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Prediction of debris flow inundation areas using empirical mobility relationships

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A method proposed for delineating lahar-hazard zones in volcano valleys is adapted to debris flows. The original method is based on two predictive equations that relate the lahar volume (V) to the cross-sectional inundated area (A) and to the planimetric inundated area (B). These predictive equations were derived by combining a scaling analysis of lahar kinematics with the statistical analysis of data for 27 historical lahars.

This work tests the validity of this approach in case of debris flow fans. Forty debris flow basins in the Italian Alps were surveyed, and data on 27 historical debris flow events were collected in the field or by means of aerial-photo analysis. Collected data reveal that the flow area A and the planimetric area B are linearly correlated to the debris flow volume V on a logarithmic scale, with high statistical significance.

Moreover, the computed regression equations are nearly coincident with those obtained from other published datasets on debris flows, leading to the global fitting equations $A = 0.08V^{2/3}$ and $B = 17V^{2/3}$. These predictive equations are then implemented in an automated code (DFLOWZ) that delineates the inundated area on a debris flow fan on the basis of a user-specified debris flow volume V with taking the statistical uncertainty in the prediction into account.

DFLOWZ is simple, reproducible, and it can handle both confined and unconfined flow. The model is tested against 10 historical debris flow events, providing a satisfactory agreement between observed and computed inundated areas. In spite of the limitations due to DEM accuracy and statistical uncertainty of the regression parameters, test results show that the method can be useful for practical applications.