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AdaptAlp
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Generating useable process-oriented susceptibility-maps regarding spontaneous gravitational mass movements in soil as an objective basis for planning on local scale

- which are the best methods and which data do we need?

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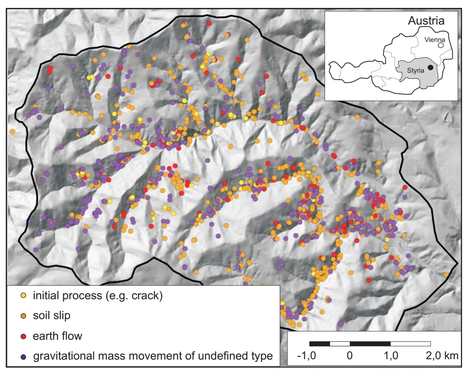
Introduction

The area (approx. 50 km²) of the communities Gasen and Haslau in Styria (Austria), which was studied for the ADAPTALP-project, is a region that experienced numerous gravitational mass movements - mainly soil slips and earth flows - last time in August 2005. Particularly on steep slopes showing low surface roughness, earth flows were able to travel long distances and reach high velocities. As a result, major damages were sometimes caused by relatively small masses of material. In many places, infrastructure or buildings in villages, as well as connecting roads between localities were badly damaged. There was also one tragic casualty in Gasen, in which two people were killed.
Because of these dramatic events, it was necessary that experts from different institutions worked together in mapping the processes and damages. Since the documentation was carried out in different ways, the collected data were compiled to a common process inventory of high quality as part of a project within the framework of FLOOD RISK II (see Tilch et al. 2009).



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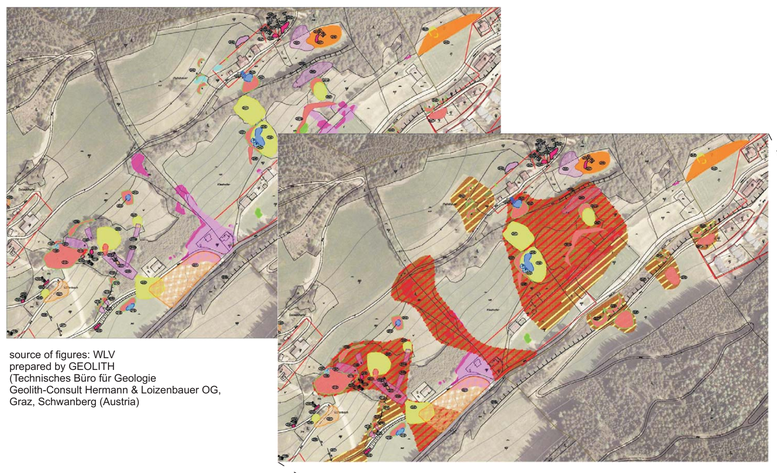
Goals and Challenges



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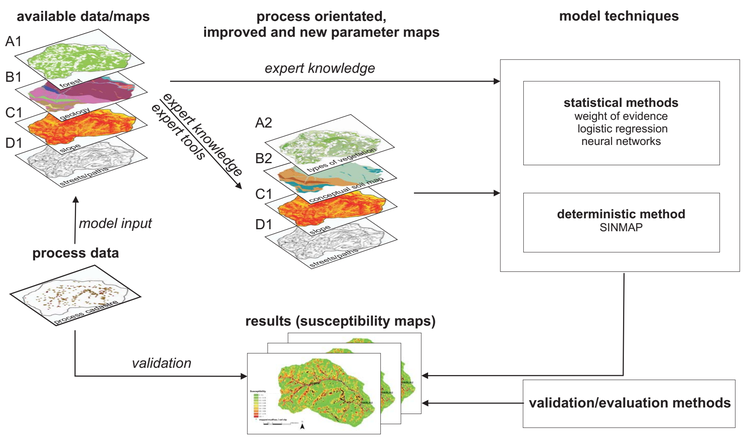
In order to achieve a comprehensive assessment of hazard areas due to gravitational mass movements, in general also those areas have to be assessed that are supposedly stable, but might become unstable and dangerous in the future. Therefore, experts mapped those phenomena, which are indicators for high susceptibility with regard to gravitational mass movements, on and near the relevant slopes for planning purposes, bearing in mind the created digital process cadastre. These more or less subjective results are already taken into account in the hazard zone map of the municipality Gasen in the form of brown-red (high hazard potential) and brown-yellow (moderat hazard potential) marked zones. Nevertheless, it was tried in this project to identify these dangerous areas in a more objective way by applying various statistical and deterministic models. Against this background, the following questions were investigated:

- which method performs best to obtain results of high quality?
- which input data quality is needed for this purpose?
- which expenditure (work steps, methods) is required to get the best result (benefit)?
- how can realistic maps with regard to the influence of variable conditions on the process-specific susceptibility of the slopes be obtained?



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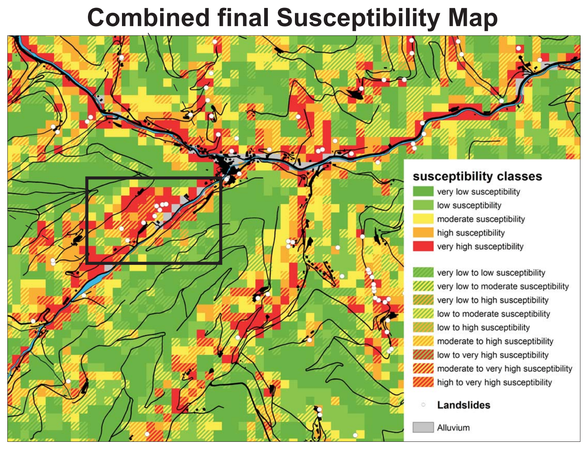
Methods and best Result

Methods and Models

In order to get answers to these questions, on the one hand the process inventory was used as training and validation data set. On the other hand, the area-wide available digital data/maps were used to create process-oriented parameter maps to describe the spatial variability of process-relevant characteristics and conditions.
This was achieved by using expert methods which were developed by the project partners (e.g. for interpretating systematically the geological map to a process-oriented conceptual soil map). Numerous parameter maps of different quality were integrated in various combinations using different modelling methods (neural networks, logistic regression, weight of evidence, deterministic model) for creating susceptibility maps (see Schmid et al. 2009, Tilch & Schwarz 2010).

The validation of these maps was performed using summarized area-wide methods that are internationally accepted, e.g. after Chung and Fabbri (2003). Also further additional validation methods, which were developed by project partners, were applied.

Combined final Susceptibility Map



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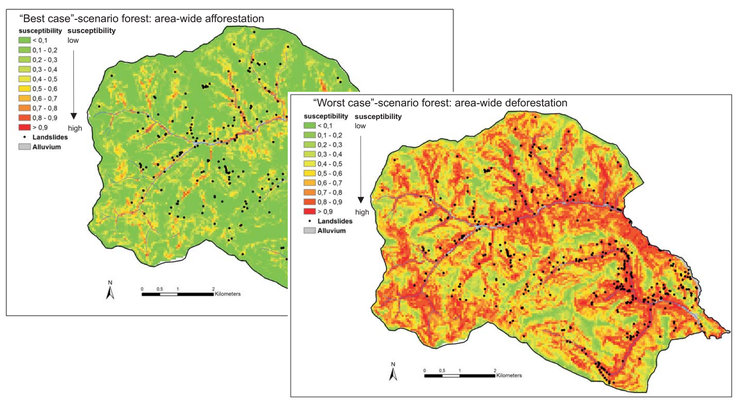
Results and their Validation

The best results of neural networks and of logistic regression as well as the best results within one method performed quite similarly well (about 92% AUC). Since no „best" result could be identified, a combined final susceptibility map was created, which was derived by combining the 5 best results of each method, showing all possible susceptibility classes.

The substitution of the improved, process-oriented parameter maps in most cases did not improve the quality of the susceptibility maps significantly, compared to the use of simple routinely generated parameter maps. So the (sometimes immense) expenditure to create these process-oriented maps was in most cases in vain. Using field mapped data of forest and roads could strongly improve the model performance, in comparison to the use of generally available information. It is likely that the similarity of the validation results and the lack of improvement using the process-oriented parameter maps are caused by the simplified, summarized area-wide validation methods applied, which can only give a rough assessment of the quality of the result.

Future-oriented Maps for Planning- what can happen if ...?

Afforestation / Deforestation



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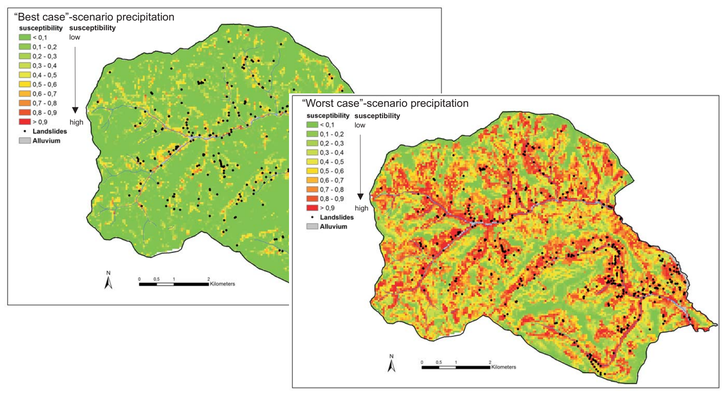
By means of neural networks and logistic regression it was possible to calculate plausible susceptibility-scenarios for changed land use and variable amount of precipitation. Susceptibility maps were calculated, showing the area wide scenarios „complete deforestation", „complete afforestation", „maximum precipitation" and „minimum precipitation" regarding the event of August 2005. Based on these scenarios, it is basically possible to answer some concrete questions of spatial planning and forestry like:

- in which areas does it make sense / no sense to plant trees?
- in which areas deforestation has to be avoided / can be tolerated?
- which areas were lucky in 2005 to receive less precipitation, but could expect much more landslide activity when receiving the maximum precipitation of the event of August 2005?
- which areas were more / less sensitive to changing amount of precipitation?

By using this methodology, it would in general also be possible to integrate climate-change precipitation scenarios into landslide-susceptibility modelling.

Variability of Event Precipitation



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Conclusions

By using neural networks and logistic regression it was possible to model objective susceptibility maps of high quality and scenario maps for changed land use and variable precipitation, which can be a helpful basis for decision makers to delineate brown hazard zones for gravitational mass movements. As final result of the project, unlike in many other studies not one single „best map", but a combined final susceptibility map, derived by several „best results" of both modelling methods is presented. In this way the final result also includes the uncertainties in the distribution of landslide susceptibility which arise from the incompleteness of process data as well as the simplified, summarized area-wide validation methods applied. This also highlights the need to create new, partial and more differentiating validation methods.

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