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Estimation of debris flow deposition volumes using LiDAR data.

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The magnitude of channel based hazard processes like debris flows, are mostly interpreted by their measurable geomorphologic features. Eye-witnesses often describe occurred phenomena by approximating flow-depth, flow-velocity, covered surface and volume on the deposition area (fan). It has been found necessary to investigate geomorphometrical parameters such as potential debris volume, mean flow velocity, peak discharge, and runout distance to perform a hazard assessment on a fan and eventually to design protective measures against debris flows. However, for effective natural hazard management, exact approximations of Digital Terrain Models (DTM) are often a basic requirement to automate danger delineations by empirical or analytical approaches. Light Detection And Ranging (LiDAR) is a widely used technology for estimating digital elevation data. LiDAR data in alpine regions can be obtained by several commercial companies where the automated feature removal is proprietary and varies from companies to companies. Very often the processing of feature removal is therefore already implemented. The emphasis of this contribution lays on the calculation of deposition volumes using digital terrain models derived from such "commercial" airborne LiDAR data. The estimation of the deposition volumes are based on two digital terrain models (DTM-2001, DTM-2005) covering the same area but differing in their time of surveying. The basis for generating DTM-2001 and DTM-2005, are two independent LiDAR point clouds scanned in the years 2001 and 2005, whereas each point corresponds to a bare earth point in nature (already filtered via feature removal). Two surveyed deposition areas of debris flows, located in the canton of Berne, Switzerland, have been chosen as test cases, namely defined due to the

location of “Pletschbächligraben” and “Chratzmattigraben”. The deposit volume may be calculated by comparing the digital terrain model-2001, surveyed before the debris flow event, with the associated digital terrain model-2005, surveyed after the event. In doing so it has to take into account that the accuracy of the calculated volume is directly related to the density of the surveyed LiDAR points and, as a result to the accuracy of the interpolated terrain grids (DTMs). A statement about the precision of the calculated volume is therefore related to the chosen grid interpolating techniques. Cross-validation and a methodology characterised as “jack-knife” process, is used to provide a basic comparison of three common interpolation techniques, namely Inverse Distance Weighted (IDW), Natural Neighbourhood (NN) and Universal Kriging (UK). By using descriptive statistical methods (mean error, standard deviation) the best fit interpolation technique is then applied to estimate the deposition volume. The accuracy of the density of the surveyed LiDAR points is finally described by the use of a t-test.