Geophysical Research Abstracts
Vol. 18, EGU2016-10894, 2016
EGU General Assembly 2016


# Reliability of drumlin morphometric data based on manual mapping – assessment of inter-mapper differences using a morphometrically diverse sample of relict drumlins

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Mapper-dependent (subjective) differences in drumlin morphometry have received little attention even though over one-hundred thousand drumlins have been manually mapped and used to characterize drumlin morphometry and infer drumlin genesis, and several obstacles to objectivity in drumlin mapping can be identified. Due to uncertainty in drumlin genesis, drumlins remain putative morphogenetic landforms, yet still lack a complete single morphological definition. Additionally, post-formational degradation of relict subglacial landscapes challenges our ability: 1) to identify all drumlins in the landscape (some [potential] drumlins may be too degraded to be mapped and are thus excluded from the inventory), with implications for the analysis of field properties (e.g., spatial arrangement and autocorrelation); and 2) to accurately map the original footprint (i.e. shape and size). These issues (definitional ambiguity; degradation of original drumlin topography) are a problem for both manual and automated mapping. Automation is touted as the solution to the subjectivity of manual mapping, but the quality of any automated method directly depends on the quality of the operational definition (ruleset) it draws upon; if drumlin definitions are subjective (expert-dependent), so will be the automated algorithms relying on them. Additionally, recognizing highly degraded drumlins is, arguably, more difficult automatedly than manually (visually).

Because a single morphologic definition is missing, mapping is expert-dependent. Therefore, quantifying the magnitude of inter-mapper differences is important for fully understanding the morphology of drumlins, constraining the robustness of drumlin morphometric inventories and assisting in the development of stricter operational definitions/mapping guidelines. We present the results of an experiment to quantify inter-mapper differences in mapped drumlin morphometry. All participants mapped 42 morphologically diverse drumlins in the Puget Lowland, WA at 2 spatial resolutions (1.8 m and 10.8 m cell size DEMs) in a GIS, using exactly the same base maps (analytical hillshade; semi-transparent elevation; contours) and informed by the same loose operational definition (e.g., drumlins delimited at their base by concave breaks in slope). Preliminary results (3 mappers) indicate that differences between manual mappers are substantial. For example, for the footprints mapped from the 10.8 m terrain data: average length ranges from 4603 m to 5454 m, and the mean absolute difference in length from 693 m to 1101 m; average elongation ratio (ER) ranges from 5.0 to 6.1; average footprint area ranges from 0.39 km2 to 0.50 km2.