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Patterns in Landslide Shape, Ellipticity and Length-to-Width Ratio

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This work presents a methodology and tools to systematically and rapidly quantify the shape of landslides in large triggered-event inventories and explores statistical patterns in landslide shape. We experiment with different methods of abstracting a landslide shape to an ellipse to show that the method of ellipse fitting affects statistical patterns of shape. The best method uses a combination of fitting a convex hull to the landslide polygon, and forcing the perimeter and area of the convex hull to an ellipse. We present results from applying the tool to two large triggered landslide event inventories representing different landslide triggering mechanisms and geomorphic settings. Those inventories are (i) 11,111 landslides triggered by the 1994 Northridge (USA) earthquake and (ii) 9,594 landslides triggered by the 1998 Hurricane Mitch in Guatemala. Using our method >80% of landslides in each landslide inventory are well modelled by an ellipse. Those landslides not well modelled by an ellipse can be related to landscape processes such as coalescence. Of landslides well represented by an ellipse, the length-to-width ratio of ellipses (Λ_E) ranges $1.2 \leq \Lambda_E \leq 15.1$ and shows a similar distribution across both inventories. When landslides are separated into landslide area categories, the statistical distribution of Λ_E is well modelled by an Inverse-Gamma probability density function, with parameters dependent on area category. In Northridge (earthquake-triggered), Λ_E tends to decrease with landslide area and in Guatemala (rainfall-triggered), the opposite is observed. Application of the method to three additional smaller rainfall-triggered inventories indicates similar trends to Guatemala. R and ArcPython scripts are shared online for the application of this method to additional inventories. This new methodology gives insight into landscape processes and allows comparison between landslide inventories, indicating similarity in landslide shape formation across different geographic settings.