews and closed-question surveys, we have gained insights about changes in water resources as well as impacts on agriculture, tourism, and urban migration. Here, there was a sharp contrast in the perceptions of the rural, upstream communities and the urban, downstream communities. The upstream communities cited their main concern as being changing water availability, particularly as it related to their ability to maintain agricultural production, whereas the priority of urban communities downstream, such as Huaraz, was the threat of another glacial lake outburst flood.

All of the community consultations located in both Nepal and Peru provided a new understanding about the broader impacts of climate change as it relates to local economies, social dynamics, and political institutions. This holistic view of climate change can only be obtained by talking with high mountain communities – the people who have an intimate experience with the changes in their environment and lives. These perspectives will be highlighted in this Fall Newsletter. We hope that the insights can provide a valuable and thought-provoking perspective to encourage further research that looks at both the technical changes occurring in high mountain glacial watersheds as well as the significance of these changes for the communities that are directly impacted.

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New Methods for High Mountain Research: An Interview with Jeff La Frenierre

Jeff La Frenierre, a graduate student at The Ohio State University, is leading a research initiative to provide new insight to research methods in the high mountains, particularly related to our understanding of debris-covered glaciers. Through a case study at Volcán Chimborazo, Ecuador, La Frenierre is deploying Terrestrial Laser Scan (TLS) technology as a test case for alpine research. In this interview, Jeff talks to us about these ongoing research activities.

Kate Voss (KV): Why did you select Volcán Chimborazo, Ecuador as your research site?

Jeff La Frenierre (JLF): The TLS project at Volcán Chimborazo, Ecuador is an extension of the dissertation research I am doing to examine the impact of glacier retreat on water supply and the resulting potential for increased livelihood vulnerability on the part of water users there. I initially became familiar with the area as a result of volunteer work I have done with the organization Engineers Without Borders, building domestic water systems for several indigenous communities in the Chimborazo region. I chose to do my dissertation research here once it became clear to me that the region was already experiencing water stress and that no one had yet studied the role of Chimborazo's glaciers in the area's hydrologic system. So, that the TLS research is happening there is, in part, a function of opportunity. However, the fact that Chimborazo has fairly extensive areas of debris-covered glacier ice (I don't have a firm number yet, but I would estimate around 15-25% of the mountain's total glacier area) is another reason why it is a very interesting site for TLS-based glaciological research, as I'll explain below, so the opportunity turns out to be rather fortuitous.

KV: What is Terrestrial Laser Scan technology and why is it valuable/important?

JLF: A Terrestrial Laser Scanner uses the exact same technology as the more familiar LiDAR, except that the scanner is situated on the ground rather than housed in an airplane flying overhead. In either case, the technology bounces a laser beam off of an object in order to make a very high precision, three-dimensional image (or map) of its surface... In the project at Chimborazo, we are producing an image of the debris-covered surface of a glacier that has a resolution of 15-20cm, meaning that we can differentiate distinct objects such as rocks, exposed areas of ice, and pools of water – and map their location in three-dimensional space – that are that small. While TLS isn't able to cover the same area as LiDAR, the fact that the work is done without an airplane makes it relatively simple and inexpensive to use (aside from the cost of the scanner, of course, which is around \$200,000).

TLS has only recently been employed in glaciological studies, but shows great promise – especially for work involving debris-covered glaciers. Aside from trying to determine how debris-covered glaciers on Chimborazo are behaving under current climatic conditions, the other key motivation for this research is to demonstrate how TLS can be used to identify the location of glacial ice under debris cover. If repeated TLS scans can help identify areas of melting ice core by identifying even modest areas of surface depression (at a scale of 10-20 cm over 6-12 months), then this might be a simpler, less expensive option compared to the other methods available (seismic scans, drilling). I hope to demonstrate this capability by showing how TLS can identify these sorts of changes by using a debris-covered glacier on Chimborazo as a case study.

KV: This research is already underway – what have been your results thus far?

JLF: The basic premise of using TLS to monitor glacier change is that by comparing the results of two scans made at different points in time, you can identify the location and magnitude of glacier change occurring during that interval by quantifying before/after surface elevation differences. The first phase, which was completed in June 2012, involved creation of the "baseline" map of the surface of the debris-covered portion of the Reschreiter Glacier, one of the largest ice masses on Chimborazo and one with a stagnant, debris-covered tongue that is about 1 km in length. The



Project PI Jeff La Frenierre gazes in amazement at the bottom portion of Chimborazo volcano during a brief moment of "clear" weather. The field site remained cloaked in fog, rain, and snow for much of the week-long expedition on the mountain. Without visibility, TLS data collection is impossible. Photo by B. Hodge.



The challenges of fieldwork. Sometimes even the best mule guide gives little incentive for horses to follow. Photo by Ollie Wigmore.

glaciologist with INAMHI, the Ecuadorian agency for meteorological and hydrological science. We spent six days on Chimborazo battling illness and extremely poor weather to get the scan done. TLS requires clear line of sight between the scanner and the surface being mapped (in this case, up to 1 km away), and one of the challenges with doing this work at Chimborazo is that it can be a very rainy/snowy/foggy environment. In the end, out of six days on the mountain, we only had about three hours of weather in which we could scan! Fortunately, one of those hours came on the very last afternoon and we were able to get it done.

KV: Phase Two of the research starts in January. What are your goals for the second phase?

JLF: In Phase 2, we'll complete the second scan, which will repeat, as closely as possible, the first scan. Once that's complete, I'll compare the second surface map to the first and quantify how much change has occurred. Based on what I've observed over similar time intervals in the past few years, I expect to see that the glacier surface has depressed as much as a meter or more in some places. Given the high resolution of maps created by TLS, we'll be able to identify any change greater than about 20 cm.

KV: Are there any key lessons that you have already learned from the research that you think are particularly important for broader glaciology/hydrology research in the high mountains?

JLF: TLS is a potential tool for providing the most precise quantification for change on debris-covered glaciers over relatively short time-scales (6-12 months). The importance of this is not only in understanding how a debris-covered glacier is responding to changing climatic conditions, but potentially in improving our ability to evaluate risks associated with dynamic conditions at the fore of debris-covered glaciers, particularly with regards to GLOFs.

I'd also like to acknowledge that this project at Chimborazo, which is funded by the USAID Climate Change Resilient Development program and is managed by Glen Anderson and John Furlow, is a direct consequence of the Imja Lake expedition organized by The Mountain Institute in September 2011. It was at Imja



Field team members (Brendan Hodge, Bolivar Caceres, Leonardo Segundo, Jeff La Frenierre, and Ollie Wigmore, not pictured) pause for a rest en route to the study site on the glacier moraine at 15,000 feet above sea level. Photo by Ollie Wigmore.

Lake that I first conceived of the idea to use TLS as a means to determine whether or not ice was present in a proglacial lake moraine dam, and it was through the contact with Glen and John while on the expedition that this project was submitted to them for funding support. So, please note that the HMGWP's efforts to build relationships between practitioners has, in this case, thus far had a very positive outcome.

HMGWP Launches Community Consultations in the Khumbu

By: Meghan Hartman (Engility) and Kate Voss (TMI)

During our September 2012 fieldwork, our trainers led three community consultations in the Khumbu in Phakding, Namche Bazaar, and Dingboche. Consultation trainers included Ang Rita Sherpa, Bheem Rai, Dambar Thapa, and Phurba Sherpa, who were supported by Vulnerability and Adaptation (V&A) specialists Jonathan Cook/USAID, Meghan Hartman/Engility, and Dr. Daene McKinney, Co-Manager of the HMGWP.

The September 2012 consultations were designed to provide communities with information and tools for understanding vulnerability and planning adaptation, as well as to gather their feedback on climate change-related issues to inform stakeholders such as government agencies and development partners. Specifically, the HMGWP is partnering with a proposed UNDP project that would seek to reduce the risk of a glacial lake outburst flood (GLOF) at Imja Lake. Input from these consultations was intended to inform the proposed project and give the communities a voice in its design – something that has not happened until now. The community consultation material was based on USAID's existing two-day V&A training program. However, the material was tailored to use a more participatory approach that also incorporated local context. The consultations revealed that communities in the Khumbu region are more or less aware of climate change processes and their real and perceived impacts. In particular, all communities were unanimous in stating that the priority for the region is to lower the volume of Imja Lake to reduce the threat of a GLOF and to continue sustainable use of their key resources in the context of a changing climate, including potential hydropower infrastructure, improving tourism infrastructure, and utilizing forest resources.

Based on the geography of the Khumbu and the range of vulnerabilities, it was determined that three locations throughout the valley would enable better information dissemination along with gathering diverse participant feedback. The three locations were chosen for the following general reasons:

- **Phakding** sits directly next to the Dudh Koshi River, of which the Imja Khola (the outflow from Imja Lake) is a tributary. In addition, workshops are rarely held in Phakding, so community members may not have the same access to information about climate change and related issues.
- **Namche Bazaar** is an economic hub and central meeting point for people throughout the Khumbu. The main focus is on the tourism sector, but there is also access to other institutions such as the Sagarmatha National Park, the military, and social groups.
- **Dingboche** lies within 10 kilometers of Imja Lake and has had a number of concerns about the potential risks from a GLOF there. TMI has a longstanding relationship with the Khumbu Alpine Conservation Council (KACC), which is based in Dingboche.



Community consultations in Phakding. Photos by Chris Rainier

During this September trip, the Glacial Lake Rapid Reconnaissance team (Dr. Daene McKinney, Dr. Alton Byers, and Marcelo Somos) also conducted ground-penetrating radar surveys at Imja Lake. A transect of the entire Imja glacier was completed, providing valuable data regarding the structure and depth of the glacier. In addition, the HMGWP launched the first radar-based bathymetric survey of Imja Lake. The bathymetry results provided astounding data about the current volume of the lake, which is almost twice as large as previous estimates. University of Texas at Austin graduate

students Marcelo Somos and David Rounce are using these data to develop a hydrologic balance model for Imja Lake to be used to predict future evolution and risk of the lake. The results from the ground penetrating radar (GPR) and bathymetric surveys will be presented in the first HMGWP Community of Practice webinar, which will be hosted in early January and will highlight all of the HMGWP Glacial Lake Rapid Reconnaissance work.

After the work in the field, HMGWP coordinated with UNDP to host a partner's workshop for the Imja Lake Risk Reduction Project on October 8, 2012. This meeting provided the first opportunity for partners working on the project to discuss current work and future collaboration. In addition, on their return to the United States, Dr. Alton Byers and Dr. Daene McKinney stopped in Bangkok to present the most recent Imja Lake data to the UNDP Asia regional office.

Detailed information from each community consultation can be found at:

<http://www.adaptationpartnership.org/communities/high-mountain-glacial-watershed-program>

A New Perspective on Changing Water Resources: Risk Perception Studies in Peru's Cordillera Blanca

Through the HMGWP, The Mountain Institute (TMI) is launching a second risk perception study in Catac, a region located in the watershed below the Pastoruri Glacier in the Cordillera Blanca. This region has seen substantial changes in local water resources as the Pastoruri Glacier retreats. The changing hydrology of the region has not only impacted water supply and agriculture, but has also had a devastating effect on tourism in the area. The Pastoruri Glacier was once a popular ski destination, but now that the glacier has retreated, the tourism in the region has declined substantially. TMI and the University of Texas at Austin will partner with the Huascarán National Park on a new climate change exhibit at the glacier entitled "The Route of Climate Change," which will mark the retreat of the glacier and provide additional information about climate change in the Cordillera Blanca. The project will also include a risk perception study to gain insights from the local communities about their main concerns, identify their priorities for the future, and begin discussion about potential projects that the community can undertake to better adapt to the changes they are experiencing.



A campesino explains his concerns about changing water resources and supplies in the Cordillera Blanca to TMI's Laura Trejo. Photos by Kate Voss

This risk perception study will be the second in a series of studies conducted by TMI through the HMGWP. The first took place in the Palcacoccha watershed and provided fascinating insights regarding the significance of climate change for high mountain communities in the area, finding that there was a stark contrast between the concerns of the upstream, rural communities and the downstream, urban community of Huaraz. Upstream communities were mainly concerned about the changes in water supply and shifting precipitation patterns. These concerns directly link to their ability to maintain their agricultural livelihoods. In recent years, the decline in agricultural productivity and new economic opportunities in Huaraz has drawn the men of the communities away from the rural areas and into the cities while the women have been left to maintain the fields. Because of the labor-intensive work required to maintain the land, the women have shifted their agricultural production to medicinal plant cultivation. During the risk perception interviews, many people in the community lamented this broader economic and social shift, particularly the subsequent urban migration, which has dramatically changed the day-to-day life of the rural communities and their traditional livelihoods.



Yet, while these concerns dominated the conversations with the rural communities, in urban Huaraz the majority of people were concerned about another flood from Laguna Palcacoccha, which had previously burst in 1941. These differences in risk perception are particularly important as we work toward finding solutions. Clearly, there is a need to integrate the concerns of the urban and rural areas, and to better understand the intricate, interdependent relationship between upstream and downstream communities in the watershed. The broader economic and social dynamics at play must be included into any risk management strategies in the region; otherwise, we risk addressing only part of the issue and not developing a sustainable, holistic solution.

Imja Lake Risk Reduction Project: Bringing Together the Partners

On October 8, 2012, after almost a month of fieldwork in the Khumbu region, HMGWP and the UN Development Program hosted the first Partners Workshop for the Community-Based Glacier Lake Outburst and Flood Risk Reduction Project. The project brings together expertise from the University of Texas at Austin, TMI, UNDP, Kathmandu University, Tribhuvan University, and ICIMOD to actively move forward in the development of a risk reduction strategy for Imja Lake. The project includes both the technical proposal of an engineering solution to reduce the threat of a glacial lake outburst flood from Imja as well as a community adaption component to reduce the vulnerability of downstream communities.

The October 8th meeting was the first time that all the main partners of the project sat down and discussed the overall problem, missing information, and potential solutions for reducing the risks of Imja Lake. Partners made presentations about their current knowledge and efforts at Imja Lake, each followed by a 10-minute question and answer session. The HMGWP presented results of recent field studies using ground penetrating radar, sonar bathymetry, and community consultations. The GPR survey gathered



Participants at the Oct. 8th Imja Lake Partners Meeting. Photo by Alton Byers.

new information showing the wide extent of ice present in the core of the terminal moraine at Imja Lake. The bathymetric survey provided data for estimates showing that the volume of the lake is 63.8 million m³, almost twice the previous estimate. The HMGWP also presented flood-modeling results showing that the current plan to lower the lake by 3 m would only reduce the risk of flooding by 6%. Results of modeling other alternatives that may reduce the risk to downstream communities were also presented for discussion. The HMGWP also reported out on the preliminary results of the community consultations held in Phakding, Namche, and Dingboche villages. Local people in all three villages voiced particular concern about the possibility of an outburst flood at Imja lake, and at the same time expressed a new appreciation for being actively involved in the dialogue (e.g., HMGWP brought Ang Cherring Sherpa, Pheriche village, to Kathmandu to attend the partners meeting). Another partner's workshop is planned for early 2013 to continue discussions and begin designs for the engineering component of the project.

Expedition Logs: Community Consultations in the Khumbu

By: Dr. Alton C. Byers, HMGWP Co-Manager

September 11-12, 2012, Phakding

Following an introduction to the consultation on September 11, participants were asked to describe their current lives, goals, needs, what is important, and recent changes in their communities and environments. A review of key climate change concepts was then presented. This was followed by a short field trip to identify local assets (e.g., agricultural land, lodges, forests) and the identification of contemporary problems. The day ended with the reporting out of field trip results by consultation participants, followed by an introduction by Phurba Sherpa on climate stressors (specific changes in climate that may impact a community or area, such as increased temperatures, heavy rainfall, or changes in weather patterns).

Day 2 began with a description a discussion of key climate change concepts, including vulnerability (the degree to which something could be affected by climate change) and adaptive capacity (the ability to adjust to the consequences of climate change). Following an excellent lunch of dal bhat (the traditional Nepalese meal of rice, lentil pea soup, and vegetables), the team led participants through a discussion of adaptation actions (actions taken by a person or community to reduce vulnerability to climate change) and exercises designed to identify actions appropriate to local conditions. An introduction to adaptation planning was then presented, followed by a wrap-up of the two-day community consultation activity. The day ended with a lively discussion of recommendations by participants regarding next steps, including the unanimous desire for continued and more in-depth community consultations so that participants could develop the skills needed for truly effective climate change adaptation.

September 14 – 15, 2012, Namche Bazaar

Thirty years ago Namche Bazaar was a sleepy little village of several dozen traditional Sherpa stone, two-story houses with roofs of split fir shingles held down by rocks. Livestock lived in the lower floors, which served to help heat the upper levels where the kitchen and living spaces were. Outhouses were built based on a composting design, using detritus gathered from the forest floor each fall, which was then used to fertilize the fields each spring. If you were one of the relatively few trekkers visiting the village and all villages beyond, you either stayed in your own tent, pitched in a potato field, or in peoples' homes where for a few rupees you could get a bowl of small Sherpa potatoes, tea, and a place to sleep.

The Namche that greeted us was totally different, the bowl-shaped hillslope now half filled with wall-to-wall, candy-colored, three- and four-storied lodges to accommodate many of the approximately 37,000 tourists who pass through the village annually. Internet, hot showers, convenience stores, mountaineering equipment stores, pizza, and TV are all available, and lodges compete fiercely for the tourist dollar. Rooms are cheap but food is expensive, and 8x11 computer printouts warn visitors "if you eat in any other lodge you will be fined Rs. 2,500/." But one thing that hasn't changed is Sherpa hospitality, and few trekkers leave without feeling that they've made friends for life even after a short stay.

But participants in the September 14-15 community consultation reported that in recent years weather patterns had become less predictable, snowfall and rainfall was heavier than any other time in the past, and poor weather was causing increasing problems regarding the reliability of flights from Kathmandu to Lukla. Could these and other climate change-related impacts eventually have a detrimental impact on tourism, which has become the economic core of Sherpa life?



Namche Bazaar in 1973 and in 2008. Over the years, the town has grown into a bustling hub for trade and tourism in the Khumbu Valley. Photos by Alton Byers.

September 18-19, 2012, Dingboche

It can be argued that climate change adaptation is strongly linked to the promotion of healthy ecosystems with continuous vegetation coverage. Forests, for example, create cooler temperatures, intercept rainfall, discourage soil erosion, and promote good groundwater storage. As tourist numbers increased exponentially in the 1970-80s, lodge owners in the alpine zone along the Everest region needed some form of fuel to prepare the food, hot water, and heat required by tourist groups, and they quite naturally turned to the most logical and available source – i.e., shrub juniper, dwarf rhododendron, and alpine cushion plants.

In 2002, however, researchers discovered that up to 50% of these fragile, slow-growing shrubs had been removed from the hill slopes above the main trekking villages, explaining the extremely high soil erosion rates measured by previous studies in the region. In response, TMI and the American Alpine Club worked with local communities in the early 2000s to form the Khumbu Alpine Conservation Council in 2004, the first NGO of its kind dedicated to the conservation and restoration of alpine ecosystems. The cutting and burning of shrub juniper, even in the Everest basecamp area where tons were burned annually by climbing expeditions, was halted, replaced by kerosene for cooking fuel. The KACC has also been one of the HMGWP's main partners in the Imja lake management and control aspects of our work, beginning with the September 2011 Andean-Asian Expedition, where they expressed a desire to become more meaningfully involved in future research and mitigation activities after years of being left out of the dialogue.

During the community consultations in Dingboche, the KACC members played a key role in discussing their resource assets and the threat of changes in climate to their livelihoods and conservation efforts.



Community consultations in Dingboche. Photo by Chris Rainier.

Save the Date: Experiencing the Living Laboratory of the Andes

You are invited to the 3rd International High Mountain Glacial Watershed Community of Practice Conference! The conference will take place from July 8-21, 2013 in Huaraz, Peru. The Conference will bring together the HMGWP's Community of Practice, which includes researchers and practitioners from the Andes, Asia, and the rest of the world, to experience the "living laboratory" of the Peruvian Andes. Unlike past conferences, this event will focus on learning through a series of hands-on training modules led by expert practitioners who have extensive experience in the Andes.

The Cordillera Blanca of Peru provides an ideal setting to gain first-hand, practical experience on a variety of issues affecting high mountains, glacial watersheds, and the people who live there. Our conference will focus on the threat of climate change in tropical and temperate high mountain glacial watersheds. The impacts of climate change are a global threat, and the lessons to be learned in the Andes can spark international cooperation and a global dialogue to tackle these challenges.

The Andes is a "living laboratory" where natural-human system interactions are intimately linked, and where substantial progress in Vulnerability and Adaptation training, capacity building, and implementation, glacier research methods, and the impacts of climate change on present and future water supplies has already been made. As a result, the HMGWP team will launch a unique conference/skills training workshop in Huaraz, Peru in July 2013 that brings together our Community of Practice and other stakeholders from high mountain countries throughout the world.

This event will take place during Peru's "Month of Glaciology," which will consist of several activities including a research symposium led by the Glaciology Unit, our HGMWP international conference, and public awareness campaigns in Huaraz, Lima, and Cusco.

We hope that you will be able to participate in this unique and dynamic event. For more information, please contact Kate Voss (kvoss@mountain.org).



View of the Andes from Laguna Paron. Photo by Kate Voss

HMGWP at the Wilson Center

On October 17, 2012, the High Mountain Glacial Watershed Program made a presentation at the Woodrow Wilson Center in Washington, DC during an event on "Managing Mountains for Ecological Services and Environmental Security." The event included presentations by Lisa Friedman (ClimateWire), John Furlow (US Agency for International Development), Andrew Taber (The Mountain Institute), Paul Schopf (George Mason University), and Ruth Greenspan Bell (World Resources Institute). The presentations highlighted the impacts of climate change on the high mountains as well as emerging environmental, social, economic, and cultural issues that must be addressed if the high mountain environment and communities are to prosper in the upcoming decades.

More information about the talk can be found here:

<http://www.wilsoncenter.org/event/managing-mountains-for-ecological-services-and-environmental-security>