Presidential Faculty/Student Collaboration and Publication Grant
Deadline Monday, February 24th

Please use this checklist and budget. Include with your completed application. For more information about Presidential Faculty/Student Collaboration and Publication grants, please see https://gustavus.edu/kendallcenter/grant-opportunities/presidential-grant.php.

FACULTY INFORMATION

Name: Jeff La Frenierre | Email: jlafreni@gustavus.edu

Department: Geography | Rank: Assistant Professor

STUDENT INFORMATION

Name: Helen Thompson | Email: hthomps2@gustavus.edu

Major(s): Geography and Environmental Studies | Graduation Year: 2017

CHECKLIST

Project Details

- **X** Brief description of the proposed project including its collaborative nature
- **X** Clear statement of anticipated outcomes
- **X** Likely placement for publication or performances
- **X** Anticipated research completion date

Participant Details

- **X** Names and brief biographies of all participants
- **X** Explanation of how this project fits into the career of the faculty member
  Note: Applications from faculty at all career stages are encouraged
- **X** Explanation of how this project fits into the educational trajectory of the student
  Note: Statement should be written by the student; include year of graduation; student eligibility is limited to full-time returning students

- **X** **Presidential Budget Proposal Form**

- **X** If successful, my proposal can be used as an example to assist future applications. Check to give permission. This decision will not influence the application evaluation.

Submit electronically as a PDF to cblaukat@gustavus.edu at the John S. Kendall Center for Engaged Learning.

Presidential Faculty/Student Collaboration Grant

Budget Information

Faculty Stipend ($300 per week, up to $3,000 for a maximum of 10 weeks)
Student Summer Stipend ($400 per week, up to $4,000 for a maximum of 10 weeks)
Student Summer Campus Housing ($60 per week, for a maximum of 10 weeks)
Budget Maximum ($8,100 for all categories)

Item		**Amount**
Equipment (e.g., transcription machine, camera, cassette recorder – but not to include computer hardware)		**$ 0**
1:	Cost:	
2:	Cost:	
3:	Cost:	
Materials (e.g., books, printing, software, lab supplies)		**$ 1000**
1: Water sampling materials	Cost: $500	
2: Partial laboratory analyses (likely University of MN)	Cost: $500	
3:	Cost:	
Travel Costs (cannot include conference travel, see http://gustavus.edu/finance/travel.php for allowable travel expenses)		**$ 3700**
Airfare: MSP to Quito (Helen Thompson only)		$1200
Rental 4WD vehicle in Ecuador (2 weeks)		$ 1500
Lodging: $20/night X 20 nights (Helen Thompson only)		$400
Meals: $30 / day X 20 days (Helen Thompson only)		$600
Stipends & Housing		**$ 3040**
Faculty Stipend	$300 per week, up to $3,000 for a maximum of 10 weeks	$0
Student Summer Stipend (7 weeks)	$400 per week, up to $4,000 for a maximum of 10 weeks	$2800
Student Summer Campus Housing (4 weeks)	$60 per week, up to 10 weeks	$240
Total Expenses		**$ 4700**
Amount Requested (Total Expenses + Requested Stipends + Housing)		**$ 7740**

Have you applied for, or received funding from, another source to help support this project? (If no, skip a, b, and c below.)

X Yes ☐ No

a. Funding Source: **CICE course development grant**
b. Amount: **$2000 (verbal approval)**
c. Please explain how the Presidential grant will be used in addition to the other funding, and (if relevant), how the Presidential grant project would be impacted if external funding is not approved**. This funding source will be used for Jeff La Frenierre's airfare to Ecuador, and a portion of the 4WD vehicle rental. These funds are provided to aid in the development of Jeff's January 2016 J-term course to Ecuador. CICE approve of my continued stay in Ecuador for research purposes after course-preparation research is complete. Similarly, because several course components will be held at Chimborazo research sites, the double use of the 4WD vehicle for this research project and the course preparation is**

appropriate. Additional costs for Jeff's hotel and meals, and some laboratory expenses will be covered through Jeff's start-up fund. I have been given a verbal commitment by CICE that these funds will be available, however in case they are not, I will use a portion of my start-up funds to cover my additional expenses.

Hydrological Implications of Glacier Retreat on Andean Volcanoes

Jeff La Frenierre, Department of Geography
Helen Thompson, Geography '17

Description of Proposed Project

Background

Across the great latitudinal transect of the Andes mountain range, glacier meltwater runoff is an important component of the water budget in watersheds that are home to tens of millions of people (Barnett, Adam et al. 2005, Vergara, Deeb et al. 2007). Given the near-ubiquitous shrinkage of glaciers in the Andes (Rabatel, Francou et al. 2013), ongoing climate change thus represents a considerable driver of regional water resources insecurity (Bradley, Vuille et al. 2006, IPCC 2014). An increasing body of research seeks to quantify the contribution of glacier meltwater runoff to total watershed yield in locations ranging from Columbia to Chile (e.g. Villacís 2008, Mark, Bury et al. 2010, Gascoin, Kinnard et al. 2011), however potential underestimation of the hydrological importance of glacier-bed infiltration into groundwater systems and the logistical challenges of conducting groundwater research in remote mountain settings has meant that nearly all such research has been limited to consideration of the surface-water implications of glacier change (La Frenierre and Mark 2014). There is evidence, however, that there is a much greater connection between glacier meltwater and downstream groundwater systems than has previously been recognized, at least in certain geological settings (Favier, Coudrain et al. 2008, Baraer, McKenzie et al. 2009). Thus, in some watersheds, communities dependent on springs and other groundwater discharge systems rather than (or in addition to) surface water flows may be more vulnerable to future water stress due to ongoing glacier loss than is currently appreciated by water resource managers.

One such situation has been identified at Volcán Chimborazo, Ecuador. Chimborazo is a 6279-meter (~20,700 feet) ice-capped volcano, which features 17 glaciers radiating outward into four different watersheds (Figure 1). Several dozen indigenous communities practice smallholder agriculture on the lower slopes of the mountain, and the combination of rapid glacier retreat and increasing local water stress has become worrisome for people here. Jeff La Frenierre conducted his doctoral dissertation research here to quantify the relationship between glacier meltwater and water supply in the area (La Frenierre 2014, additional publications forthcoming). One key finding was surprising: though glacier meltwater contribution to total river flow appears minimal (less than 5%), there is significantly less surface water runoff than expected considering the relatively high precipitation, high humidity, and the rapid rate of glacier loss on the mountain. In fact, only one of the four watersheds experienced regular surface runoff at all, and even here, the proportion contributed by glacierized areas is less than half of what would be expected simply given the proportion of ice covered and ice-free surface area in the basin. This finding suggests that a high (and presently unquantified) proportion of glacier meltwater is actually infiltrating into the mountain's groundwater systems rather than flowing downriver on the surface, possibly due to the fractured and porous bedrock of the volcano. Because nearly all people here, including the 150,000 residents of the city of Riobamba, rely upon (decreasing) spring discharge for their

domestic water supplies, it appears that the potential impact of glacier loss on regional water resources has yet to be adequately resolved. As communities scramble to develop the few remaining unallocated springs on the mountain as existing water supplies become increasingly undependable, this question is one of immediate and considerable importance for the people of Chimborazo. It is also reasonable to hypothesize that similar circumstances exist on other glaciered Andean volcanoes (which stretch from Columbia through Ecuador as well as through southern Peru, Bolivia, and northern Chile).

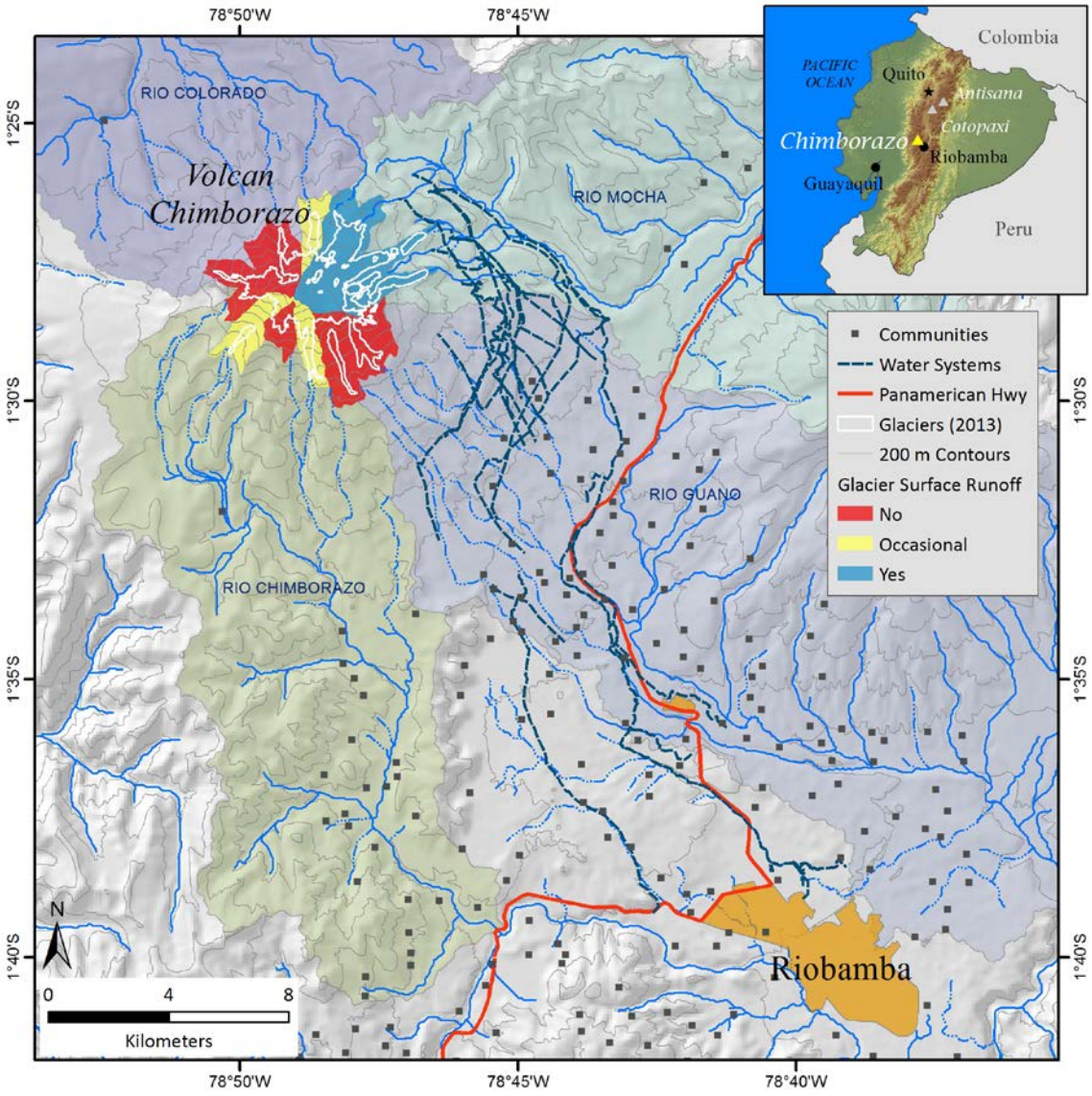

Figure 1: Volcán Chimborazo region.

Proposed Research

We propose to use requested Presidential Faculty-Student Collaboration Grant funds to support Helen Thompson in collaborative field work with co-principle investigators Jeff La Frenierre, Gene-Hua Crystal Ng (University of Minnesota), and Andrew Wickert (University of Minnesota)

in June, 2015 to produce an initial collection of data that will support a formal research proposal to the National Science Foundation's Hydrological Sciences program in 2015. Our specific research objectives for this project include:

1. Calculate a seasonably-appropriate water budget for Chimborazo's four glacierized watersheds that fully describes the distribution, movement, and residence time of glacier meltwater, including explicit quantification of glacier meltwater contribution to aquifer recharge.
2. Identify and describe aquifer systems that originate in Chimborazo's glacierized watersheds, trace the infiltration points for aquifers that supply community-developed springs, and calculate water residence times for these aquifer systems.
3. Create a predictive model of the Chimborazo's glacio-hydrological system that is capable of forecasting glacier change given a range of climate change scenarios, as well as the hydrological consequences (both for surface and groundwater discharge) of anticipated glacier change.
4. Assess the potential water resources vulnerabilities facing communities due to altered aquifer recharge resulting from anticipated acceleration of glacier loss (and other hydrological manifestations of climate change).

Note that our full proposal to the National Science Foundation will incorporate a latitudinal Andean transect of three or four research sites that integrates Chimborazo with analyses from other glacierized volcanoes in Columbia, Peru, Bolivia, and/or Chile.

In Ecuador, Helen Thompson's will take a leadership role in developing a data collection and documentation plan for an approximately three-week field season at Volcán Chimborazo. This work will include assessment of existing climatic and hydrologic data collection infrastructure in the area; identification of spring location in each of Chimborazo's four glacierized watersheds; measurement of spring and surface stream discharge rates; and methodologically-rigorous sampling of spring, well, and surface waters for later laboratory analyses that will identify unique hydrochemical signatures of different water sources for future hydrological tracing efforts. Upon return to Minnesota, Helen will assist in the preparation of water samples for laboratory analyses (facilities to be determined) and the organization and documentation of other field-collected data. Helen will also assist in the development of the NSF proposal by building a database of glacierized volcanoes in the Andes and identifying and obtaining scientific literature relating to these potential study sites. Anticipating that laboratory analyses won't be complete until the end of the summer, Helen's involvement with analysis aspects of this initial phase of research will be dependent upon her course load in the Fall 2015 semester.

<u>Anticipated Project Outcomes and Publication Outlets</u>

1. *A competitive proposal for December 2015 submission to the National Science Foundation's Hydrological Sciences program:* This field research will play an essential role in the development of a competitive multi-year funding proposal. The data collected will be used to determine the specific types, quantities, and installation locations of the instrumentation necessary for the Chimborazo component of the proposal, test proposed

methodological approaches, and further inform specific research questions and hypotheses. In addition, this field campaign will be used to identify potential Ecuadorian collaborators, including communities with whom water resources issues will be investigated, and a hydrologist who would participate in longer-term data collection and analysis activities.

2. *Scholarly presentations:* Though this initial phase of the full research project will not generate a peer-reviewed publication, results of initial data analyses will be presented in several research forums. Jeff La Frenierre will seek to share initial results and a general outline of our methodological approach with peers at the 2015 meeting of the American Geophysical Union (in a poster format). Though this conference is concurrent with the NSF proposal submission deadline, we anticipate that feedback received at AGU will be very useful in fine-tuning an effective approach to the project. Helen Thompson will present at an on-campus undergraduate research forum (e.g. 2016 Celebration of Creative Inquiry - CCI) as well as off-campus events such as the Midwest Undergraduate Geography Symposium (MUGS).
3. *Applied research experience for Helen Thompson:* This research opportunity gives Helen a great learning experience that will help her in reaching her future goal of graduate school and make her a strong candidate in careers within the fields of geography and environmental studies.

Project Participants

Jeff La Frenierre: Jeff La Frenierre is an Assistant Professor in the Department of Geography, and has been on the faculty at Gustavus Adolphus College since 2014. Jeff earned his Ph.D. in Geography from Ohio State University. His research is focused on understanding the hydrological consequences of climate change, both from biogeophysical and socioeconomic perspectives. His work focuses particularly upon mountain glacier change and its impact on downstream water supply. Jeff's dissertation research was supported by a National Science Foundation Doctoral Dissertation Research Improvement Grant, a Fulbright research grant, and funding from the Geological Society of America.

Helen Thompson: Helen Thompson is currently a sophomore attending Gustavus Adolphus College. She is majoring in both geography and environmental studies. Helen intends to continue her education in graduate school with a focus on human-environment interactions in relation to environmental problems. She is particularly interested in gaining a better understanding of the different environmental challenges that society is facing and what can be done to combat them.

Gene-Hua Crystal Ng: Crystal Ng is an Assistant Professor in the Department of Earth Sciences at the University of Minnesota. Crystal's research investigates interlinkages within hydrological systems, and the impact of environmental change on those interlinkages. Crystal's research emphasizes the use of computer models to describe the movement of water between the land surface and underground aquifers. She has conducted research in the American Great Plains, the Mojave Desert, northern Minnesota, and at Cape Cod.

Andrew Wickert: Andrew Wickert is also an Assistant Professor in the Department of Earth Sciences at the University of Minnesota, and will be starting his appointment in Fall 2015. Andy's research combines field observations, field instrumentation, and numerical modeling to understand the dynamics of ice and water in glacier systems worldwide. Andy is currently completing a post-doctoral research position at the University of Potsdam (Germany), and is conducting research in Argentina.

Relevance to Future Careers

Jeff La Frenierre: My expectation in applying for this grant is that it will help launch me on the path towards several important career goals. First, as a first-year faculty member, this project represents my first post-dissertation research endeavor. If we are successful in obtaining funding from the National Science Foundation, this will be a multiyear project that will lay the foundation for scholarly activities many years into the future. This research would support multiple peer-reviewed publications and international conference presentations, and will demonstrate the type or scholarly productivity expected of a tenured professor at Gustavus. Second, this project represents an important opportunity to develop productive relationships with external research collaborators. Given my shared interests with Drs. Ng and Wickert and my physical proximity to the University of Minnesota, I anticipate that this project could be the first of multiple research activities that we share in the years ahead. Third, this project represents my first opportunity to perform collaborative research with an undergraduate student at Gustavus. This type of opportunity is one of the primary reasons why I have sought an academic career at an institution like Gustavus, and I am extremely excited to mentor students like Helen and to see them develop into talented professionals and, perhaps eventually, academic researchers themselves. I see development of this skill as an essential part of my development as a professor.

Helen Thompson: This project fits into my career because of my future goals; I hope to become a researcher involved with environmental issues or teach at an academic institution. With my intention of going to graduate school this experience would be very beneficial to my future. It gives me the opportunity to gain first-hand research experience, which is essential for graduate school. I find this project especially fascinating because it looks at glaciers and how they interact with the environment, which is very prominent now that the effects of climate change are becoming more visible. From this project I would gain invaluable skills that I would be able to apply in graduate school, as well as build off of a growing interest in glacial processes.

Budget Justification

Travel

Roundtrip airfare Minneapolis to Quito, Ecuador for Helen Thompson (Jeff La Frenierre will use alternative funding for his airfare): $1,200

4x4 truck rental in Ecuador (2 weeks, additional rental period to be covered using alternative funding): $1,500

Lodging and meals for Helen Thompson in Ecuador (Jeff La Frenierre will use alternative funding): $1,000 ($50 day X 20 days)

Equipment

No new equipment will be purchased for this project.

Materials and Analysis

Water sampling bottles, filters, syringes, and associated materials: $500

Laboratory analysis: $500 (because laboratory availability at the University of Minnesota has not yet been determined, this is an estimated expense. If necessary, additional funds will be obtained from alternative sources such as Jeff La Frenierre's start-up funding).

Stipends

7 week stipend for Helen Thompson ($400/week; 3 weeks in Ecuador, 4 weeks in Minnesota): $2,800

4 weeks summer housing at Gustavus Adolphus College for Helen Thompson ($60/week): $240

Jeff La Frenierre is not requesting a summer stipend.

Total Request: $7,740

Anticipated Research Completion Date

The primary output resulting from this funding request, the National Science Foundation funding proposal, will be submitted on or before the Hydrological Sciences program deadline of December 7, 2015. Scholarly presentations will occur in December 2015 (La Frenierre – AGU) and in Spring 2016 (Thompson – CCI and MUGS).

References

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