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Quantitative assessment of changes in landslide risk using a regional scale run-out model

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The risk of landslide hazard continuously changes in time and space and is rarely a static or constant phenomena in an affected area. However one of the main challenges of quantitatively assessing changes in landslide risk is the availability of multi-temporal data for the different components of risk. Furthermore, a truly "quantitative" landslide risk analysis requires the modeling of the landslide intensity (e.g. flow depth, velocities or impact pressures) affecting the elements at risk. Such a quantitative approach is often lacking in medium to regional scale studies in the scientific literature or is left out altogether. In this research we modelled the temporal and spatial changes of debris flow risk in a narrow alpine valley in the North Eastern Italian Alps. The debris flow inventory from 1996 to 2011 and multi-temporal digital elevation models (DEMs) were used to assess the susceptibility of debris flow triggering areas and to simulate debris flow run-out using the Flow-R regional scale model. In order to determine debris flow intensities, we used a linear relationship that was found between back calibrated physically based Flo-2D simulations (local scale models of five debris flows from 2003) and the probability values of the Flow-R software. This gave us the possibility to assign flow depth to a total of 10 separate classes on a regional scale. Debris flow vulnerability curves from the literature and one curve specifically for our case study area were used to determine the damage for different material and building types associated with the elements at risk. The building values were obtained from the Italian Revenue Agency (Agenzia delle Entrate) and were classified per cadastral zone according to the Real Estate Observatory data (Osservatorio del Mercato Immobiliare, Agenzia Entrate – OMI). The minimum and maximum market value for each building was obtained by multiplying the corresponding land-use value (€msq) with building area and number of floors. The risk was calculated by multiplying the vulnerability with the spatial probability and the building values. Changes in landslide risk was assessed using the loss estimation of four different periods: (1) pre-August 2003 disaster, (2) the August 2003 event, (3) post-August 2003 to 2011 and (4) smaller frequent events occurring between the entire 1996-2011 period. One of the major findings of our work was the calculation of a significant decrease in landslide risk after the 2003 disaster compared to the pre-disaster risk period. This indicates the importance of estimating risk after a few years of a major event in order to avoid overestimation or exaggeration of future losses.