Geomorphological and sedimentological analyses of outburst flood deposits around Öræfajökull, SE Iceland

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Summary and aims

The high magnitude and low frequency occurrence of outburst floods (jökulhlaups) makes them very difficult to measure directly. Increasing global temperatures as a function of global warming are likely to change both the magnitude and frequency of outburst floods. Iceland provides the opportunity to utilise a combination of historic record (Sagas) together with field evidence to constrain the distribution and magnitude of past jökulhlaup events. The aim of this project was to reconstruct the characteristics of the 1362 and 1727 CE Öræfajökull outburst events in the Kotá valley, SE Iceland, which caused fatalities and significant damage to farmland.

Methodology

We used field data, aerial imagery and a 5m LIDAR DTM in order to produce a geomorphological map of the valley. Even with a 5 m DTM, small-scale topographic features (<10 m scale) are often obscured. We selected a site containing small-scale topographic features which we wanted to investigate further. We used unmanned aerial vehicle (UAV) remote sensing using a DJI Phantom. The survey was georeferenced using ground control points. Flights were pre-planned to ensure 80% endlap and 85% sidelap, providing maximal overlap between adjacent images. The data were analysed using Structure from Motion (SfM) to create 3D imagery and a Digital Terrain Model (DTM). The model accuracy of the UAV imagery is ± 5 cm. The resolution of the Orphophotos is 1.5 cm, whilst the resolution of the DTM is 5.9 cm. Boulders were also sampled in the field in order to undertake historical flood modelling based on the approach of (Mather and Stokes, 2016) and terrace levels were surveyed, to help understand the evolution of the flood deposits.

Main findings

The Kotá Valley emanates from Öræfajökull in a south westerly direction. Two glaciers, Kotárjökull and Rótarjökull occupy the upper catchment and would have previously coalesced down valley. The flood deposits are extensive and several terrace levels are apparent and can be mapped up valley. On the eastern side of the valley, well preserved terraces exist, which have subsequently been downcut by fluvial erosion, exposing sediment sections. Primary routing of the 1727 flood appears to have been towards the western part of the valley, forming a large dark-coloured fan. The large size of the fan attests to the highly debris-charged flows needed to transport such large amounts of sediment. The landscape preserves numerous kettleholes, which formed as a result of melting ice blocks, deposited by the flood waters. Large boulders are found within the flood deposit limits which have been transported >2km from their source. These consist of palagonite and tillite. It is difficult to delimit the extent of the 1362 eruption as it appears to have been almost entirely covered by the 1727 deposits. The UAV survey allowed an orphophoto to be produced, which can be viewed in 3D, as well as a DTM (Figure 1). This survey allows for the description of small-scale topographic features in much more detail than would be possible otherwise. This site contains kettle hole topography and the orthophoto allows for the identification of former meltwater channels as well as small-scale depressions and ridges at the site. The historical flood modelling is ongoing and the detailed morphological observations are currently being combined with the sedimentological data.

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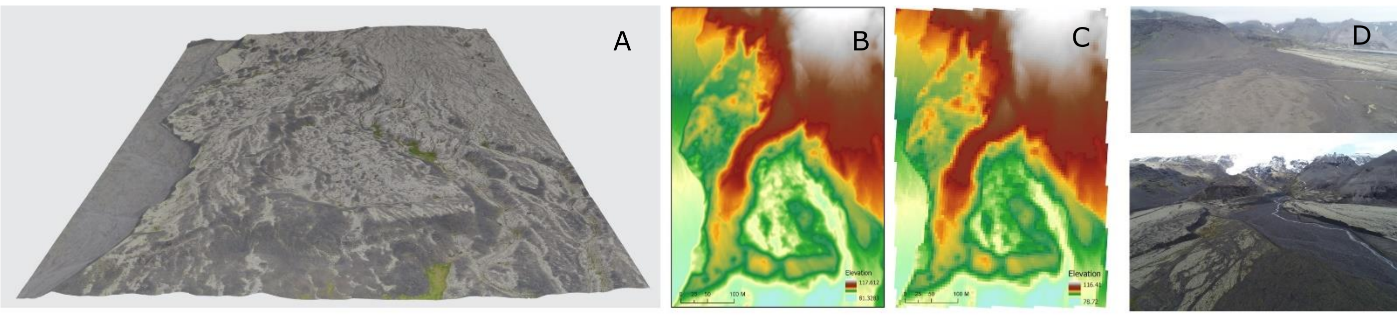

Figure 1. 3D Structure from Motion imagery (A), UAV derived DTM (B), Lidar DTM (C) UAV oblique images of the fan deposits looking up-valley (D).

References

Mather, A.E. & Stokes, M. 2016. *Earth Surface Processes and Landforms*. DOI: 10.1002/esp.4001