PROJECT TITLE: Revegetation and landscape stabilisation after explosive eruptions

DTP Research Theme(s): Dynamic Earth

Lead Institution: University of Bristol

Lead Supervisor: Byron Adams, University of Bristol School of Earth Sciences

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Project keywords: slope stability, revegetation, landslides, explosive volcanic eruptions

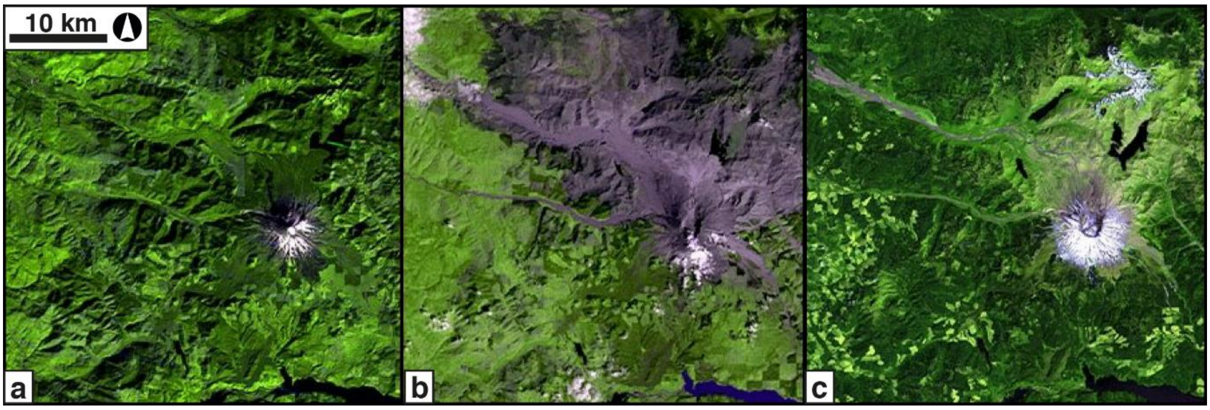

Figure 1. Landsat satellite visible-near infrared images of Mount St. Helens, USA. (a) 1974. (b) 1980, shortly after the eruption that year. (c) 2011. Note the change in topography and ground cover (green: vegetation; grey: volcanic material) (a) before and (b) after the eruption, and the re-establishment of vegetation between (b) and (c).

Project Background

Vegetation is a key factor in the stability of hillslopes and river channels. The pace of revegetation and the types of pioneering species strongly affect rates of surface processes by strengthening soil with their roots (Hales, 2018), and moderating hydrology (Neilson, 1995). Therefore, losing vegetation during cataclysmic events such as volcanic eruptions (Figure 1) can perpetuate long-term instabilities in the landscape such as landslides, lahars, and riverbank erosion (Gran et al., 2005; Horton et al., 2017).

Satellite-based monitoring of vegetation has been routine for decades (Hansen et al., 2008), but its full potential in testing geomorphic hypotheses has yet to be realised, primarily because the details of vegetation types, rooting properties, etc. are difficult to assess at course resolution. New, high resolution visible and near-infrared remotely sensed data and improved digital topography data provide an opportunity to improve our ability to relate the properties of vegetation to geomorphic change across large areas and through time.

Project Aims and Methods

There are two primary tasks involved with this project; however, there is also scope for the student to explore other lines of research as new, exciting hypotheses emerge.

Task 1) Quantify the amount of devegetation after recent eruptions of Mount St Helens (USA) and Mount Pinatubo (Philippines), and the pattern and pace of revegetation. These observations will be derived from a time series of remotely sensed datasets, which will be largely sourced from the Google Earth Engine. Depending on the interests of the student Task 1 may also include a field component where remote sensing data are ground truthed in the USA or the Philippines.

Task 2) Develop methods for estimating the timescale of landscape stabilization after an eruption based on the quantitative understanding of the way vegetation returns in different settings from Task 1. This task may be accomplished by using existing programs, which estimate the factor of safety including root cohesion. Alternatively, models may be designed by the student based on their observations from Task 1.

Candidate Requirements
This project requires a student with a background in geology, physical geography, engineering or a related topic. Programming or GIS experience is desirable. Good communication and the ability to work independently, as well as in a group, are essential skills.

CASE or Collaborative Partner
The collaborative partner for this project is Cardiff University. There will be regular meetings between the supervisory team, both by video conference and in person. This will provide the student with access to Dr Hales who is an expert in hillslope processes, especially in the context of plant root strength. Dr Hales has a great deal of experience with many of the numerical models that are likely to be used in this project.

Training
The student will receive training in remote sensing, geographic information systems, data analysis and statistics, and models of slope stability. Where necessary, training in appropriate computational languages will be provided. The student will acquire a diverse range of numerical skills that will prepare them for a career either in academia or in the consulting industry. The student will attend at least one major international conference - either the American Geophysical Union (San Francisco) or the European Geoscience Union (Vienna). In-the-field survey training (in the USA or Philippines) may also be provided if that is of interest to the student.

References
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Hansen, M.C., et al. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, 342, 850-853.

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Neilson, R.P. (1995). A model for predicting continental-scale vegetation distribution and water balance. *Ecological Applications*, 5, 362-385.

Schmidt, K.M., et al. (2001). The variability of root cohesion as an influence on shallow landslide susceptibility in the Oregon Coast Range. *Canadian Geotechnical Journal*, 38, 995-1024.

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The application deadline is 1600 hours GMT Monday 6 January 2020 and interviews will take place between 10 and 21 February 2020

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