2025-2026 Twinning Program Research Projects

PROJECT 2: Quantifying infrastructure resilience to volcanic hazards in Cascadia

Project Director:
Einat Lev
Columbia University:
Lamont-Doherty Earth Observatory (Palisades, NY)

Twin Mentor:
Nathaniel Klema
Fort Lewis College (Durango, CO)

Project Summary:
This project will develop a formal educational collaboration between the Lamont-Doherty Earth Observatory (LDEO) and the Engineering/Applied Physics department at Fort Lewis College (FLC), which is an MSI identified as a Tribal Serving Institution. The work will leverage existing tephra dispersion models accessible through the VICTOR project by using model outputs for potential eruptions of high-threat volcanoes in the Cascades subduction zone as initial conditions for assessing structural stability and resilience of infrastructure in surrounding communities. A student with a background in structural/civil engineering or physics will learn to identify vulnerable structures and generate load maps for a range of eruption scenarios. Scenarios will be informed by the current understanding of potential eruption behaviors at South Sister, Mount Hood, Mount St Helens, Mount Adams, and Mount Rainier. In addition to providing access for an FLC student to the expertise and resources available at LDEO, this project would expose the student to interdisciplinary research that connects volcanology to civil/structural engineering, thus increasing the societal impact of open-source volcanology codes and the VICTOR platform.

Role and probable activities for a student researcher in this project:
The student researcher will first become familiar with the execution of ash and tephra dispersal codes available on the VICTOR platform, including tephra2 and ASH3D. They will then generate maps of spatial load distributions from tephra fallout encompassing a range of eruption scenarios for each volcano based on current knowledge of chemical compositions, potential eruption volumes, likely weather conditions, and tephra properties (grain size distributions, moisture content). The student will design and conduct a streamlined quantitative comparison between the predictions of the two tools and assess the sensitivity of model outputs to variation in input parameters. The student will also study common regional design trends and perform structural analyses to derive generalized failure criterion for essential infrastructure elements. These criteria will then be compared with the tephra fallout maps to assess vulnerability of northwestern communities to regional volcanic hazard and identify regions of likely infrastructure problems in the event of a volcanic eruption.

Preferred Skills
This project will require proficiency in programming (preferably in Python) and experience calculating dynamic loads on structural elements. A student participant will be required to have passed courses on basic python programming and engineering dynamics. An ideal candidate will also have completed courses on computational methods and the mechanics of materials. An interest in geoscience and geological hazards are a plus.