Geophysical Research Abstracts
Vol. 14, EGU2012-5046, 2012
EGU General Assembly 2012

Robust 3D Quantification of Glacial Landforms: A Use of Idealised Drumlins in a Real DEM

J. K. Hillier (1) and M. S. Smith (2)

(1) Loughborough University, Dept. Geography, Loughborough, UK (j.hillier@lboro.ac.uk), (2) Kingston University, Dept. Geography, London, UK (mike@hsm.org.uk)

Drumlins' attributes, such as height (h) and volume (V), may preserve important information about the dynamics of former ice sheets. However, measurement errors are large (e.g., 39.2% of V within ±25% of their real values for the 'cookie cutter') and, in general, poorly understood. To accurately quantify the morphology of glacial landforms, the relief belonging to that landform must be reliably isolated from other components of the landscape (e.g. buildings, hills). A number of techniques have been proposed for this regional-residual separation (RRS). Which is best? Justifications for those applied remain qualitative assertions. A recently developed, novel method using idealised drumlins of known size (h_{in}, V_{in}) in a real digital elevation model (DEM) is used to quantitatively determine the best RRS technique, allowing general guidelines for quantifying glacial landforms to be proposed.

184 drumlins with digitised outlines in western Central Scotland are used as a case study. The NEXTMap™ surface model (DSM) is the primary dataset employed. A variety of techniques are then investigated for their ability to recover sizes (h_r, V_r). A metric, ϵ, is used that maximises the number of H_r/H_{in} values near 1.0 whilst giving equal weight to different drumlin sizes: a metric dominated by the large number of small drumlins is not desirable. For simplicity, the semi-automated 'cookie cutter' technique is used as a baseline for comparison. This removes heights within a drumlin from a DEM, cuts a hole, then estimates its basal surface by interpolating across the space with a fully tensioned bi-cubic spline (-T1). Metrics for h and V are ϵ_h = 0.885 and ϵ_V = 0.247. Other tensions do not improve this significantly, with ϵ_V of 0.245 at best, but using Delauney triangulation reduces ϵ_V to 0.206. Windowed 'sliding median' filters, which do not require heights within drumlins to be removed, attain a minimum ϵ_V of 0.470 at a best width of 340 m (-Fm340). Finally, even crudely (-Fm60) removing clutter (e.g. trees and buildings) to estimate a terrain model (DTM) before processing improves ϵ_h dramatically to 0.412. Mean height ($\overline{h_{in}}$) of 6.8 m is then much better recovered at 7.1±0.3 (2σ), as opposed to 12.5 ± 0.6 (2σ) before decluttering. So, guidelines proposed to best quantify mapped glacial landforms are to i) declutter before ii) removing heights within the drumlin, then iii) interpolating to estimate a basal surface using Delauney triangulation. Mapping landforms' outlines from DTMs is not recommended since outlines are shifted by the distortions they contain, inducing errors.

The 'synthetic' DEMs used have been demonstrated to be statistically valid, reliably representing reality. So, the optimal isolation method will now be used to assess the drumlins and their populations in the study area. Synthetic DEMs could be readily created to assess a variety of other landforms and other areas.