HIGH MOUNTAIN GLACIAL WATERSHED PROGRAM

August 28 – September 30, 2013

Nepal Trip

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1. Introduction

The aim of the High Mountain-Glacial Watershed Program is to increase awareness for the critical importance of high mountain glacial watersheds globally in the context of climate change, highland-lowland interactions, and ecosystem services. This is achieved through the development of innovative high mountain tools, approaches, and the establishment of a unique high mountain Community of Practice. The Program creates enabling conditions necessary for local communities, governments, and stakeholders living in and/or dependant on high glacial watersheds to (a) build resilience to the impacts of climate change, (b) advance scientific knowledge of high mountain systems and processes, and (c) increase global awareness and support for the critical importance of high mountain glacial environments.

In September 2013, UT Austin staff, Professor Daene McKinney and PhD student David Rounce, traveled to Nepal to conduct technical assessment to identify the melting rate of the Imja Glacier and the future expansion of Imja Lake. This report details the activities on the trip. This travel covered the period August 28 to September 30, 2013.

2. Information on Activities

This trip focuses on the following main activities that fall within the following two 2013 High Mountain Glacial Watershed Program subtasks.

Subtask 3.2.3.1 Local Adaptation Plan for Action and Mainstreaming for the Khumbu Valley

1. Field, desktop, and rapid quantification of identified priority vulnerabilities including: (a) Verification and analysis of trends in precipitation patterns, extreme events, and river stage/discharge, (b) Investigate evolving glacier lakes and glacier melting rates at Imja glacier; (c) Work in collaboration with Climber-scientist small grantee Ulyana Horodyskyj.

2. Finalization of Khumbu LAPA: Meet with UNDP/Nepal to discuss results and integration HMGWP with the UNDP Imja lake project

3. Identify and develop plan to mainstream priority climate change adaptation projects: Emerging glacial lakes--problems and prospective solutions, e.g., Ngozumpa glacier in collaboration with Climber-scientist small grantee Ulyana Horodyskyj

4. Development of Case Study: Glacial Lake Risk and Adaptation Options in the Mt. Everest Region of Nepal using the USAID Mainstreaming Framework and results from the V&A training, community consultations, and glacial lake field studies and modeling results.

Subtask 3.2.3.2 – Khumbu Valley GLOF reconnaissance, risk modeling, and community-based risk management and mitigation

1. Continue development of enhanced GLOF model with parameters for debris flow, moraine stability, breach formation, and avalanche wave set-up and glacial lake hydrology (water balance) model for Imja Lake, including: Weather survey at glacier, including wind speed and temperature measurements in glacier debris-cover.

2. Discuss recent findings with the community, and request feedback, starting with the Khumbu Alpine Conservation Committee (KACC) and extending to other groups such as the National Park and others.

3. Collaborate, as requested, with the UNDP *Community-based Outburst Flood and Flood Risk Reduction* project.

3. Itinerary and Daily Activities

August 28-31 – Travel from Austin, TX to Nepal. Delayed one day in Tokyo due to aircraft maintenance difficulties. Overnight in Tokyo and then overnight in Bangkok.

September 1 – Kathmandu - Preparation for travel to Khumbu. Writing and editing report on analyses of Khumbu climate trends. Preparation of National Parck permit documents. Prepared and programmed temperature sensors for deployment at Imja glacier. We need to measure the temperature gradient (survace to ice at about 40-60 cm) in order to estimate the melting rate of the glacier for the glacier lake hydrology model. Sis holes will be dug in the glacier debris and sensors installed in each hole. Two holes will have sensors measuring temperature every 10 minutes (Short Term sensors) and four holes will measure once per hour (Long Term sensors). We will remove the Short Term sensors and return them to Kathmandu with us and download the data before returning to the US. The Long Term sensors will remain in the ground measuring temperature for one year. The sensors were provided by HRE and are manufactured by TandD Corp. TR-52 (Accuracy: Avg. ±0.3°C [-20 to 80°C]).

Due to the National Park staff's sensitivity regarding the placement of time-lapse cameras on the glaciers in Sagarmatha NP, we decided not to bring the camera with us at this time and to lleave it in the Himalayan Research Expeditions office in Kathmandu until we can secure permission to deploy it at Imja glacier.

September 2 – 4 – Three days of attempts to fly from Kathmandu to Lukla and trek to Phakding failed due to weather. All flights were cancelled. Worked on plan for sampling the water seeping from the terminal moraine face at Imja Lake. We will test the water to determine if it is precipitation, melted ice or lake water. If it is lake water, then there is a direct route for water to seep from the lake to the downstream face of the moraine and may represent a major instability in the terminal moraine complex. Worked on analyses of Khumbu climate trends.

September 5 – Fourth day to attempt to fly from Kathmandu to Lukla and trek to Phakding. Weather was bad and all flights were cancelled. Helicopter was hired to fly us to Shoolkay, two hour trek below Lukla. Trek to Phakding and overnight there. Revised trip schedule in light of losing 3 full days to weather. Had stomache bug in the evening, but passed by midnight.

Figure – Helicopter landed in field at Shoolkay.

September 6 – Trek to Namche Bazar and overnight there. Meet Climber-scientist small grantee Ulyana Horodyskyj who joined us for the work at Imja.

September 7 – Acclimatization day at Namche Bazar and overnight there. There has been no electricity in the village for the past 3 months as the turbines in the hydroelectric plant are upgraded. Writing and editing report on analyses of Khumbu climate trends using Pyramid climate data from 4 stations in the Khumbu. The climate data that we received from the Pyramid station (2003-2011) shows: increasing monthly temperature at Pyramid station, increasing monthly temperature at Pheriche, no change in monthly temperature at Namche, and decreasing monthly temperature at Lukla.

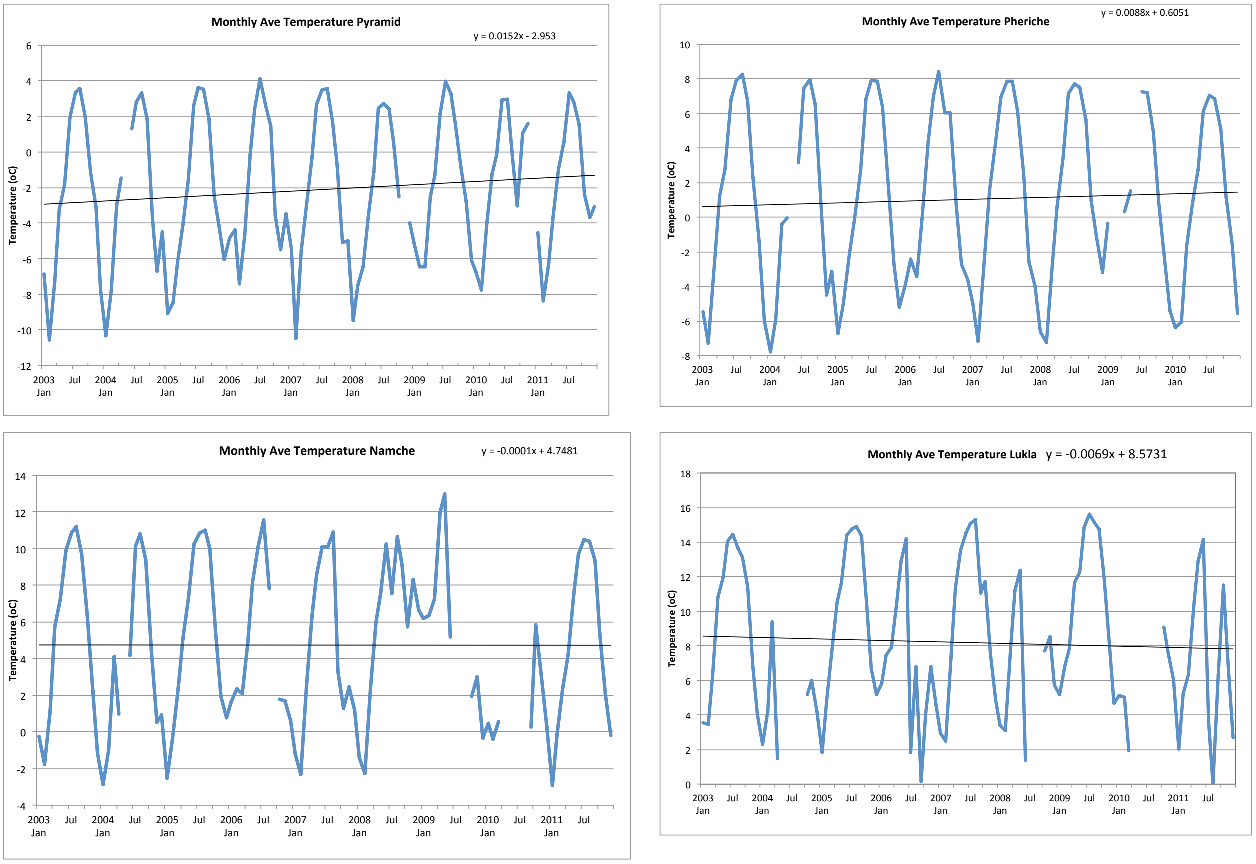

Figure – Temperature trends at Khumbu stations (Pyramid, Pheriche, Namche, and Lukla).

September 8 – Trek to Tengboche and overnight there.

September 9 – Trek to Dingboche and overnight there. I had altitude sickness in the afternoon on the way to Dingboche. Fine in the evening.

September 10 – Acclimatization day at Dingboche and overnight there, brief KACC representative Sonam Ishi Sherpa on Imja Lake studies and next steps. Took field measurements of water levels and terrace elevations for GLOF modeling.

Table – Locations and Distances From River Surface to Agricultural Terraces at Dingboche.

Date	North (deg)	North (min)	East (deg)	East (min)	Elev (m)	Distance to water (m)
9/9/13	27	53.563	86	50.092	4321	22
9/9/13	27	53.611	86	50.139	4330	23
10/9/13	27	53.648	86	50.160	4341	31
10/9/13	27	53.666	86	50.193	4349	25.8
11/9/13	27	53.753	86	50.178	4369	25.8

Figure – Measuring distances from river surface to agricultural terraces at Dingboche.

Figure – Location of river survey points at Dingboche.

September 11 – Trek to Chukhung and overnight there.

September 12 – Trek to Imja Lake. Set up weather measurement instruments.

Figure – Weather station site (left) and station (right)

September 13 – Imja Lake – Installed temperature sensors at different depths in holes in the debris of Imja glacier. A total of 6 holes were instrumented and 6-7 sensors placed about 5-10 cm apart to depths up to 50 cm (see table): 2 short-term (removed after 5 days) and 4 long-term (to be removed after one year). These measurements are needed in order to complete the glacier hydrology component of the Imja Lake hydrologic model.

Table – Locations of Temperature Sensors and Weather Station at Imja Glacier.

Point #	Date	North (deg)	North (min)	East (deg)	East (min)	Elev (m)	Depth to Ice (cm)
ST-1	13/9/2013	27	54.055 N	86	56.222 E	5048	30
ST-2	13/9/2013	27	54.027 N	86	56.209 E	5040	40
LT-1	13/9/2013	27	54.055 N	86	56.222 E	5048	31
LT-2	13/9/2013	27	54.027 N	86	56.209 E	5040	47
LT-3	13/9/2013	27	54.027 N	86	56.27 E	5053	36
LT-4	13/9/2013	27	54.043 N	86	56.261 E	5054	40
AWS	13/9/2013	27	54.101 N	86	56.266 E	5041	Weather St.

Figure – Location of temperature sensors and weather station at Imja glacier.

Figure – Installing temperature sensors at Imja glacier.

September 14 – Imja Lake – Flow measurements were made at the Imja Lake outlet (bridge over the Imja Khola) and the moraine seepage location. At the bridge, 3 sets of measurements were taken and an average flow of 2.2 m^3/s was calculated. At the seepage outlet, 2 set of measurements were taken and an averge flow of 0.005 m^3/s was calculated. Water samples were taken of the lake outlet, seepage water, and fewsh snow at the base camp. The samples were sent for analysis by Jeff Le Frenierre at Ohio State University to determine the origin and differences in the water. If the seepage water is originating at the lake, then there is a direct conduit from the lake to the face of the moraine.

Figure – Measuring flow at bridge below Imja Lake outlet (left) and seepage (right).

Figure – Locations of flow at bridge below Imja Lake outlet and seepage.

Figure – Locations of water samples (WS-1, 2 and 3) near Imja Lake outlet and seepage.

Table – Locations of Water Samples at Imja Lake and Glacier.

Point #	North (deg)	North (min)	East (deg)	East (min)	Elev (m)	
WS-1	27	53.961	86	54.284	4968	Imja Outlet Bridge
WS-2	27	53.886	86	54.242	4982	Snow at Imja Lake Base Camp
WS-3	27	53.898	86	54.335	4975	Seepage outflow
WS-4	27	54.055	86	56.222	5048	Melt pond near ST1/LT1
WS-5	27	54.101	86	56.266	5041	Melt pond near AWS
WS-6	27	54.052	86	56.264	5050	Debris hole 5

September 15 – Imja Lake – Survey of glacier calving front from Amphu (South) side of Imja Lake.

Figure – Imja Glacier Calving Front from Amphu (south) side of lake.

Table – Location of Glacier Calving Front Survey at Imja Glacier.

Point #	Description	North (deg)	North (min)	East (deg)	East (min)	Elev (m)
3	Rock above Amphu	27	53.589 N	86	55.940 E	5150

September 16 – Imja Lake – GPR and debris thickness survey on Imja glacier.

September 17 – Imja Lake – GPR and debris thickness survey on Imja glacier

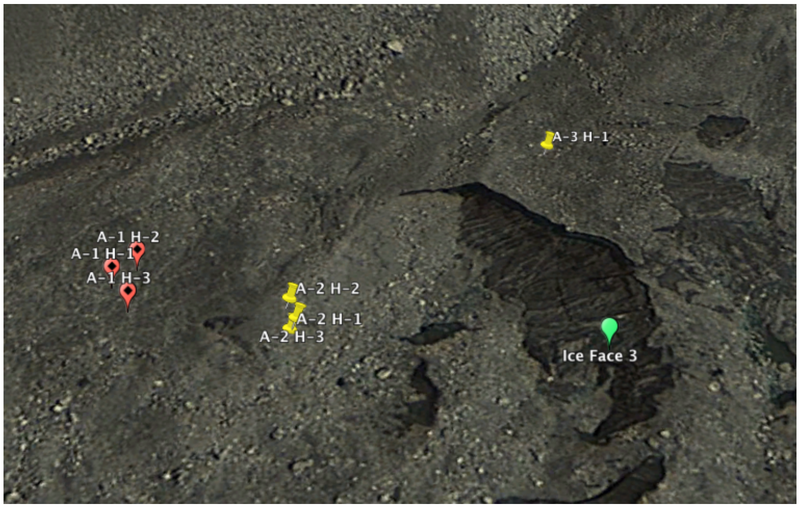

Figure – Location of Imja Glacier debris thickness survey.

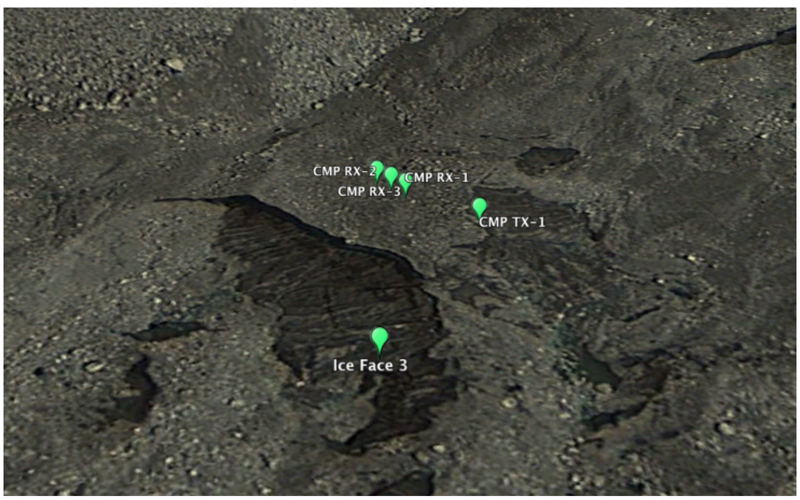

Figure – Location of Imja Glacier ice face for Common Midpoint GPR survey.

Figure – Imja Glacier ice face for Common Midpoint GPR survey.

Table – Points for Imja Glacier Common Midpoint GPR Survey.

Point #	Description	Date	North (deg)	North (min)	East (deg)	East (min)	Elev (m)
1	Receiver 1	17/9/2013	27	54.127 N	86	56.398 E	5066
2	Receiver 2	17/9/2013	27	54.129 N	86	56.396 E	5060
3	Receiver 3	17/9/2013	27	54.131 N	86	56.394 E	5057
4	Transmitter 1	17/9/2013	27	54.119 N	86	56.408 E	5066
5	Pyramid Top	17/9/2013	27	54.12 N	86	56.406 E	5067

September 18 – Collect field instruments from glacier, conduct further debris thickness survey (16 holes dug and measured) and trek to Dingboche. Overnight in Dingboche.

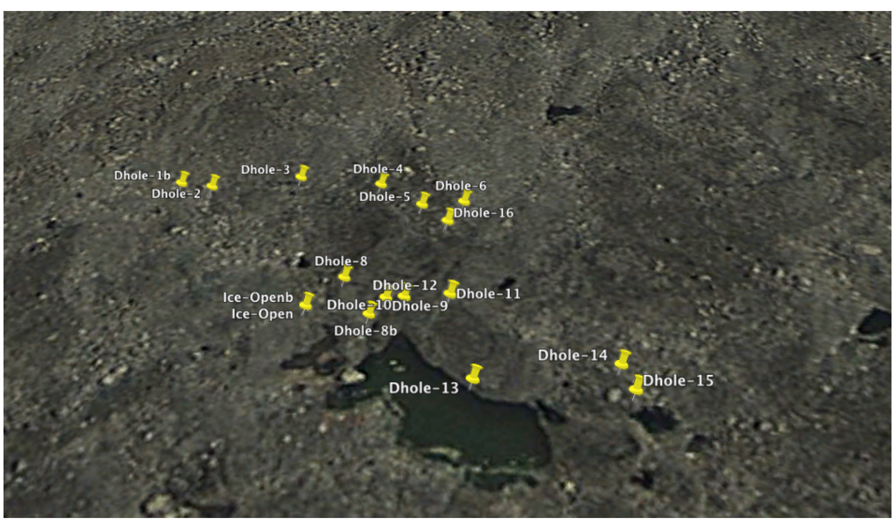

Figure – Location of further Imja Glacier debris thickness survey.

September 19 – Trek to Lebouche. Overnight in Lebouche.

September 20 – Lebouche – Meeting with EVK2 Pyramid staff to discuss data exchange and future collaboration. Overnight in Lebouche. We had a good tour of all the Pyramid Station facilities. Pyramid staff agreed to give us climate data from 1990 to 2003 to filling missing data that we did not receive before. This will greatly improve the Imja glacier hydrology model. They also agreed to give us climate data from 2011 – 2013 (to present).

September 21 – Trek to Deboche. Meet with Alton Byers and UNDP Imja Lake Project staff. Overnight in Deboche.

September 22 – Trek to Namche Bazar and overnight there.

September 23 – Trek to Phakding and overnight there. Field measurements of water levels and terrace elevations for GLOF modeling.

September 24 – Trek to Lukla and overnight there.

September 25 – Fly to Kathmandu

September 26 – Kathmandu. Download debris temperature sensor data from sensors at HRE office.

September 27 – Kathmandu. Meet with Birendra Bajracharya from ICIMOD about satellite images. Birendra informed us that ICIMOD has received one set of images form the International Space Station from NASA – Huntsville but the Imja area was completely clouded over, so the images are not useful for us. He did not know when they would receive any new images of the frequency of image capture by NASA. He encouraged us to contact HASA-Huntsville and work directly with them. We set up weather station download and double checked the download of debris temperature data at HRE office.

September 28 – Kathmandu. Prepare for departure to US.

September 29 – Fly to Bangkok overnight there.

September 30 – Fly to Austin, TX