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Using Lidar to define roughness fingerprint and displacement of earth flows

A. Corsini (1), A. Daehne (1), F. Cervi (1), P. Sterzai (2), M. Vellico (2), U. Kniess (3), M. Berti (4), L. Borgatti (4), and P. Mora (4)

(1) University of Modena and Reggio Emilia, Modena, Italy (alessandro.corsini@unimore.it), (2) National Institute of Oceanography and Experimental Geophysics – OGS, Trieste, Italy , (3) University Joseph Fourier, Grenoble, France, (4) University of Bologna, Bologna, Italy

When confronted with earth flows, field surveyors base their assessment of the state of activity of the landslide by performing (often unconsciously) a subjective, expert-based estimate of small scale topographic roughness. The general assumption is that the higher is the movement, the higher is terrain roughness. Defining the roughness fingerprint of dormant and active earth flows using Lidar data from local surveys, could contribute, in perspective, to develop routines for semi automatic detection of landslides from large regional datasets, and for evaluating their degree of activity. Differential DEMs are only capable of detecting elevation changes related to depletion or accumulation, but not movements. Image correlation techniques might be used on Lidar data to estimate 3D displacement vectors, an information that cannot be retrieved by simple DEM subtraction. The validation of this approach could provide an added value to the use of multitemporal Lidar on active earth flows.
In this research we considered dormant and active earth flows for which multitemporal local-scale Lidar surveys were available. Surveys contained an average of 4 to 6 pt/sqm classified as ground. Several different roughness calculation methods (Slope Curvature Kernel 3x3, RMS height, RMS deviation, Hurst exponent, Flatness and Organization strength)were applied to 0.2 m rasters obtained by point-cloud interpolation. Results showd that the difference between active and dormant landslides is evident in most cases and that long-time dormant landslides are less easily discernable from stable areas than from active ones. However, results also demonstrated that roughness is highly variable within the same landslide, that the correlation with the measured rates of movement is not always straightforward and that different roughness estimate methods can provide partly contradictory results.
Multitemporal Lidar surveys have been also analysed to generate displacement maps.. The use of Image Correlation techniques was found to be rather complex, raising many problems concerning point cloud densities, lidar-noise, subpixel correlation, change of morphology patterns, judging of miss-correlations. However, when compared with displacement vectors obtained by supervised analysis of shaded reliefs or by independent monitoring methods, preliminary results obtained so far are somehow promising.
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