IMPLEMENTATION OF DIFFERENT CLASSIFICATION METHODS FOR DETECTING SOIL SLIPS

Maik Hamberger[1], Michael Moser[2]

INTRODUCTION

On August 15th, 1997 a thunderstorm in Sachseln/Switzerland, which had a total rainfall of 150 mm over a 2 hour period, was recorded and resulted in more than 700 soil slips (Fig. 1). These soil slips were evaluated and analysed in the following years by the Swiss Federal Institute for Forest, Snow and Landscape Research of Birmensdorf/Switzerland as well as the Department of Geology at the University of Erlangen/Germany.

RESULTS OF PRELIMINARY EVALUATIONS

The results of the analysed soil slips highlighted that morphological, geotechnical, geological, hydrological and botanical factors have a crucial influence on the slope stability. Comparing the rainfall totals and the intensities with other thunderstorm events the thunderstorm of Sachseln/Switzerland can be characterized as highly intensive but of a short duration (Fig. 2). Due to its dynamic the resulted soil slips can be classified after Cruden & Varnes (1996) as *complex earth slide - debris flows* or *complex debris slide - debris flows*. The length of the mostly shallow landslides averages out at 18 m, the width at 13 m and the depth at 0.9 m. The mean value of the transported material per scar was 115 m³. The analyses of slope inclination pointed out that 95 % of all investigated soil slips occur at slope with 30 – 45°. Whereas in forested areas with gentle slopes less soil slips occur bigger soil slips were detected at steeper slopes (> 39 °). The influence of stratigraphical layers on the soil slip activity as well as the morphological features of slopes and other parameters could not be quantified with simple statistical methods.

Fig. 1: Soil slips after the thunderstorm in Sachseln/CH.

Thus it was determined that the occurrence of a soil slips is not reliant on a single parameter, but rather on a set of parameters. The focus of this investigation was to find the relevant combination of parameters for the study area

METHODOLOGY

Besides the parameters inherent to the cells (5 x 5 m) used to represent the study area, characteristics of the surrounding cells were analysed and used to identify the unstable

1 Dipl.-Geol., Trumer Schutzbauten GmbH, Weißenbach 106, 5431 Kuchl, Österreich (Tel.: +43-6244-20325; Fax: +43-6244-20325-11; email: m.hamberger@trumerschutzbauten.com)
2 Prof. Dr., Lehrstuhl für Angewandte Geologie, Schlossgarten 5, 91054 Erlangen, Deutschland (Tel.: +49-9131-85-22697; Fax: +49-9131-85-29294; email: moser@geol.uni-erlangen.de)

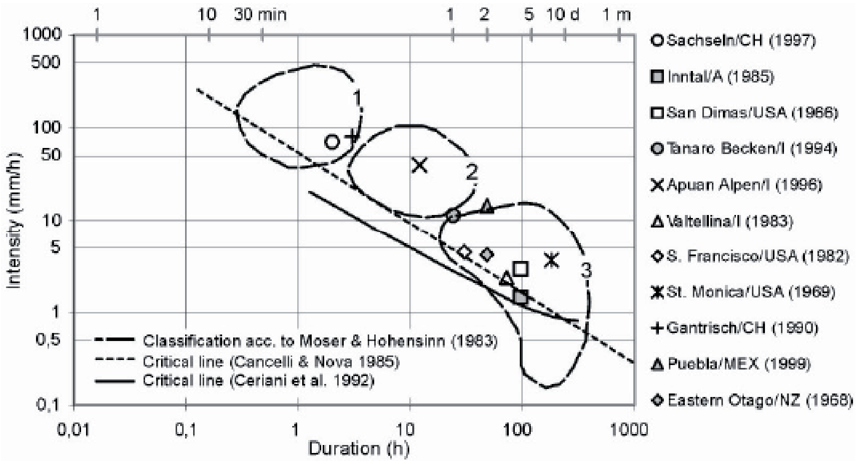

Fig. 2: Comparison of rainfall totals and intensities of different thunderstorm events.

areas. GIS was not only used for digitising but also for managing data and creating new parameters that may have an influence on soil slip activity.

Using three different classification methods - linear discriminant analysis (LDA), support vector machines (SVMs) and classification trees - the set of parameters that best separate elements of the soil slips from non-soil-slip areas were investigated, while at the same time attempting to find the simplest combination thereof. Analyses were conducted for the cases where only cells of the upper edge of the soil slips and non-soil-slip cells were considered, as well as the case where the entire soil slip scars were incorporated. While linear discriminant analysis and classification trees are used in past to classify similar problems, support vector machines are used mostly for speech pattern recognition or in medical sciences.

RESULTS OF INVESTIGATION

The results of the soil slip recognition demonstrate that it is possible to recognize, on the one hand, most of the soil slips (81 %, see Tab. 1) using different models and, on the other hand, up to 75 % of both soil slip cells and non-soil-slip cells - an important difference.
Classification trees proved to be the best and simplest method for solving the two-classes-problem, which does not incorporate the areas beneath the upper edges of soil slips or the parameters of neighbouring cells. In contrast, the method of linear discriminant analysis out performed the other models when the two-classes-problem is considered which incorporates the entire soil slip scar as well as parameters of surrounding cells. The use of modern and time-consuming support vector machines did not result in better recognition rates and has not proved satisfactory.
This contribution highlights the advantages of the three different analytical methods for soil slip recognition as well as their limits and disadvantages.

Tab. 1: Results of tests to solve two-classes-problem *soil slips/non-soil-slips* (incorporating entire soil slip scars) stating overall recognition rates and recognition rates of classes (* SS = soil slip class, NS = non-soil-slip-class).

Model		**Recognition rates (%)**					
Name	**Number of parameters**	**LDA** overall	**LDA** SS / NS*	**SVM** overall	**SVM** SS / NS*	**Classification trees** overall	**Classification trees** SS / NS*
Val-58	58	72,9	79,5 / 63,8	71,2	78,1 / 62,8	72,1	58,8 / 83,3
Val-326	326	74,8	80,9 / 67,0	70,7	73,4 / 64,3	67,2	58,2 / 73,7
Val-391	391	75,2	81,1 / 67,7	71,7	80,5 / 60,4	66,3	57,2 / 73,3
Val-401	401	75,4	81,0 / 68,1	72,1	78,8 / 62,6	71,4	59,2 / 81,7
Val-962	962	74,4	77,1 / 69,7	73,5	79,9 / 64,3	72,9	61,8 / 81,6
Val-1200	1200	73,6	76,0 / 69,5	73,0	79,5 / 63,6	71,5	57,9 / 82,5

Keywords: Natural hazard assessment, soil slips, analytical methods.