# Effects of Land-Use Changes on Snow-Gliding Processes & Assessment of Potential Risk

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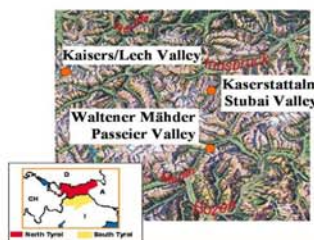
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## Introduction and Hypotheses

To know the causes for natural disasters is essential for regional management. One cause of erosion and ground avalanches is snow gliding - the slide of entire snow pack over sloping terrain. The aim of this work is to analyse the causes of snow-gliding movements comprehensively by finding the significant influence factors. Subsequently, a model is designed in order to predict snow-gliding rates. We use the model to analyse (1) the effects of land-use changes and (2) the correlation with ground avalanches.

Our hypotheses are:

1. A set of site factors, land-use factors, and vegetation factors is suitable to model snow-gliding rates.
2. Land use (grazing, mowing) has a decisive influence on snow gliding.
3. Snow-gliding rates are positively correlated with the frequency of ground avalanches.

## Research Areas

The studies were conducted in three different areas in the Eastern Alps. Different conditions of climate and small-scale property structures - different types of management and different stages of succession are found close to each other - allowed the combination of varying influence factors (sea level, slope inclination, land use, vegetation, aspect, …).



## 1. Modelling

Altogether 450 measurements of snow-gliding rates were carried out with gliding shoes according to Newesely et al. (2000). The influence factors were found by multiple linear regression with 50% of the samples (selected randomly). The extremely significant ($p < .001$) prediction function explained the dependent variable 'gliding distance' with the accuracy of 75.7%.

Statistical validation was carried out with the remaining 50% of the samples and obtained a determination of 72.8%.



## 2. Effects of land-use changes

**Stubai Valley**



The spatial intersect of the modelled snow-gliding map with the map of historical land use in a GIS reveals lowest snow-gliding distances on agriculturally used areas. After abandonment, a period of about 30 years with increased snow gliding develops. The coming up of robust dwarf shrubs or trees reduces snow gliding.

Even the reduction of mowing from every year to every two years leads to an increase of snow-gliding distances.

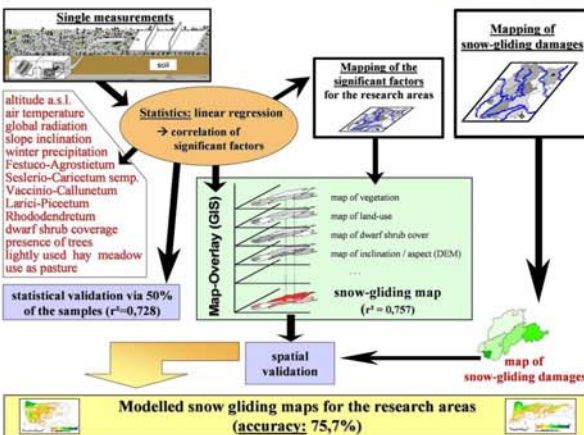## 3. Snow gliding and forming of avalanches

In the Passeier Valley we used pictures from the counter slope to map ground avalanches. This map was geo-rectified and overlaid with the modelled snow-gliding map.
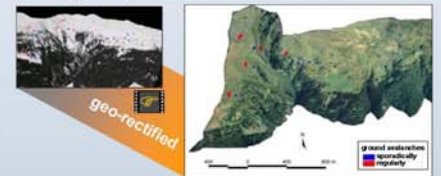


On sites with longer snow-gliding distances, a higher break-off frequency of ground avalanches occurred. The 2-sided T-test revealed an extremely significant difference between the mean values of snow-gliding rates ($p < .001$).
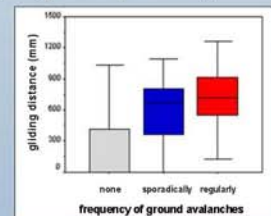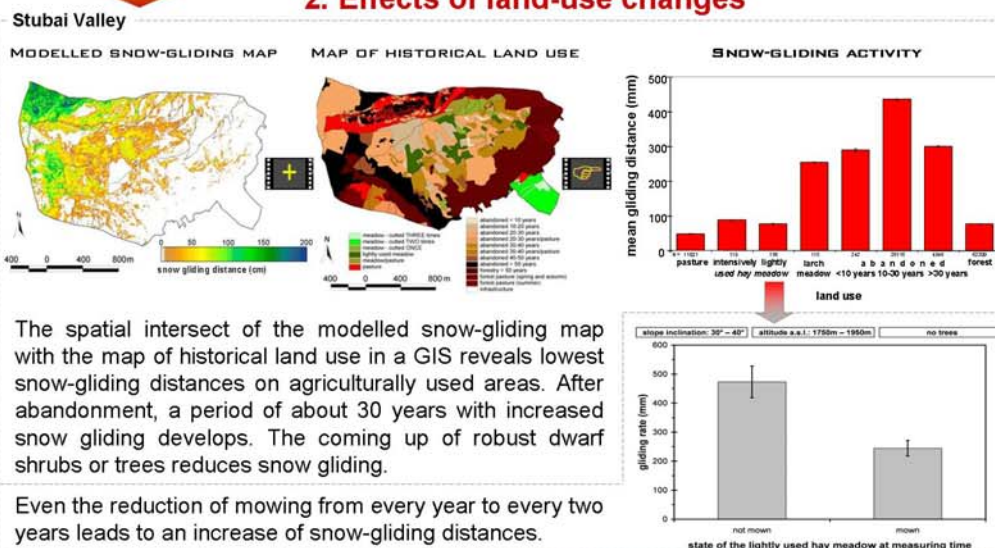


Thus, the snow-gliding maps provide a contribution to the assessment of potential risk of ground avalanches.

## Conclusions

* 14 influence factors predict snow-gliding rates with the accuracy of 75.7% (see figure "1. Modelling").

* Agriculturally used areas reveal lowest snow-gliding rates. Abandonment leads to a period of about 30 years with increased snow gliding. Afterwards, robust, tall dwarf shrubs and trees reduce snow gliding.

* Increased snow gliding leads to a higher break-off frequency of ground avalanches.

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