Avalanche hazard mapping using a regional approach: a case study in Lombardia region, northern Italy

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The mountainous area of the Lombardia region, in the central Alpine and pre-Alpine area of Italy is characterized by relevant tourism during winter and features a considerable amount of ski resort areas. Every year, several avalanches occur in the area, and in the period from 1990 to 2000 at least 7200 avalanche events were mapped, with at least 215 casualties, thus claiming for reliable avalanche hazard management and land use planning. The currently adopted approach to avalanche hazard mapping in northern Italy includes avalanche dynamic modelling, coupled with statistical analysis of snow depth at avalanche start and triggering topographic effects. The 300-years return period avalanches at a given site are computed and their run out zone and pressure are evaluated. The snow depth in the avalanche release zone is assumed to coincide with the three days snow fall depth, H_{72}. However, in order to provide reliable estimates of the 300-years quantiles using empirical distribution fitting, a least number of observations is required, in the order of n_{obs} = T/2= 150 years. In the Italian alps only short series of observed snow depth are available, covering a period of 20 years or so. The lack of observed data for distribution fitting of extreme values in hydrological sciences can be overcome by using regional approaches, including *index value* approach. Here, the authors apply index value approach to the Lombardia region, covering an area of about 8•10^3 (7713) Km^2. The distribution of $H_{72}$is investigated for a network of 40 gauging stations dating back to 1985. For each single site, the values of H_{72i} divided by the single site sample average, or H^*_{72i} are calculated. Proper tests show that the distribution of H^*_{72i} is homogeneous in the region. The frequency of occurrence of H^*_{72i} is accommodated by a General Extreme Value, GEV, probability distribution. The proposed distribution is used to assess the T-years return period quantiles of H^*_{72i}. As a result of the regional approach, the estimated value of H_{72i}(300) is far more reliable than that calculated by distribution fitting carried out using the data at each single site. A case study is then shown for a particular avalanche site. A dynamic avalanche model is tuned using the runout data for an avalanche event with return period estimated from historic analysis. Then, the 300-years runout zone is mapped. A sensitivity analysis is then carried out of the mapped runout zone to uncertainty in the 300-years quantile estimation, showing the increase in reliability due to regional estimation of snow depth at release.