PROJECT SUMMARY

Overview:

Since the Last Glacial Maximum, ~15% of Earth's terrestrial land surface has been exposed as ice sheets retreat. With exposure, "deglaciated" watersheds (separated from the ice sheet by hydrologic divides) expand and develop more drainage relative to glacial watersheds. They also allow weathering reactions of comminuted glacial sediments to progress toward completion (i.e., "weathering extent"). The combination of these effects alter stream solute and gas compositions as microbes and plants colonize the landscapes, change stream-landscape connections, and shift water availability. We hypothesize that feedbacks among biological, geochemical, and hydrologic processes control weathering extent and contend that understanding these processes is vital to enhancing predictive capabilities for how polar amplification of global warming will impact Arctic environments and societies. The societal impacts emphasize the need for effective non-technical communication of scientific findings to the public, including policy makers. However, communication between scientists and lay audiences has become increasingly challenging as science becomes more specialized and general populations become more skeptical of science, especially climate science. This difficulty highlights the need for "environmental civics", a term we use to represent science communication and leadership skills, and which makes up an integral component of this project.

We propose to test our overarching hypothesis in distinct hydrologic settings of western Greenland including supraglacial, subglacial, proglacial, and three deglaciated watersheds with differing characteristics. During two melt seasons, we propose to conduct high frequency sampling and logging for measurements of microbial community structures, radiogenic isotopes, and biogeochemically relevant solute and gas concentrations and isotope ratios at watershed outlets and within watersheds. The sampling and data collection efforts will be coupled to automated weather observations, dust collection, dosing experiments in stream reaches, and plant surveys. Stream bedload will be collected once per year per site. These data, to be collected and analyzed in collaboration with Greenlandic researchers, will reveal how weathering extent, solute and gas fluxes, and ecosystem characteristics vary across the spectrum of watersheds within the periglacial system. Our environmental civics plan includes a teacher-education program, in which our cohort will collaborate with Greenlandic researchers and high school teachers to develop climate change curricula to be disseminated on the Greenland high school web portal. We will develop educational materials to be offered at appropriate levels, as determined by our Greenlandic colleagues, for tourism in Greenland, Greenlandic secondary schools, and the Arctic Technology Center.

Intellectual Merit:

Changing Arctic weathering reactions have global impacts as they alter solute and gas fluxes to the atmosphere and ocean as shown by shifts in seawater Pb isotopes preserved in deep-sea sediments across glacial terminations. Although solute and gas fluxes are commonly measured in glacial runoff and subglacial outlets, an understanding of their contribution to the Arctic system is incomplete without considering flux measurements across periglacial landscapes. Such information is particularly critical as polar amplification of global warming increases the rate of Arctic environmental change. The proposed work will improve capacity to predict future shifts in weathering and related fluxes, bioavailability of nutrients discharged to the ocean, and interpretation of deep-sea records of past change while emphasizing environmental civics and training in science communication.

Broader Impacts:

Understanding controls of changing weathering reactions and solute fluxes will position scientists, policy makers, and the public to best prepare for environmental change, but only if scientific findings can be communicated effectively. Such communication skills will be developed in a cohort of seven PhD students and their faculty advisors through practicums developed in our work plan, including teacher-education programs, development of educational materials, and other outreach activities in Qeqqata Municipality, our primary field location. These practicums, and our partnership with Greenlandic researchers, will expand collaborations between US and Greenlandic researchers. Work proposed here will provide baseline information for expanded research opportunities as a proposed road through the interior of Qeqqata is developed.