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The LAHARZ model for inundation by mass movement flows: Need for re-calibration?

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Physics-based numerical modeling of geological mass movements such as debris avalanches, debris flows and mudflows remains difficult because of the complex and evolving rheologies of particulate or disintegrated multiphase materials, let alone the appropriate specifications of initial and boundary conditions. Accordingly, the important task of predicting likely extents of hazard zones associated with these mass movement flows is often carried out using empirically calibrated models such as the widely-used LAHARZ (Iverson et al., 1998). The calibrations of such models are based upon data sets for past events for which, in the case of LAHARZ, deposit areas, deposit volumes and cross-sectional areas along the flow path are known, but with significant uncertainties. The existence of these uncertainties means that the results of the calibration stage of model development will depend not only on the data set used but also upon the statistical regression method used in the calibration. In the case of LAHARZ, which treats deposit volume as the predictor or controlling variable upon deposit area, Ordinary Least Squares (OLS) regression was used for the calibration. We show that a more rigorous non-parametric bootstrapped reduced major axis (RMA) regression of the same data set produces significantly different results. In particular, the existing form of LAHARZ shows a bias at large mass movement volumes towards under-prediction of deposit areas and therefore runout distances. It will therefore tend to underestimate the hazard areas associated with large mass movements, and disaster management decisions based upon its use may tend to produce unrecognized risks due to low-frequency but large-magnitude mass movement events. Additional uncertainty arises regarding the shapes of predicted inundated areas, as few measurements of cross-sectional area were available for the original calibration. Within these uncertainties long and narrow deposits mostly confined to stream channels as well as broader and shorter inundated areas are likely model outcomes. This range of model outcomes further limits the reliability of hazard estimates using LAHARZ, and we argue that a re-calibration may be necessary to improve the reliability of this simple and useful model in future hazard assessments.