Geophysical Research Abstracts
Vol. 14, EGU2012-5654, 2012
EGU General Assembly 2012

Comparative analysis of roughness algorithms for the identification of active landslides

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Surface roughness is one of the most common parameter used to describe landslide activity in quantitative geomorphology. Previous studies proved that topographic roughness is closely related to both landslide mechanics and features, and a number of different techniques have emerged over the year for this task reflecting the great variety of landforms and processes that affect unstable slopes.
In this work we perform a comparative analysis of several commonly-reported methods in order to evaluate which techniques are better suited to define active landslides. To this purpose we tested the performance of popular window-based methods of roughness computation, most notably root mean square calculations applied to elevation and slope grids, eigenvalue ratios, semivariance, discrete Fourier transform, continuous wavelet transform, and wavelet lifting scheme.
The algorithms were applied on artificial test surfaces simulating different roughness conditions encountered in nature as well as on real-world topography by analysing LiDAR datasets of two case studies in the Northern Apennines, Italy. The introduction of the "effect-size" statistical test to objectively quantify algorithm performance is a core part of this research.
Results show that most algorithms perform reasonably well with similar accuracy, and that simple techniques (RMS-based, wavelet lifting scheme) achieve equal or sometimes even better results at reduced computational costs. Active non-forested slopes can be predicted with an accuracy greater than 85% for most methods, while a 15% drop in accuracy is exhibited by forested terrain. Increasing the size of the moving window had minor beneficial effects in the study areas, therefore small pixel and moving windows sizes are recommended to retain spatial resolution.