Why are good process data so important for the modelling of landslide susceptibility maps?

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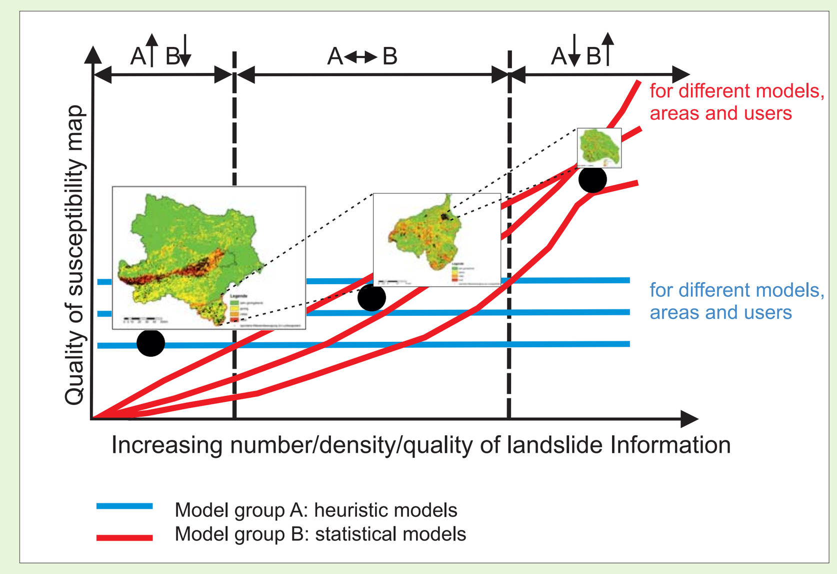
Introduction

In Austria, process data of gravitational mass movements are collected, stored and managed by various institutions (GBA, WLV, federal state governments, etc.). This data varies greatly with respect to quality, scope, and regional or partial completeness/randomness due to the different aims and responsibilities of the individual organizations. Apart from that, the status of data (scope, completeness) can, be only moderate in relatively landslide-resistant and sparsely populated landscapes (the Waldviertel area, for example), whereas very good, albeit not comprehensive data, are often available for landslide-prone and more heavily populated regions (Flysch zones).
Landslide inventories that can be generated from the complete dataset serve not only as a "memory" of previous events, they can also be used as data input in many kinds of model calculations, for example to produce susceptibility maps for landslides and rock falls.

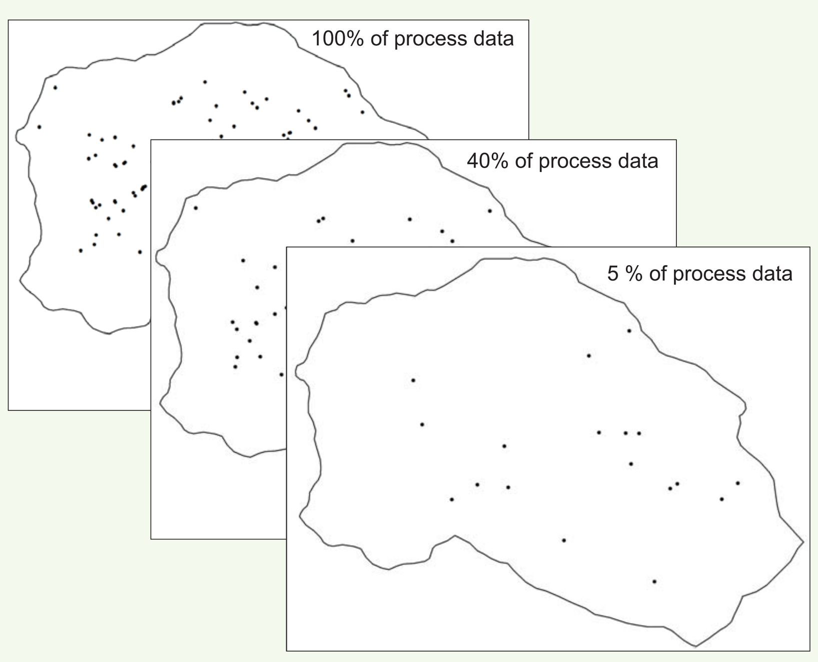


Defining problems and objectives

Process-data requirements vary considerably, depending on the method used to model susceptibility maps. For heuristic methods (model type A), process data are only required for calibration and validation, whereas when using statistical models for example logistical regression and neural networks (model type B), such data are also required as model training data. For that reason, the methods of model group A are generally more suitable for use on large-extended areas of heterogeneous landscape, for which the process data quality/state of knowledge tends to be somewhat lower. On the other hand, sophisticated methods of the model type B, for which also training data are required, are usually more suitable for small-extended areas of homogenous landscape, for which usually a higher data quality/state of knowledge is existing. This raises the question of how different process data (with respect to data quality, volume, representativity, etc.) affect method-specific results and their validation.

Methods and process data

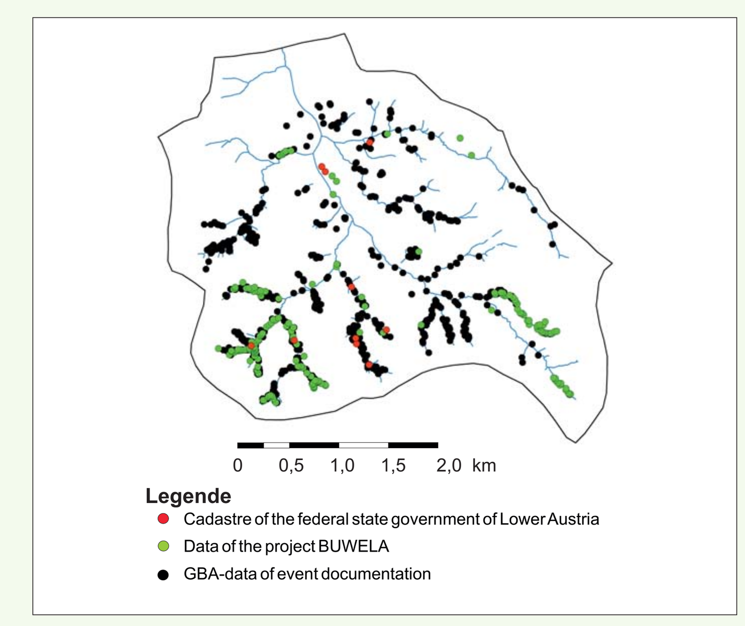
"Gasen-Haslau": data reduction



In two regions (Gasen-Haslau, Styria, 60 km²; Klingfurth, Lower Austria, 10 km²) with very high process data quality, neural networks and the "simple heuristic GBA Method" (TILCH & SCHWARZ 2010) were used to produce susceptibility maps for spontaneous mass movements in soil (such as soil slips, mud flows). These areas were chosen for study, because a relatively complete landslide inventory exists, based on extensive event documentation in the field and a comprehensive data archive.
Due to the high process-data density and the large amount of data, it was possible to progressively reduce the process-data volume. For the Gasen-Haslau region, this was done in the form of percentaged, randomly selected data reduction (to 80%, 60%, 40%, 20%, 10%, 5%, cf. SCHWARZ ET AL. 2009), whereas for the Klingfurth region, the following originator-specific data sets were used:

1. Cadastre of the federal state government of Lower Austria (10 points)
2. Data of the project BUWELA: a comprehensive landslide inventory compiled from several archives, with the inclusion of extensive field data, mapped in representative subareas (183 points)
3. GBA-data of event documentation in the summer of 2009 (769 points)

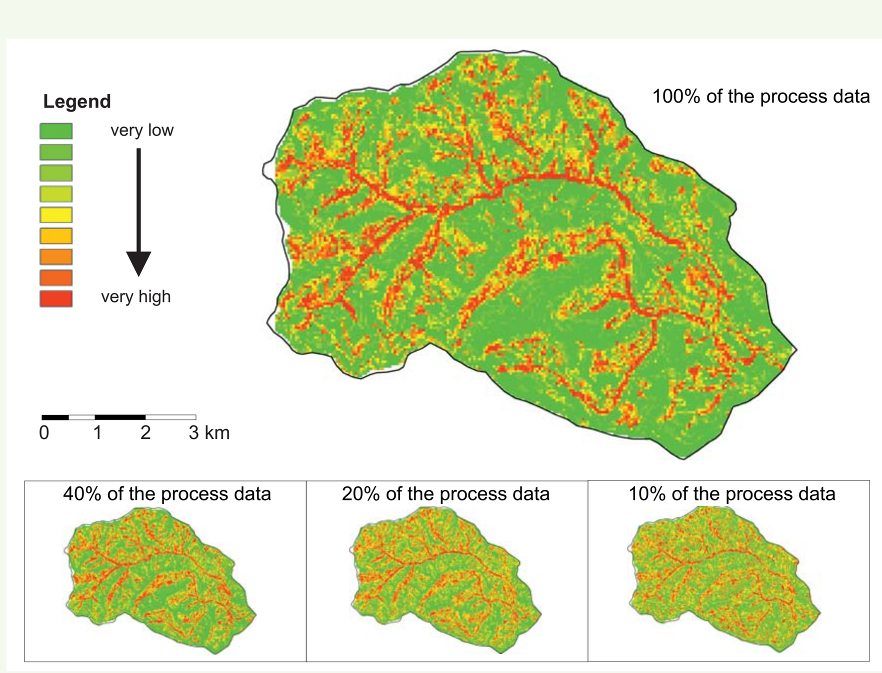
"Klingfurth": originator-specific data sets



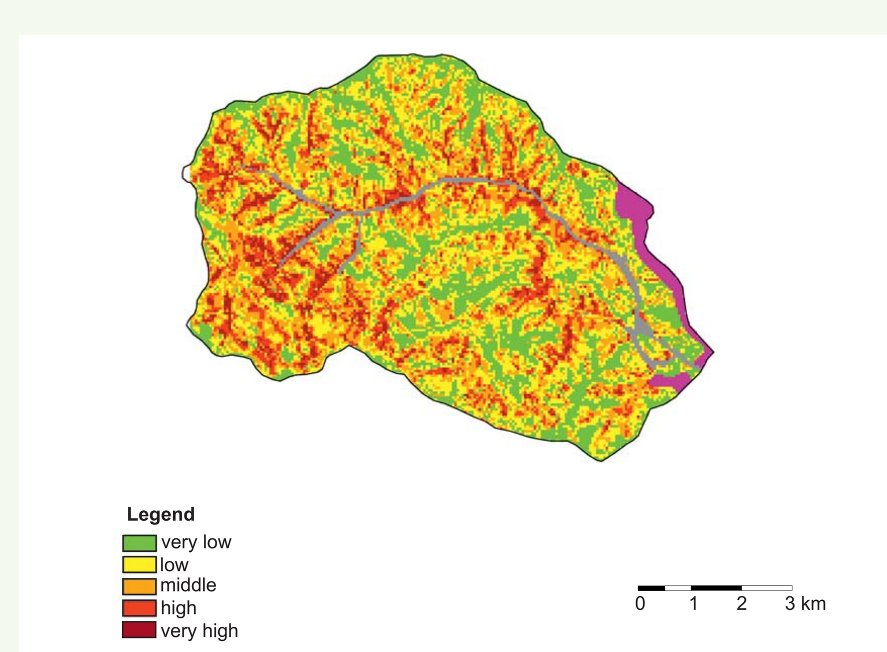
susceptibility maps

region "Gasen-Haslau"

Neural Networks

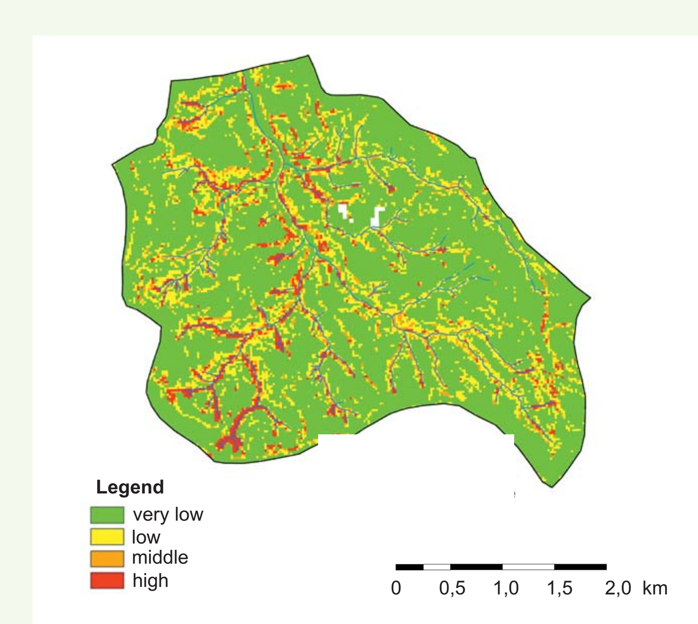


Heuristic GBA- method



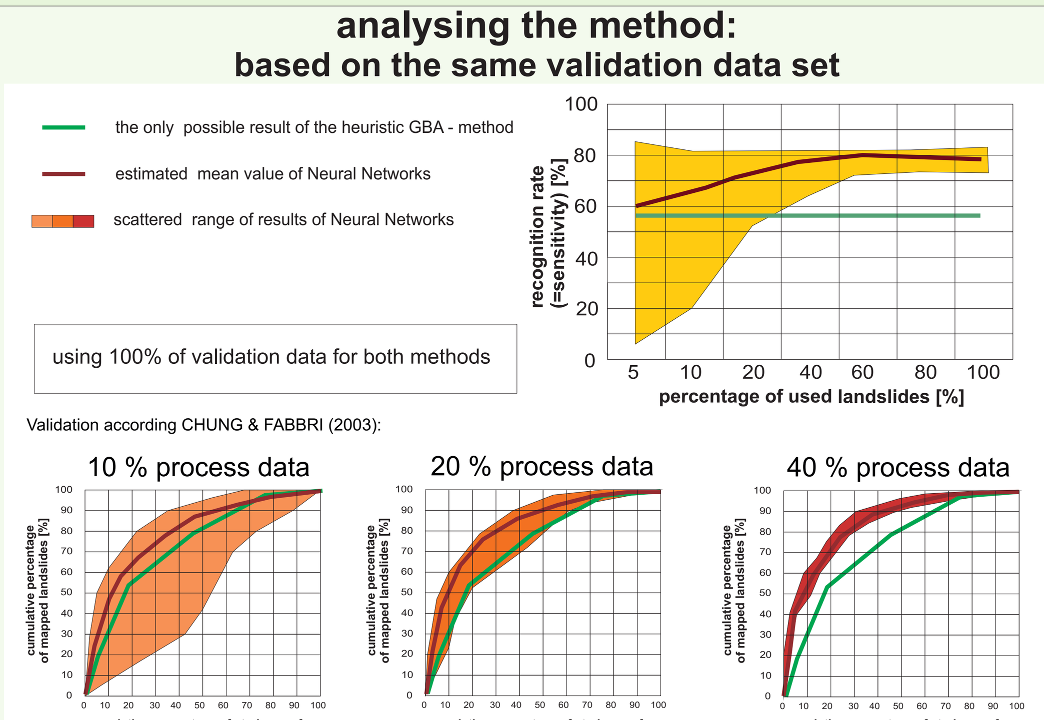
region "Klingfurth"

Heuristic GBA - method

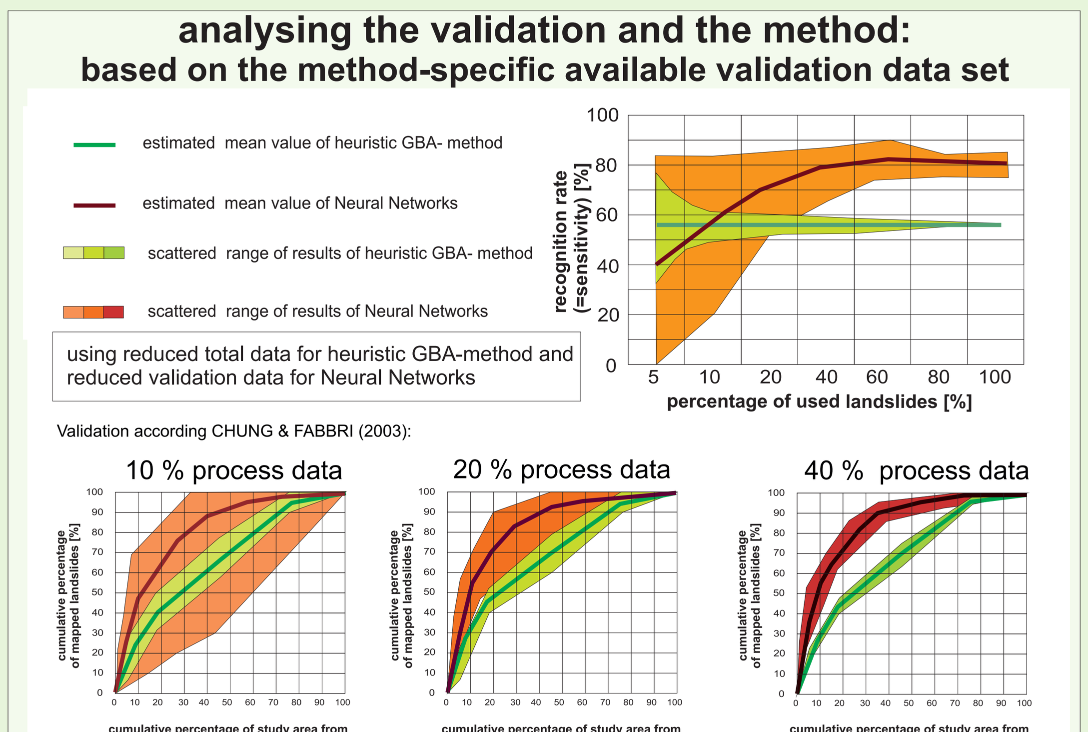


validation results....

analysing the method: based on the same validation data set

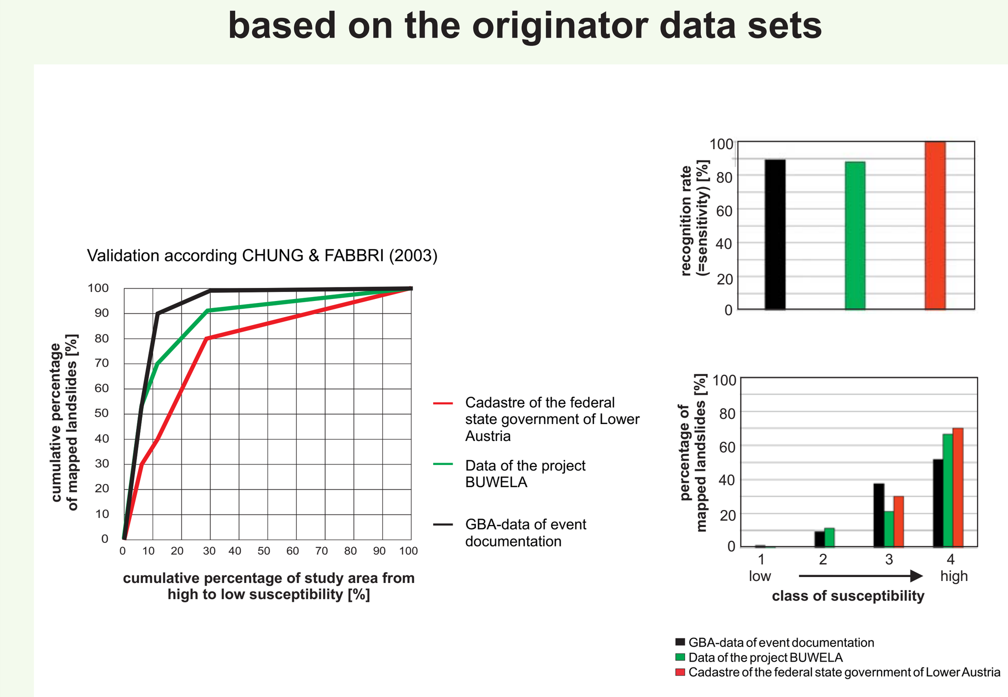


analysing the validation and the method: based on the method-specific available validation data set



validation results....

based on the originator data sets



Results

In the Gasen-Haslau region, it was established that:

- with both methods, the dispersion of validation results increased as the amount of data decreased, particularly when using the neural networks method after data reduction to 40% (73 process points = 1.2 process points/km²).
- with good data availability (>40% of the process points) the use of neural networks tended to show better validation results than the heuristic method
- with poorer data availability, the results of neural networks and heuristic methods might be equally good.
- validation itself becomes steadily more uncertain as the amount of process data decreases, which results in even greater dispersion

In addition, using the example of the Klingfurth region, it was shown:

- that originator-specific, random/selective process-data sets had different effects on validation of the same susceptibility map: incomplete data amounts could randomly produce both good and poor results.

Conclusions

From the example of the methods used in the Gasen-Haslau region, it was demonstrated that: In order to achieve high-quality results, methods that require training (for example neural networks) should be used. However, this presupposes good process data availability, because process data must also be used as model training data. Good process data availability is also necessary for all methods, in order to validate results and make reliable quality statements. Significant, representative and preferably complete process data sets are required for both purposes, because without them, randomly good or randomly poor validation results are obtained. This was also confirmed by studies in the Klingfurth region. It is therefore obvious that on the whole, process data sets that are as complete as possible, collected for example in the course of area-wide and comprehensive event documentation, are highly important.

In future, similar studies will be done in other regions as well, in order to make quantitative statements on method-specific data requirements and their effect on the quality of results.

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