Overview

Outburst megafloods from glacial Lake Missoula, occurring from 22,000 to 14,000 years ago, are the largest known floods on Earth. Prior estimates of water volume and flow discharge during these flood events rely on slopes based on modern topography. Nevertheless over this time period, glacial isostatic adjustment caused crustal deformation with rates of ~10 mm/yr (orders of magnitude above regional uplift rates), and changed local slopes by ~30%. Thus prior estimates of flood volumes include a potentially large error, which has not yet been quantified. Furthermore, over the interval of Missoula flooding, patterns of uplift and subsidence due to glacial isostatic adjustment evolved significantly, and this reshaping of topography may explain observed changes in flood routing over time.

This proposal, within disciplines of geomorphology and geophysics, seeks to investigate the influence of glacial isostatic adjustment on the Channeled Scablands landscape as it developed over the course of Missoula megaflood events. Three interconnected goals for this project are proposed: **(1)** reconstruct *drainage path evolution* across the interval of flood events in response to glacial isostatic adjustment; **(2)** accurately *estimate flood discharge* using slopes corrected for glacial isostatic adjustment; and **(3)** connect the *response of ocean, and broader climate system*, to newly-refined estimates of total freshwater flux. Glacial isostatic adjustment simulations will be performed to predict paleotopography and paleoslopes in the Channeled Scablands. Flood drainage pathways and flood discharge estimates will be calculated using the resulting topography corrected for glacial-isostatic adjustment. Finally these new estimates of freshwater flux will be compared to the geochemical record of sediment cores collected off the Oregon coast, to assess the response of the ocean's biological system to megaflood events. Tamara Pico will carry out this work under the supervision of host mentor Professor Michael Lamb (California Institute of Technology) and co-mentor Alan Mix (Oregon State University). The PI is uniquely positioned to tackle the proposed research, which transcends multiple scales by using glacial-isostatic adjustment modeling to connect geomorphic processes to both small and large wavelength features of the mantle's response to ice loading, ultimately linking local short-lived outburst flooding to longer global climate changes.

Intellectual Merit

This study aims to (1) understand the timing and routing of megafloods, (2) improve estimates of total discharge during flood events and (3) quantify the response of the ocean and broader climate system to megafloods. Accurately quantifying the volume and discharge associated with Missoula megafloods will frame our understanding of erosional processes involved in canyon carving, as well as ocean's biological response to these massive freshwater events.

The proposed research will be the first study to quantify the influence of glacial-isostatic adjustment on the Missoula megafloods. This interdisciplinary project weaves together the expertise of geomorphologists, paleooceanographers, and geodynamicists, making an important stride towards a holistic understanding of the Earth's system.

Broader Impacts

This scientific work delves into past climatic and flooding events, with implications for understanding modern climate stability and flood hazards. Further, this proposal will fund mentoring and academic scholarship aimed at the recruitment and retention of underrepresented minorities, including the hiring of undergraduate research assistants and publications on gender disparities in geoscience. The PI has extensive leadership and outreach experience in women in science and underrepresented minority groups, and will continue a committed involvement in these communities.