Improved estimates of supraglacial debris supply from Alpine rock walls

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Project aims

The aim of this project was to capitalise on recent advances in emerging high-resolution topographic surveying and digital elevation model of difference (DoD) methods to constrain rates of rockfall activity (as a proxy for debris supply) on steep Alpine bedrock slopes.

Methods

The research focused on slopes above Miage Glacier, Italy; the largest debris-covered glacier in the European Alps. The original proposal included target slopes above the Glacier de Bionnassay, France, but these were subsequently ruled out due to logistical constraints. Instead, an increased number of rock slopes than originally planned were successfully surveyed adjacent to the Miage Glacier and its tributaries.

A lightweight multirotor drone was used to capture overlapping RGB images of target rock walls. Surveys were undertaken in June and September 2016 and 2017. Photosets comprised ~4000 photographs apiece. Survey areas comprised a range of recently glacially debuttressed slopes as well as slopes which are anticipated to have been ice-free for considerably longer (i.e. 10^2 – 10^3 yrs) (Fig. 1).

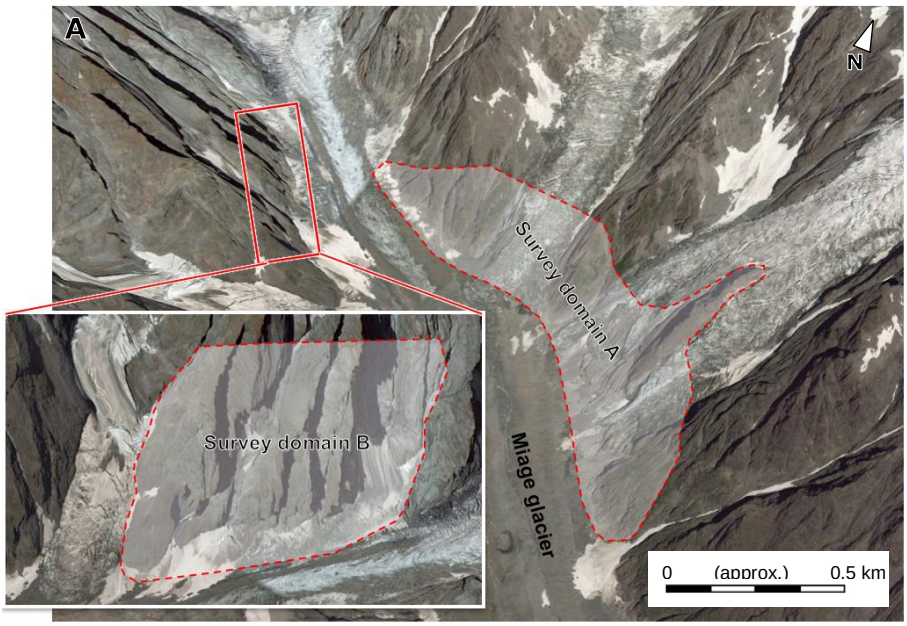

Figure 1. A: Rock wall survey domains in the upper catchment of the Miage Glacier. B: Example drone photography of complex rock assemblages, where (1) reflects rock slope topography which is likely to have been exposed since the Little Ice Age. (2) and (3) have been recently debuttressed by a tributary of the Miage Glacier (5), where the latter is currently exposed to meltwater flow. Rock slope (4) has been debuttressed by the catchment trunk glacier (Miage). Ongoing analysis will focus on variations in the nature of rockfall release from these contrasting types of rock slope.

Interim outcomes and ongoing work

Preliminary high-resolution 3D surface models have been generated using Structure-from-Motion methods. The grant holder will collaborate with colleagues at Durham University (Carbonneau) to explore the use of 'direct georeferencing' for removing the requirement for dedicated ground control for producing scaled and georegistered 3D models; this is anticipated to represent a significant advance for quantitative geomorphology and rock slope process studies. DoD methods will be used to generate rockfall/mass movement inventories for the target slopes, from which depth, area, volume, location etc information can be analysed. Methods currently in development by colleagues at Newcastle University (Dunning) will be used to extend spatial and temporal detail of the inventory by applying optical analysis methods to date older rockfall scars. Submission of project manuscripts to *ESPL* will commence in 2018.

Value of the grant and pump priming

The grant holder has benefited from additional in-kind funding via Northumbria University, which has extended the number of original field visits and considerably increased the volume of data generated by the project. Interim SfM models of the study slopes were used to support a successful application by the grant holder for the position of Vice Chancellor's Research Fellow in Extreme Environments within the Faculty of Engineering and Environment, Northumbria University, which commenced on 1st September 2017. Discussions about this work have also led to expansion of the grant holder's research network to include overseas colleagues with which the grant holder is currently working to develop funding proposals for quantifying rockfall activity and links with permafrost degradation across large (>1000 m) vertical domains in the European Alps using cable car-based SfM. Initial funding applications for this work will commence in December 2017.