Impact of quality of input data on rockfall hazard zoning

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Introduction

The challenges of a nationwide survey or hazard zoning in Austria are:

- the heterogeneous basic tectonic and geological disposition (Fig. 1) ,
- the strongly varying topographical, geomorphological and climatic conditions,
- the anthropogenic influence.

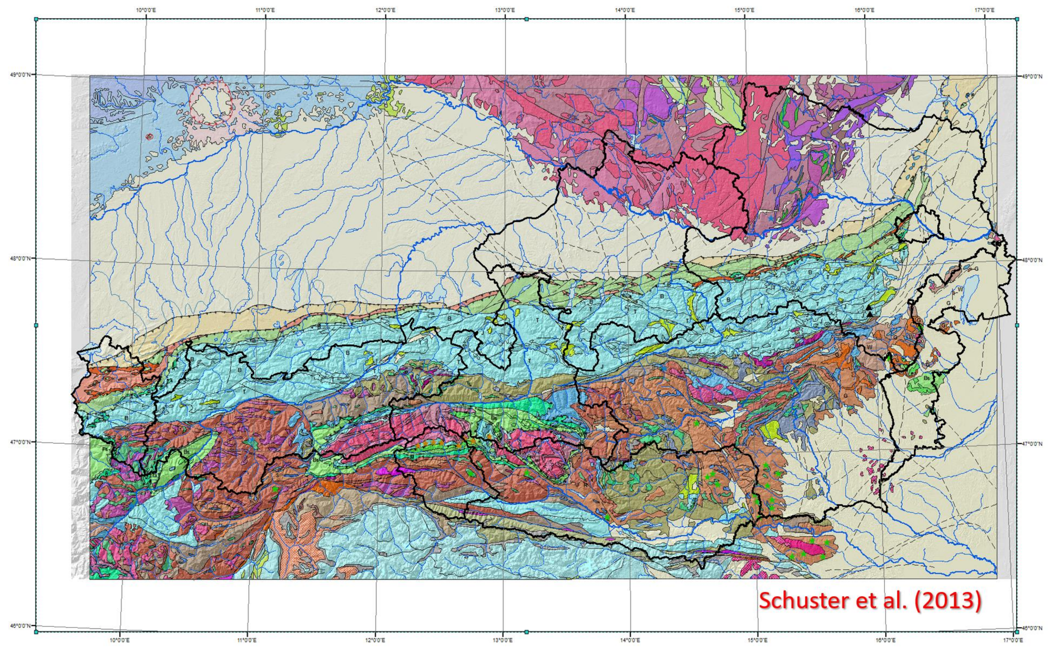

Fig. 1: Tectonic map of the Eastern Alps (Source: Schuster et al., 2013).

Depending on the objective, the area-specific characteristics (geology, topography, vegetation cover, etc.) and the available resources (finances, personel), an assessment strategy has to be developed (Fig. 2).

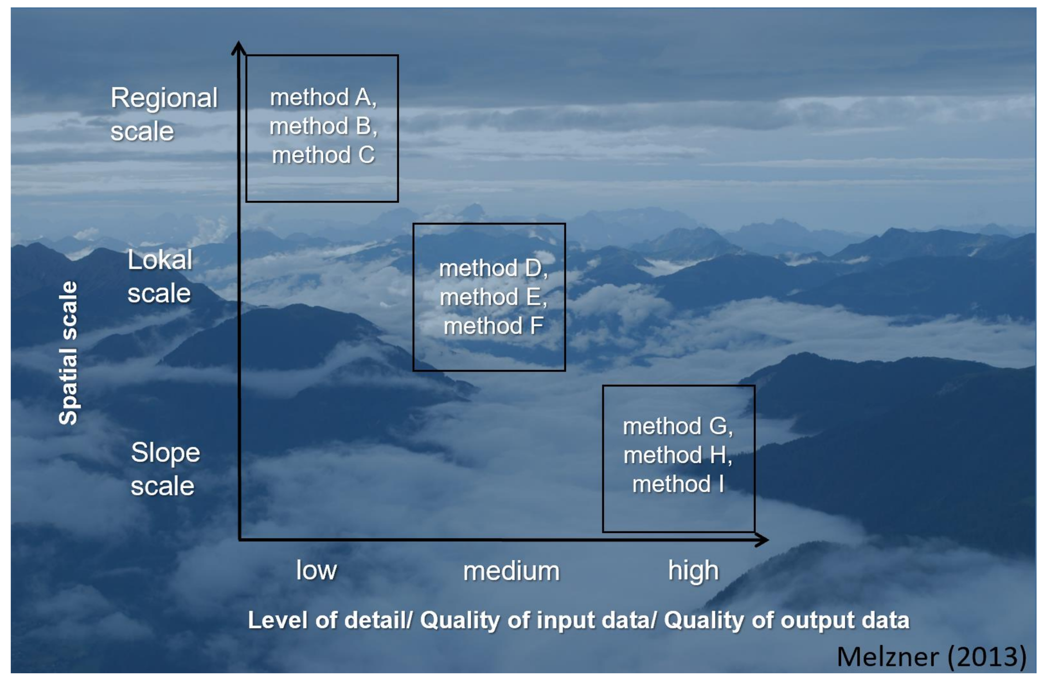

Fig. 2: Development of time and cost effective assessment strategies depending on the available data, size of the study area and objectives. (Source: Melzner 2013).

A variety of methods and techniques are available as part of a multi-scale assessment strategy (fig. 2) (Melzner et al., 2017). However, not every method is equally suitable for a spatial scale. For example, detailed mapping or carrying out TLS surveys for large areas is not efficient, as this would be too time-consuming, is not possible in particular exposed areas or, in the case of TLS, would involve a very large amount of data. For the reproducibility of the hazard analysis and the definition of standards, the input data and their quality most be published.

Impact of assessment method on data quality

Geology/Geotechnical properties

Fig. 3: Recording small-scale lithological and structural changes by means of terrain mapping (Melzner, S. 2019).

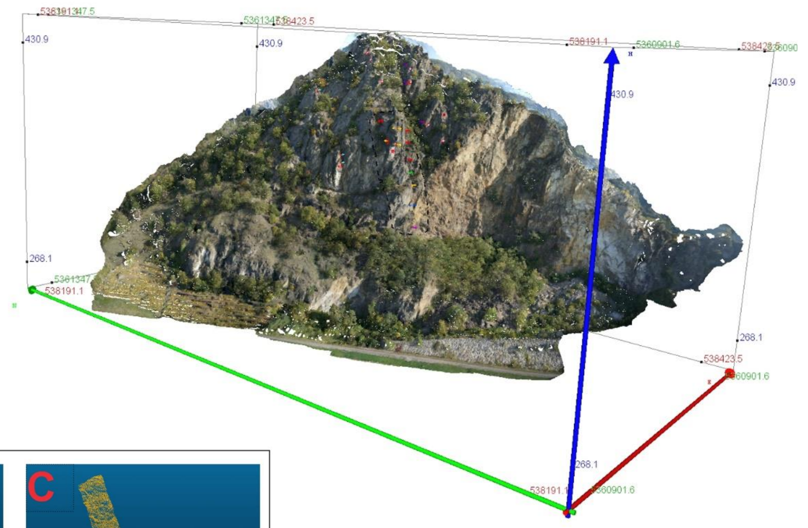

Fig. 4: Structural geological overview mapping by means of a photorealistic 3D model generated using the 3D image measurement system ShapeMetrix- UAV with a Sony A7R camera. (Abb. von Gaich, 2019, Melzner et al., 2019).

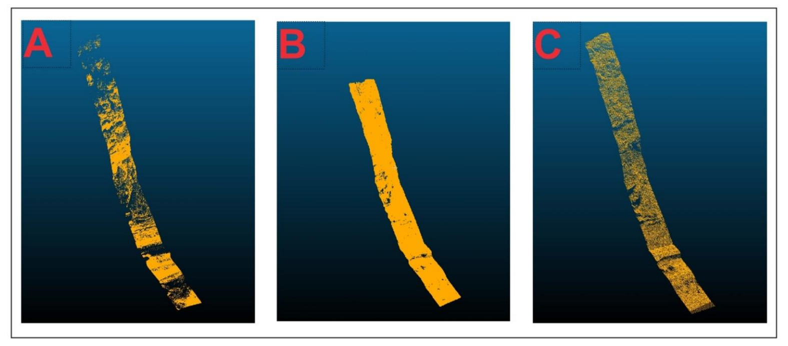

Fig. 5: Structural geological surveys using LIDAR data. Definition of quality criteria of remote sensing data. Coverage of filtered LIDAR data collected by (A) TLS (static), (B) ALS (UAV) and (C) ALS (aircraft) (Melzner und Schwarz, 2019).

Silent witnesses/ Event data

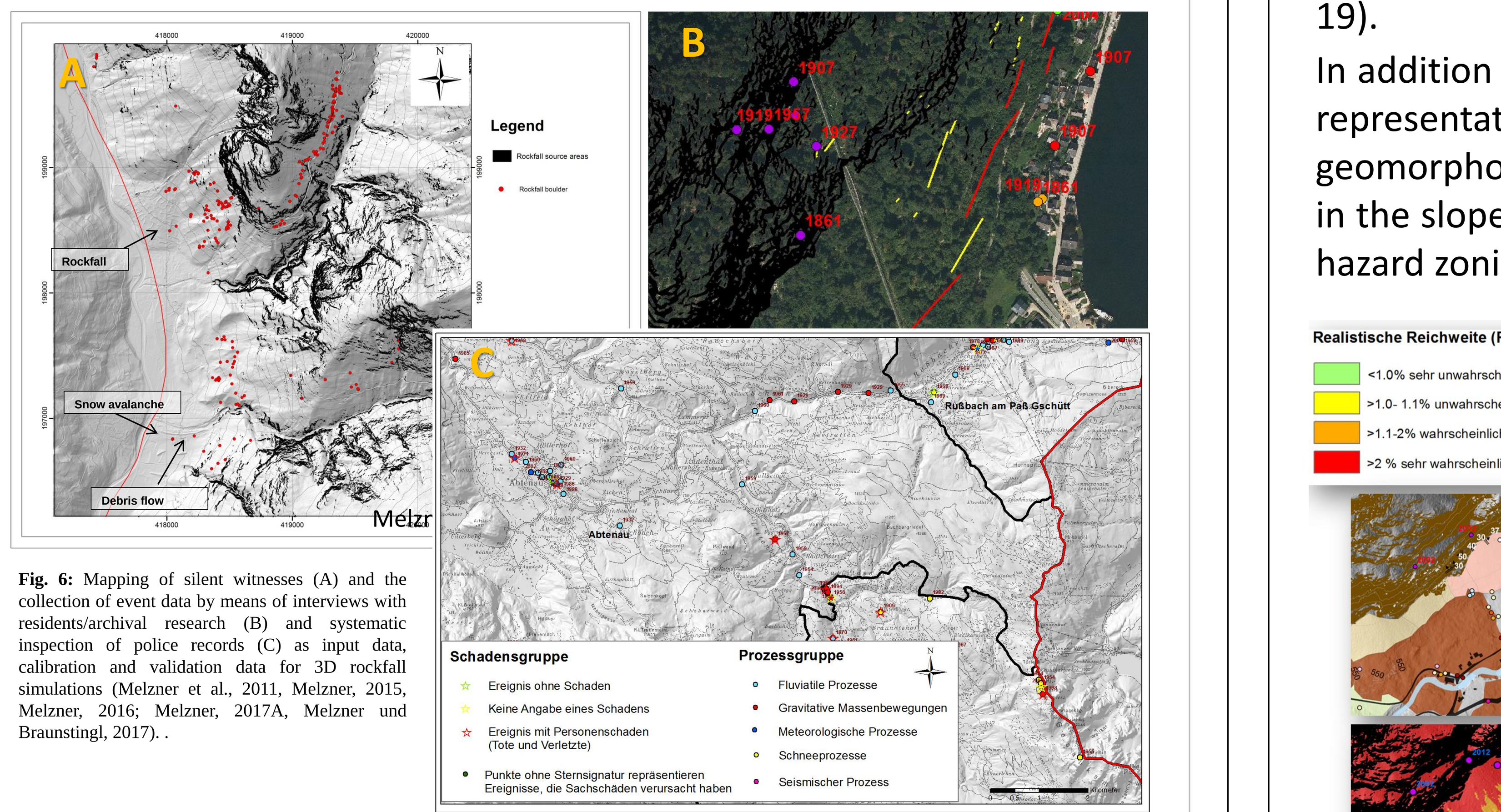

Fig. 6: Mapping of silent witnesses (A) and the collection of event data by means of interviews with residents/archival research (B) and systematic inspection of police records (C) as input data, calibration and validation data for 3D rockfall simulations (Melzner et al., 2011, Melzner, 2015, Melzner, 2016; Melzner, 2017A, Melzner und Braunstingl, 2017). .

Forest conditions/ Tree characteristics

Fig. 11: Forest coditiion in the Upper Moell Valley in the Year 2010 (Photo S. Melzner)

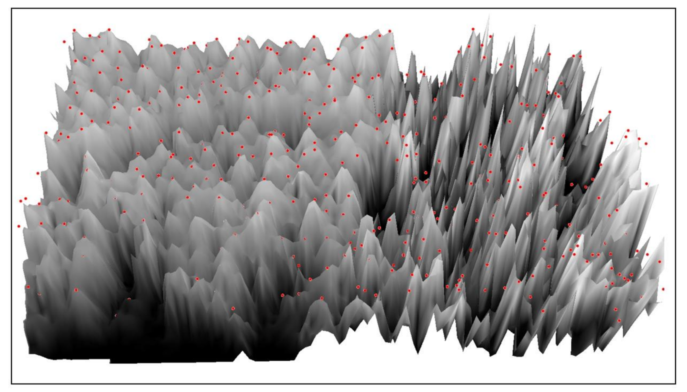

Fig. 12: Modelling of a single-tree forest map using Fint. Conifers (left) and deciduous trees (right) (Melzner und Schwarz, 2019).

Fig.. 13 Forest coditiion in the Upper Moell Valley in the Year (Photo S. Melzner)

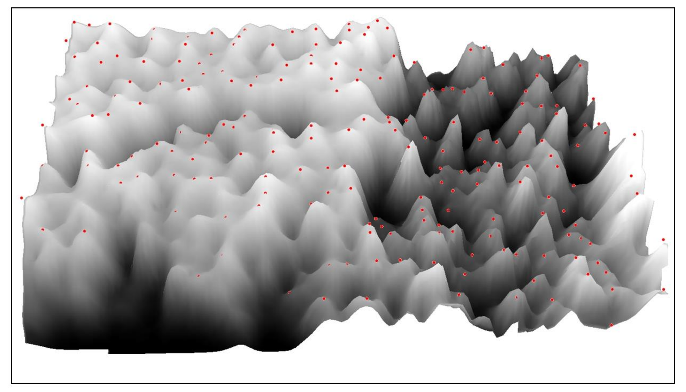

Fig. 14: Gaussian low-pass filter (5x) smoothed nDOM (1m) of the test area used to model the deciduous trees (right). Red dots = modelled tree positions (Melzner und Schwarz, 2019).

Slope parameters

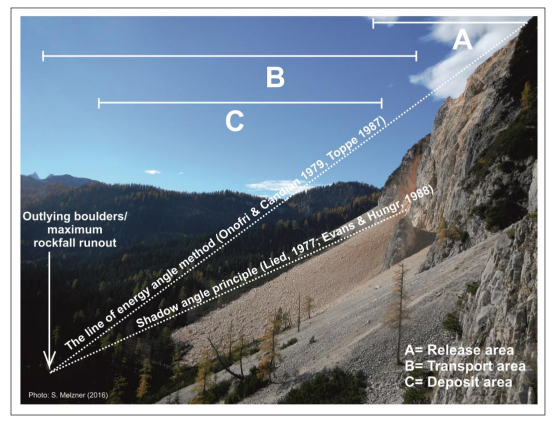

Fig. 7: Mapping of slope parameters (roughness and damping properties) (Quelle: Melzner et al., 2020).

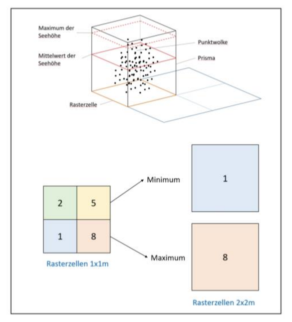

Fig. 8: Calculation of a raster value and aggregation to a coarser resultion (Quelle: Melzner and Schwarz, 2019).

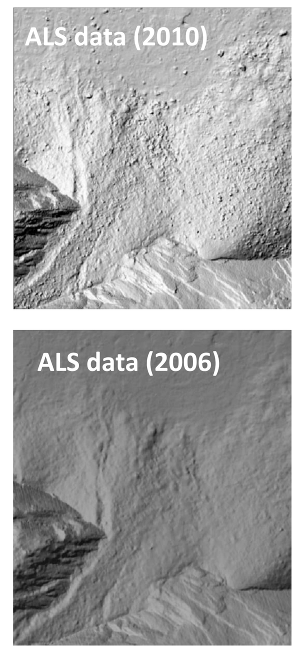

Fig. 9: Quality of the filtering of two ALS data sets (2006 und 2010) (Melzner, xxx).

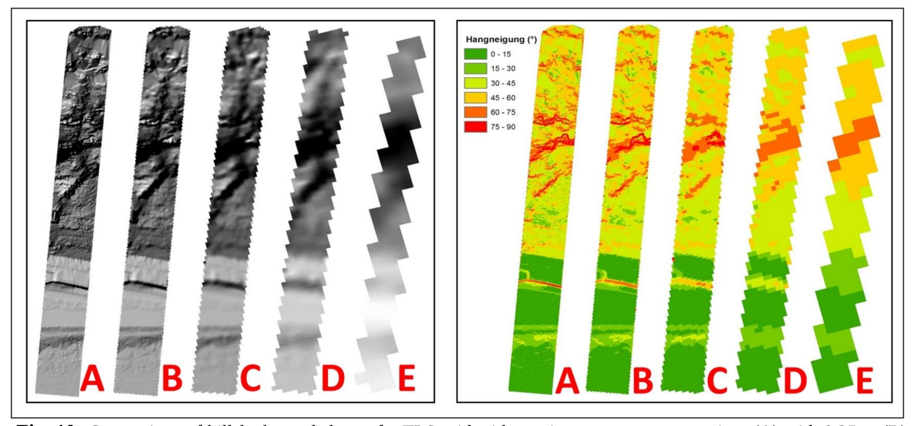

Fig. 10: Comparison of hillshades and slope of a TLS grid with continuous mean aggregation: (A) with 0.25m, (B) 0.5m, (C) 1m, (D) 2m and (E) 5m resolution. (Melzner und Schwarz, 2019).

Statistics/thresholds for the definition of a project/design block

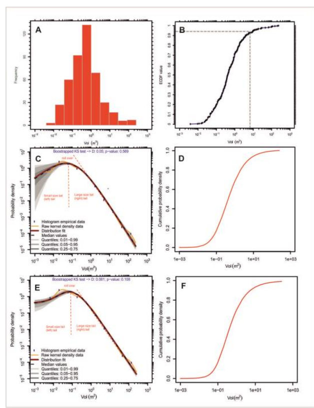

Fig. 15: Statistical methods for the evaluation of geological data (Melzner et al., 2020).

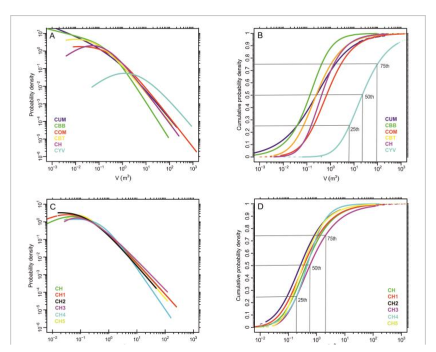

Fig. 16:. Impact of mapping strategy on probability densities of rockfall sizes (A, C, E, G) and on cumulative distribution function of rockfall size (B, D, F, H) (Melzner, S. 2020)

Set- up and application of different models

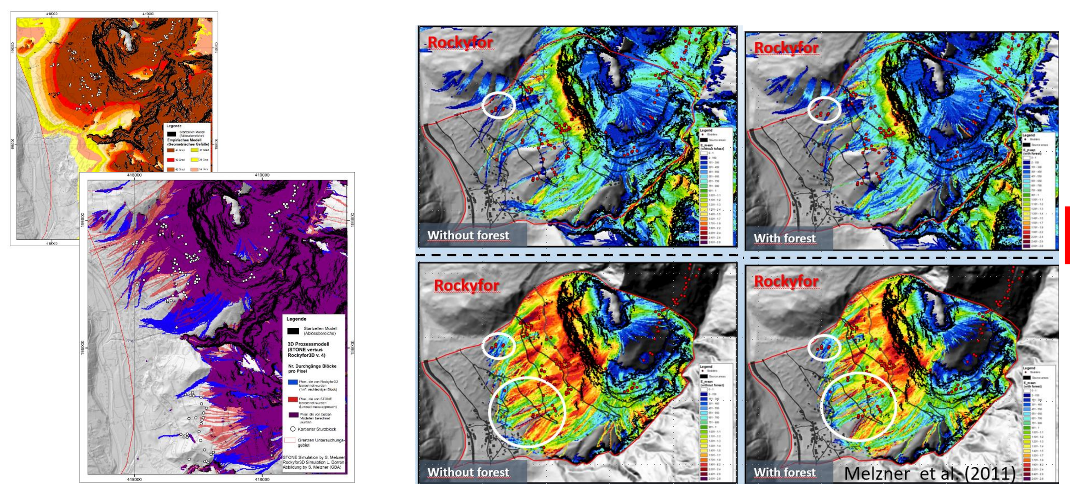

Fig. 17: Comparison of different rockfall models (Melzner et al, 2011, Melzner, S.and Preh, 2012).

Thresholds for hazard zoning

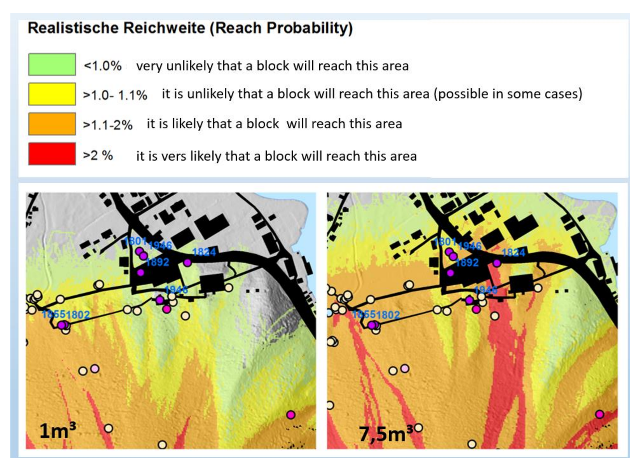

Fig. 18: Definition of thresholds for hazard zoning. Calibration and validation using silent witness and event data (Melzner & Preh, 2012, Melzner, S., 2015, Melzner, 2017B).

Cartographic display

Different model parameters and data from mapping/ archive research are available for the hazard zoning (Fig. 19).

In addition to the generally comprehensive cartographic representation of the potential impact area (modelling + geomorphological mapping), potentially unstable areas in the slope and rock face areas are to be included in the hazard zoning (Melzner, 2016).

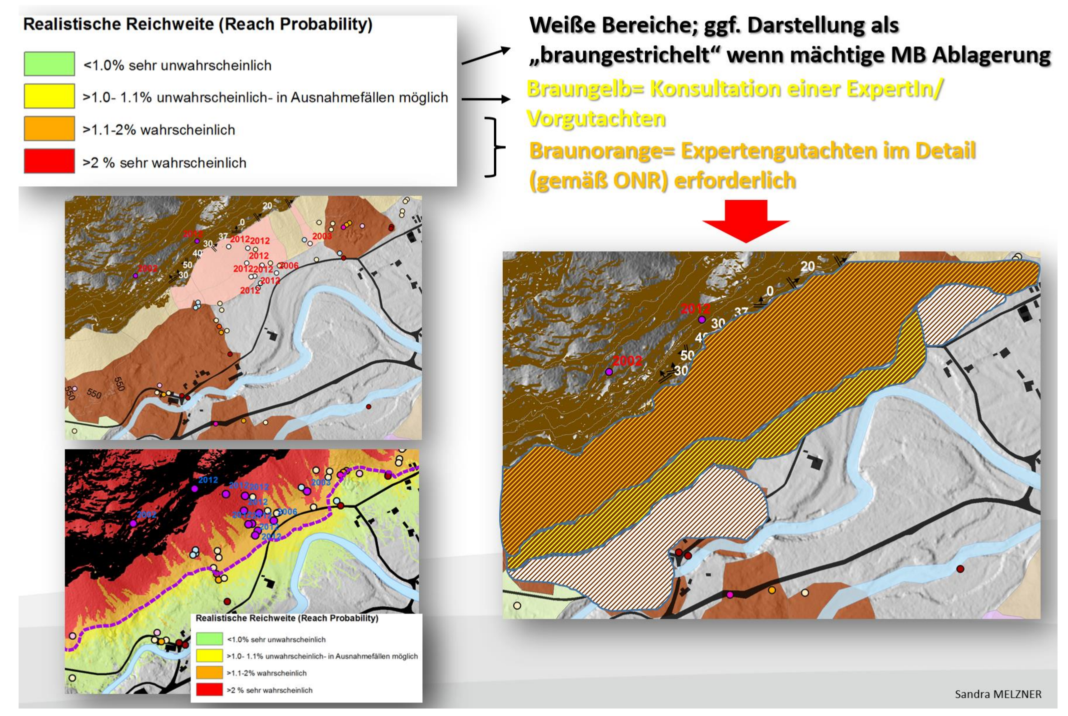

Fig. 19: Proposal for the further subdivision of the Brown Zone and integration of the mapping results as a basis for decision makers.

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