WINDSTORMS AND RISK ANALYSIS RELATED TO FOREST DAMAGE IN THE SWISS ALPS USING GIS TECHNIQUES

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Project funded by the Swiss Agency for the Environment, Forest and Landscape (SAEFL)

1. INTRODUCTION

During the 21st century climate change may lead to an increase in extreme climatic events such as windstorms, high precipitation and heat and cold waves. These events may trigger natural hazards such as floods, landslides, droughts and other catastrophes. The IPCC (2001) expects that extreme climatic events may increase in Europe, which includes Switzerland. The Swiss forest was recently partially destroyed by two windstorms *Vivian* (27.02.1990) and *Lothar* (26.12.1999). The volume of overturned wood as a result of the two windstorms is 4.9 million m^3 for *Vivian* (OFEFP, 1994) and 12.3 million m^3 for *Lothar* (SAEFL, 2000), which represents a considerable economic loss. The aim of this study is to use Geographical Information Systems (GIS) to assess the risks to Swiss forest by windstorms in terms of terrain risk zones.

2. DATA AND METHODOLOGY

Two types of data are used in this study: a) terrain data including altitude, slope orientation, slope angle, surface types and forest cover, provided by the Swiss Federal Statistical Office (SFSO) and b) forest damage data from the *Vivian* and *Lothar* windstorms, provided by the Swiss Agency for the Environment, Forests and Landscape (SAEFL). The resolution of two database sets is 100 x 100 metres. The GIS analysis of risk regions in Switzerland for forest damage from windstorms was made possible by the use of an IDRISI function called CROSSTAB. This function analyses two images and compares them for a number of categories in the two images. A table summarises the number of pixels found by this method.

3. RESULTS

Using the CROSSTAB function of IDRISI software the percentage of forest damage caused by windstorms was identified for each terrain factor. Tables 1 and 2 show the different areas overturned by *Vivian* and *Lothar* windstorms. As regards altitude *Vivian* destroyed forest situated between 1000 and 1500 metres, in line with the findings of Schüepp (1994). However *Lothar* also felled trees at lower altitudes (500-1000 m). As far as the slope orientation is concerned, both windstorms blew through slopes oriented West to North.

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This is comparable to the results of Schüepp (1994), concerning *Vivian* and Dobbertin (2002) in relation to the *Lothar* windstorm. The percentage of slopes affected by *Vivian* was higher (50-55%) than *Lothar*, but the percentage of forest damaged (9.2%) was less than for *Lothar* (17%). While *Lothar* overturned forests located on gentle slopes (0-5%) consisting of loose surface soil and rocks, *Vivian* caused damage in steeper areas where the surface type corresponded to massive calcareous stones. As regards the final factor, forest cover, a comparison between the two windstorms was not possible because database was compiled after the *Vivian* windstorm. With a help of a previous database, it is seen that of the total forest damage by *Vivian*, 97.4% of this was in dense forest. In contrast the regular database is available for *Lothar* and shows that windstorms principally damaged coniferous forest in Swiss territory (48% of the total damage).

Table 1. Summary of the influence of terrain factors on forest damage by *Vivian* windstorm (27.02.1990); in brackets, percentage of pixels affected by the selected category.

	Vivian
Altitude	1000 to 1500 metres (60%)
Slope orientation	W to N (52.4%)
Slope	50 to 55 percent (9.2%)
Surface type	Massive calcareous stones (18.2%)
Forest cover	Dense forest in 1979/85 (97.4%)

Table 2. Summary of the influence of terrain factors on forest damage by *Lothar* windstorm (26.12.1999); in brackets, percentage of pixels affected by the selected category.

	Lothar
Altitude	500 to 1000 metres (54%)
Slope orientation	W to N (35%)
Slope	0 to 5 percent (17%)
Surface type	Loose surfaces (33%)
Forest cover	Coniferous forest (48%)

4. DISCUSSION

The results of Geographical Information System methodology applied to this study are in accordance with the different terrain analyses carried out just after the *Vivian* and *Lothar* windstorms. In relation to the problem described above these databases should be used with care. This analysis is a part of a PhD study. The overall goal of the research is to understand the behaviour of windstorms to determine the risk zones in terms of terrain sensitivity in a future global warming climate.

5. REFERENCES

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