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Regional landslide hazard and risk assessments as planning and mitigation tools

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INTRODUCTION
Natural catastrophes caused by earthquakes, floods, storms, and volcanic eruptions occur worldwide and result in considerable damage. Although quite often disregarded, landslides are also heavily destructive processes with significant ecological, economic and social impact. Landslides fail at specific locations, but affect regularily large regions. An inherent problem is the uncertainty to predict landslide locations of new failures and movement behaviour of reactivated landslides. Therefore it seems most important to determine planning and mitigation tools specifically designed for landslides.

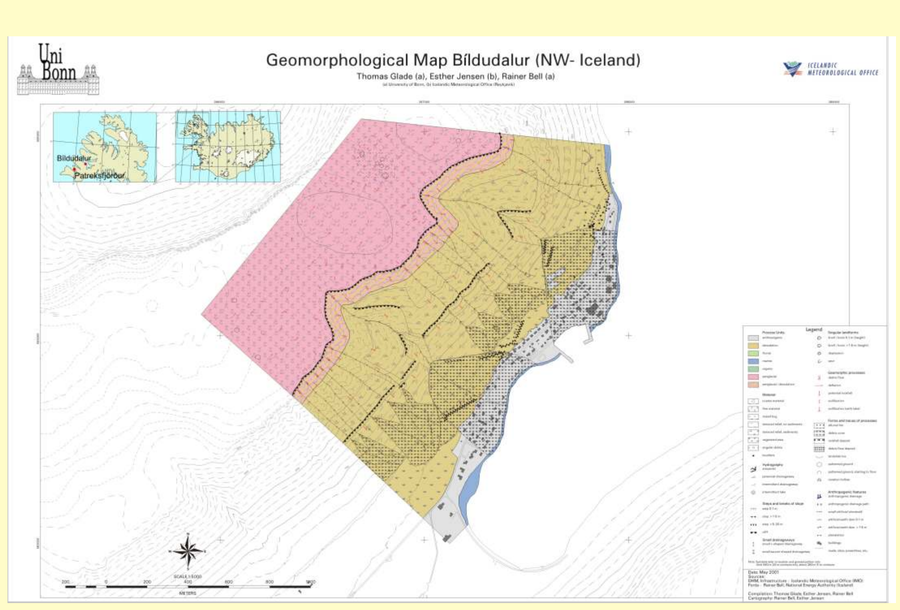

Figure 1: Geomorphological map of Bildudalur, Westfjords, NW Iceland (Glade & Jensen in press)

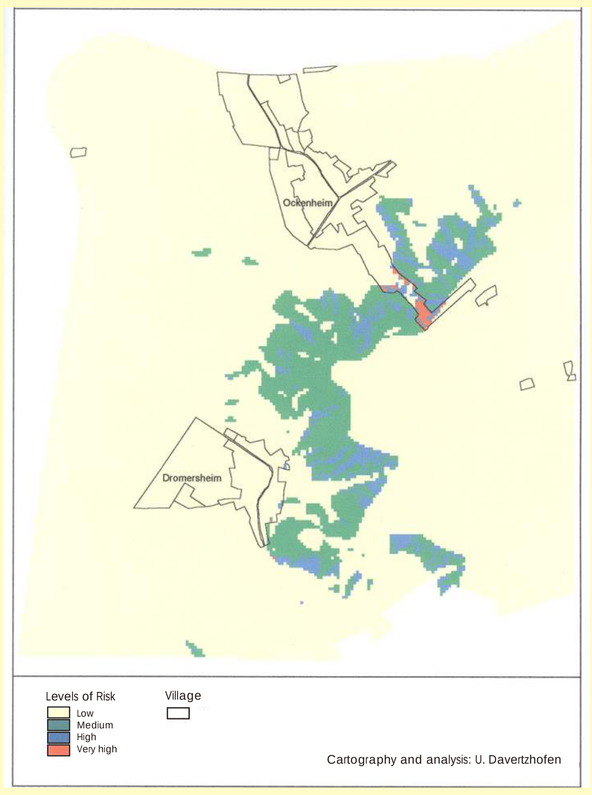

Figure 4: Landslide risk assessment based on bivariate statistics in Northwest Rheinhessen, Germany (Davertzhofen *et al*. In prep.)

Tab. 1: Spatial analysis techniques dependent on scale, ranging from small (global, national - >1:100.000), middle (regional, local - 1:50.000 - 1:25.000) to large scales (lokal - <1:25.000) (based on Soeters & van Westen 1996).

Analysis	Technique	Brief description	Recommended scale: Small	Medium	Large
Inventory	Distribution	Analysis of districution and classification	Yes	Yes	Yes
	Activity	Analysis of temporal changes	No	Yes	Yes
	Density	Calculation of landslide density in terrain units or in a given catchment	Yes	No	No
Heuristic Analysis	Geomorphological map	Field-mapping by experts	Yes	Yes	Yes
	Qualitative combination	Weighting single parameters by expert	Yes	Yes	No
Statistical Analysis	Bivariate statistics	Relation between single parameters and landslide locations	No	Yes	No
	Mulitvariate statistics	Data matrix of parameters and landslide locations	No	Yes	No
	Chaos, Fractales, SOC*	Physically based models explaining stochastically distributed landslides	No	Yes	No
Deterministic Analysis	Safety factor	Application of hydrological and slopestability models	No	No	Yes

* SOC = Self-organized criticality

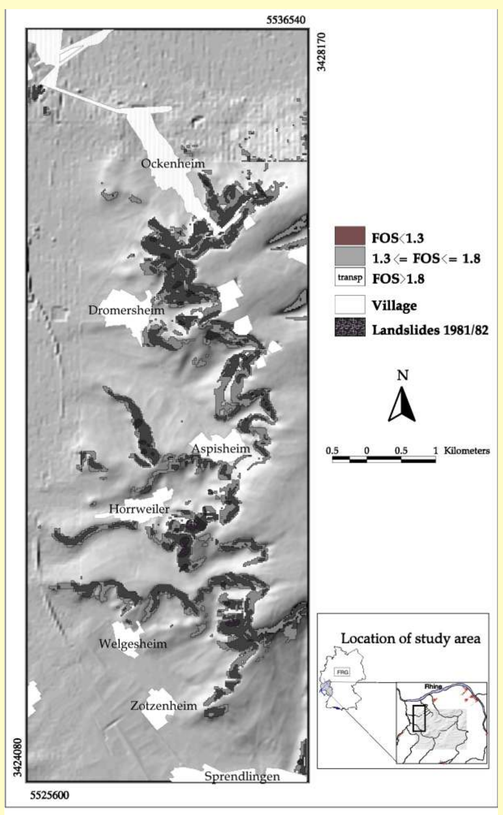

Figure 5: Landslide susceptibility map based on Factor of Safety (FOS) analysis using Soil Mechanical Response Units, Northwest Rheinhessen, Germany (Möller *et al*. 2001)

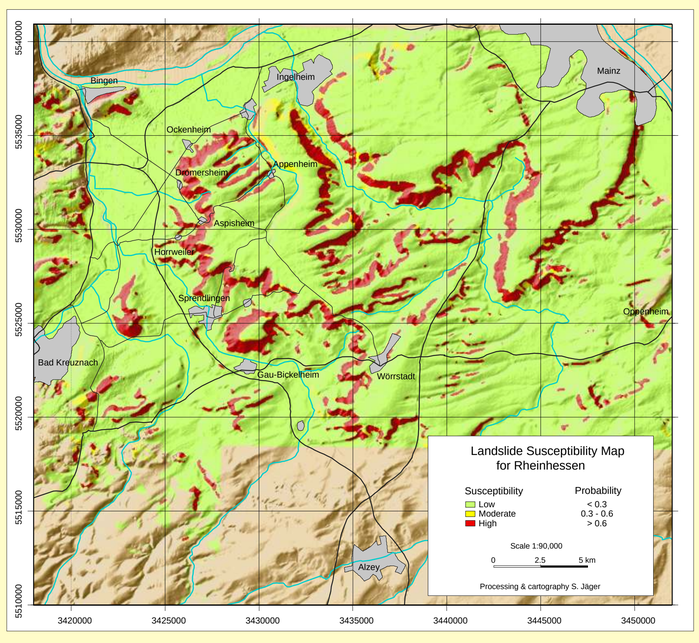

Figure 2: Landslide susceptibility map based on multivariate statistics, Northwest Rheinhessen, Germany (Jäger 1997)

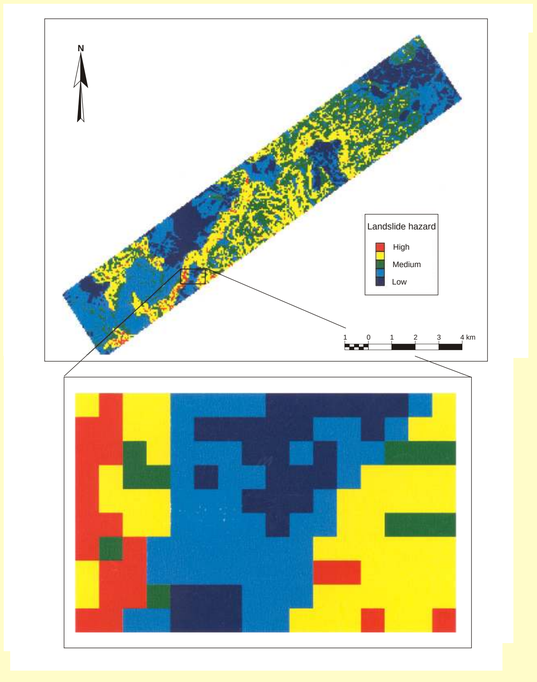

Figure 3: Landslide hazard map based on multivariate statistics for the Hawke's Bay Region, North Island, New Zealand (Glade 2001)

METHODS & RESULTS
Various methods of spatial landslide assessments (refer to Tab. 1) have been applied to different regions. The geomorphological map from Iceland indicates areas of landslide occurrence based on mapped field evidences (Fig. 1). Examples from Rheinhessen and New Zealand (Figs. 2 & 3) use multivariate techniques to calculate landslide susceptibility and hazard. Landslide risk in Rheinhessen is analysed applying bivariate techniques (Fig. 4). Deterministic analysis using the Factor of Safety slope stability modelling approach has been employed for landslide susceptibility mapping in Rheinhessen (Fig. 5).
All examples give a spatial dimension of landslide susceptibility, hazard or risk and are thus of major importance for any planning and mitigation measures at regional scales.

PERSPECTIVES
Determining the demand on regional landslide assessments
- Adopting methods to respective needs
- Implementation of spatial landslide assessments as a planning and mitigation tool in regional development plans

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