The storm Lothar 1999 in Switzerland – an incident analysis

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Abstract
On 26 December1999 the storm Lothar hit Switzerland, followed by the storm Martin during the night from 27 to 28 December. High wind speeds and heavy gusts were characteristic of both storms, which caused great damage to forests, buildings and infrastructures. More than 12 million m^3 of timber were damaged and the total cost amounted to 1.7 billion CHF. In this paper an overview of the meteorological conditions, the damage and the measures taken to deal with it is presented. It can be concluded that the consequences of the storm were well managed by most involved. However, improvements are possible for example, in the areas of the meteorological warning and communication of warnings and of communication between the different groups responsible for crisis management and recovery. Rapid decision-making according to clear criteria and the clear communication of a structured plan for coping with the damage in the forest could accelerate the recovery and lead to more satisfactory results.

Keywords: windthrow, storm, Lothar, atmosphere, risk management, natural hazards, Switzerland

1 Introduction

In December 1999 five heavy winter storms crossed over the North Atlantic ocean and western Europe. In the beginning of December, Great Britain and Denmark were hit by a storm which caused heavy damage, especially in Denmark. The second storm crossed Europe on 12 December. The most well known storms in central Europe were Lothar and Martin from 26 to 28 December 1999. At the end of January 2000 two additional storms crossed Denmark and the northern part of Germany, where they caused heavy damage as well.

For Switzerland Lothar and Martin had the most serious consequences. Due to the vast extent of the damage, long-term effects on the Swiss forest and its economy were expected. In response to this situation, the Swiss Agency for the Environment, Forests and Landscape (SAEFL) commissioned the Swiss Federal Research Institute WSL to jointly conduct an analysis of the winter storm Lothar in Switzerland.

In this paper an overview of the storm Lothar and its direct impacts is presented. Starting with the description of the meteorological conditions, the damage and the measures taken during and after the storm are analysed. The focus will be on the forest sector, but other sectors will be presented briefly as well. A more detailed description of the event is given in WSL and BUWAL (2001) in German, with an extensive summary in English, French and Italian.

2 Meteorological conditions

The origin of the storm was a big central cyclone which developed over the northern Atlantic Ocean. With a strong zonal current it moved towards Western and Central Europe (Fig. 1). Out of this cyclone a secondary cyclone (low depression) developed. This caused a rapid drop in air pressure and very high maximum wind speeds close to the ground. The combination of both a fast-moving pressure system and high wind speeds due to high pressure differences resulted in strong gusts. The trajectory of the central low crossed France and Southern Germany (Fig. 2), while the highest wind speeds were caused by the cold front in the southern sector of the depression, i.e. in Switzerland, where the impact was greatest.

The winter storm Lothar traversed Switzerland within three hours, from 9.00 to 12.00 UTC. Entering over the canton of Jura, it crossed the Swiss Plateau, central Switzerland and north-eastern Switzerland. The intra-alpine region as well as south and south-west Switzerland were spared. The top wind speeds exceeded 140 km/h (10 min. maximum) even in valley areas: In Délémont they reached 170 km/h and in Brienz 181 km/h. In the mountains, top wind speeds reached 230 km/h on the Säntis and 249 km/h on the Jungfraujoch. In the Bernese Oberland and the central part of Switzerland, the drop in pressure in advance of the cold front generated strong foehn winds with speeds as high as those of the storm itself, which increased the overall damage caused by the general meteorological conditions. The extremely high top wind speeds in the lowlands, which set records in many places, were particularly striking. On the other hand, the medium wind speeds were within the range expected for a strong storm. Figure 3 shows the high wind speed of the foehn shortly before 11.00 UTC and of the storm Lothar after 11.00 UTC at the meteorological station Altdorf in the central part of Switzerland.

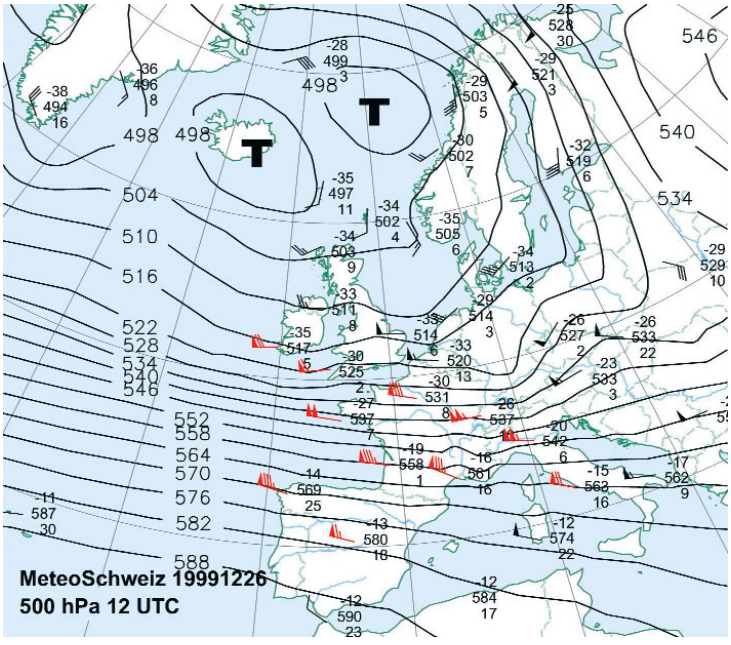

Fig. 1. Weather map at the 500 hPa level for the 26 December 1999, 12.00 UTC. Switzerland was located in a very strong high-altitude wind. Source of data: MeteoSwiss.

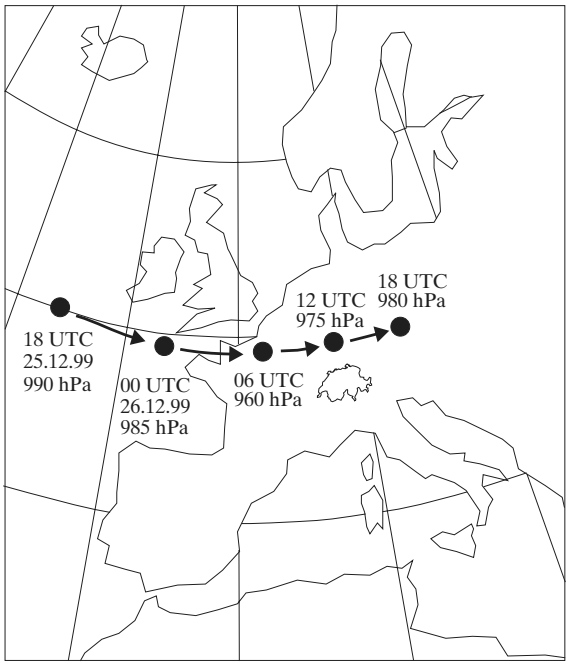

Fig. 2. Course of the low pressure zone Lothar from 25 December to 26 December 1999. The figure shows the rapid movement of the storm and the tremendous decline in pressure.

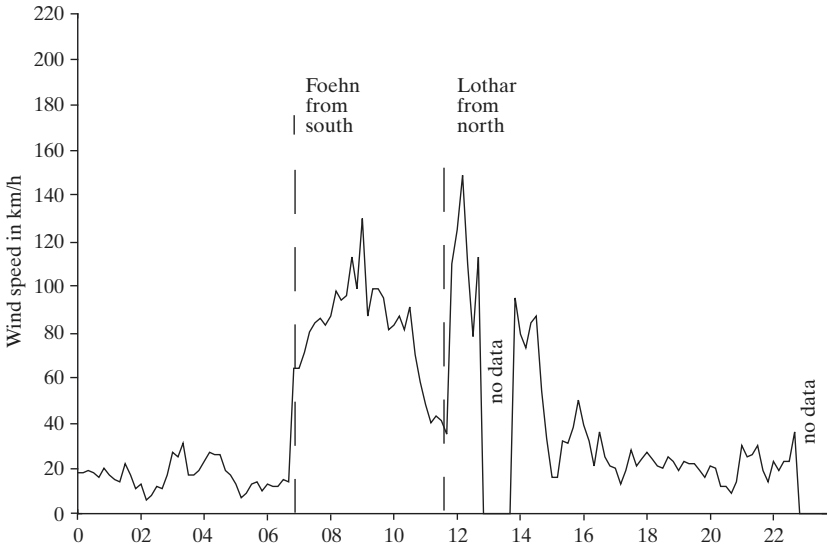

Fig. 3. Wind speeds of the foehn shortly before 11.00 UTC and during the storm Lothar after 11.00 UTC at the Altdorf meteorological station, Central Switzerland. Source of data: MeteoSwiss.

Comparing Lothar 1999 with the storm Vivian 1990, several similarities can be identified. In both cases the centre of the low crossed Switzerland in the north. In contrast Vivian was accompanied by a west-east oriented cold front which moved quite slowly. The warm air which moved from the south-west to Switzerland could not flow northwards and was moved back into the alpine areas. The consequences were high wind speeds in the alpine valleys, which caused extensive damage, especially in alpine forests. The mean wind speeds (10 min. average) were in the same order of magnitude during both storms, but the peaks of maximum wind speeds were higher in most places during Lothar. Lothar was also much more gusty, which is probably the main reason for the extensive damage. Gusts are not measured by the operational network, so no quantitative analysis is possible. Figure 4 shows the course of wind speeds during both Vivian and Lothar.

Regarding the speed of wind gusts a comparison with earlier winter storms in Switzerland shows that, although Lothar was an extremely severe event, it was well within the scope of what could be expected (HÄCHLER 1983–1999). On average one storm with similarly high wind speeds sweeps across Switzerland once every ten to fifteen years. Lothar was without doubt among the most severe storms of this type.

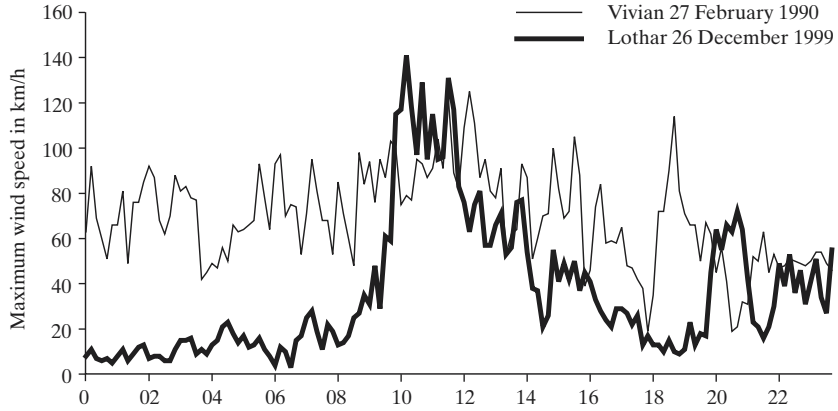

Fig. 4. Maximum wind speeds (10 min. maximum) during the storms Vivian (27 February 1990) and Lothar (26 December 1999) at the Lucerne meteorological station. Source of data: MeteoSwiss.

3 Damage

The storm Lothar caused great damage in various areas. During the event 14 persons were killed, most of them by falling trees or bricks. After the event an additional 15 people died in 2000 during clearance-work in the forest (WSL and BUWAL 2001). After Vivian, which mainly hit the mountain areas, 24 people were killed while clearing up the damage, which indicates that forestry work has become safer but this still has to be improved. A further reason for fewer deaths after Lothar might be that clearance-work in mountain forests (e.g. after Vivian) is more dangerous than it is in forests located at lower altitudes (e.g. after Lothar).

Extensive damage during Lothar occurred not only in the forest but also to buildings and real estate. Transport facilities, cable cars and ski lifts, telecommunication services, and the Swiss electricity network were also affected. The total quantifiable damage including forest, buildings etc. is estimated to have been approximately 1700 million CHF. Besides this direct damage there were also indirect consequences for the economy.

3.1 Damage to forests

The total damage in forests amounted to 12.7 million m^3 of timber (as of November 2000), which corresponds to three times the normal annual utilisation and approximately 3% of the growing stock for all of Switzerland. A total of 46 000 ha, which is 4.3% of the Swiss forest area, was affected by the storm. Approximately 50% of the affected areas were totally devastated, which means that the cover of the remaining stand was less than 0.2. Figure 5 illustrates the distribution of forest damage in Switzerland. It shows that the Swiss plateau and the pre-Alps as well as parts of central Switzerland were affected by the storm.

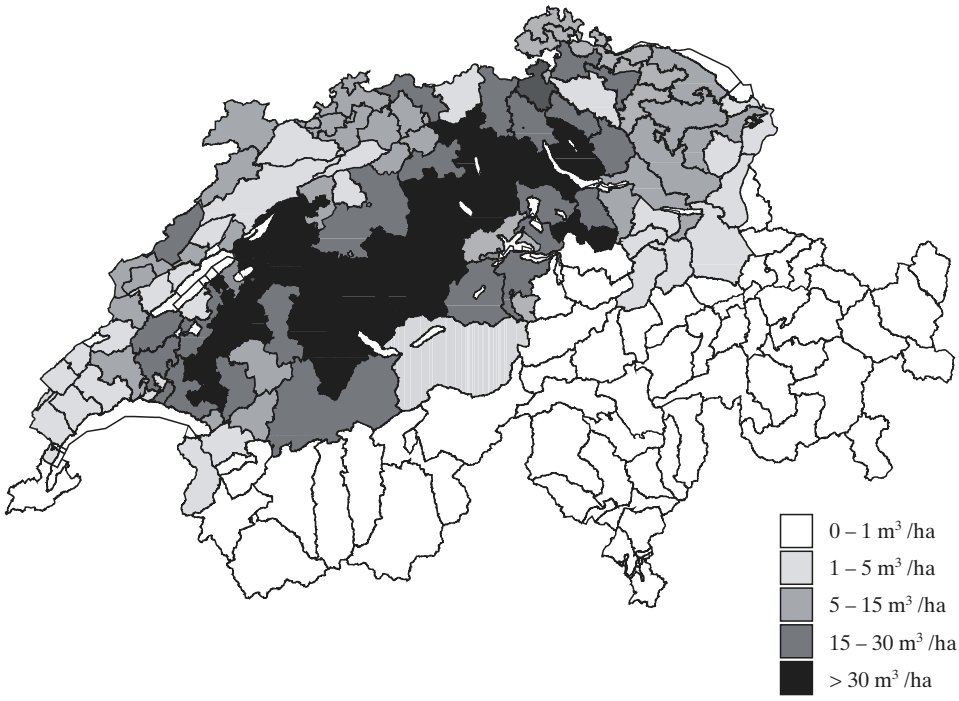

Fig. 5. Extent of damage (amount of windthrow timber volume in m3/ha) in Switzerland. Source of data: Swiss Federal Statistical Office and Swiss Forest Agency, 2000.

The areas of forest damaged by Lothar and Vivian overlap only in some regions. Most of the damage during the storm Vivian occurred in the alpine cantons of Glarus, Uri, Graubünden and the Bernese Oberland (Fig 6). Lothar affected the cantons of the Swiss plateau especially. The cantons of Bern, Obwalden, Nidwalden and Schwyz were hit by both storms. The canton of Nidwalden was hit most severely by Lothar, which felled tenfold the normal annual utilisation of timber. Overall, the damage caused by Lothar was 2.5 times greater than that caused by Vivian (4.9 million m^3 of timber).

Since most of the damage caused by Lothar was outside the alpine area, the damage in protection forests was smaller than it was with Vivian. However, in some areas, e.g. in the cantons of Obwalden, Nidwalden, and Schwyz, 15 to 20% of the protection forest was damaged by Lothar.

The total amount of damage to forests is roughly estimated to have been approximately 750 million CHF. This figure is mainly composed of: the loss due to destroyed timber; the loss in profits due to the collapse of timber prices; the subsequent damage to forest stands due to bark beetles; the costs of replanting; and additional expenses for a more costly timber harvest in terms of time and money. The cost of damage to individual trees and fruit-trees are estimated to have been 38 million CHF.

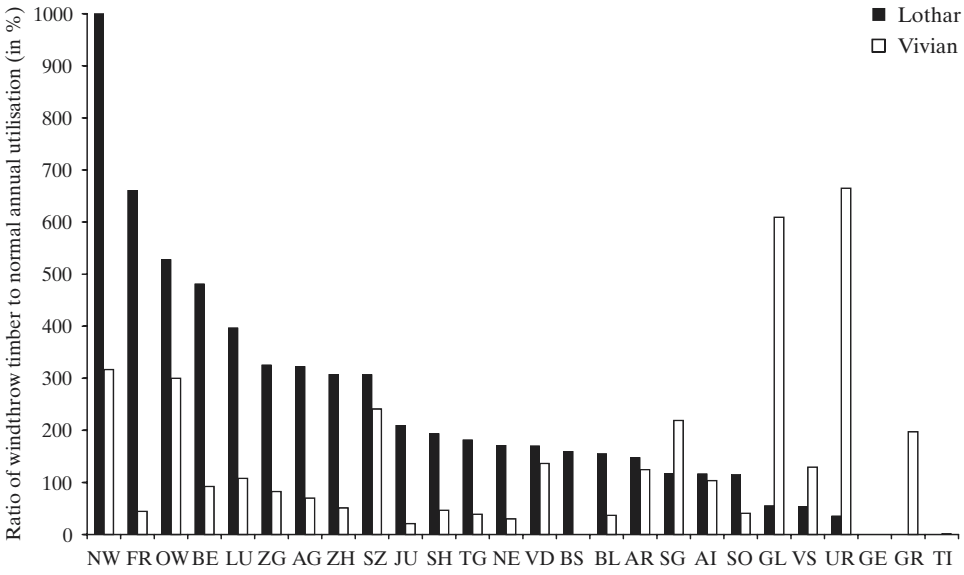

Fig. 6. Comparison of the forest damage caused by the storms Vivian 1990 and Lothar 1999 in the cantons of Switzerland. Source of data: Holenstein (1994) and Swiss Forest Agency, 2000.

The great damage caused by Lothar raises the question of whether forest damage due to storms is increasing. Damage in Swiss forests due to storms increased between 1860 and 1999 (Fig. 7). The reason why damage has increased especially since 1960 is difficult to answer. Lothar is the starting point for further research in this field and also the subject of several investigations launched at WSL after Lothar. It appears that a considerable part of the damage can be explained by the fact that the damage potential is higher. The amount of growing stock is increasing by 1% per year (BRASSEL and BRÄNDLI 1999). A second reason is probably the fact that the portion of high trees has increased, which means that forests have become more vulnerable to storms (WSL and BUWAL 2001). No significant trend for storms to be more frequent and more gusty (i.e. more destructive) than in the past has been detected in the available data.

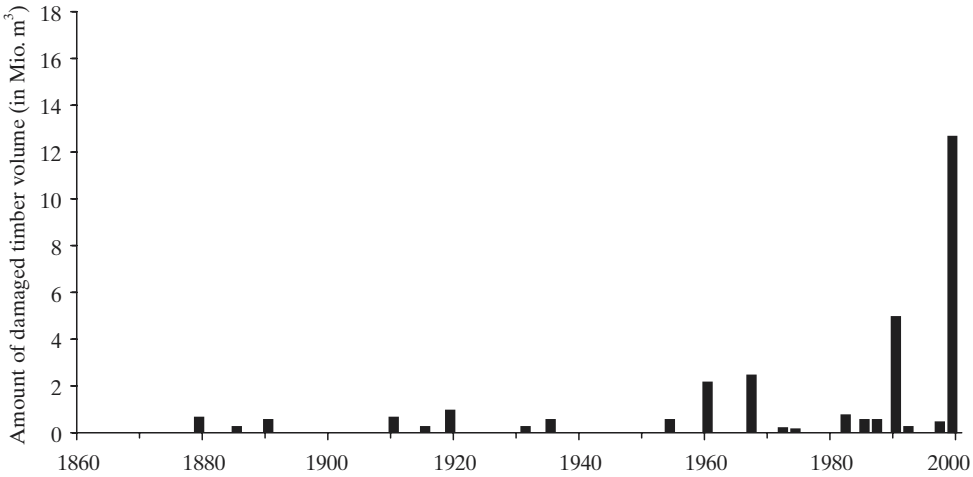

Fig. 7. Damage in forests from 1860 to 1999 in Switzerland. Source of data: Swiss Forest Agency, 2000.

3.2 Damage to buildings and infrastructure

The second sector badly damaged by Lothar consisted of buildings and real estate. Damage to buildings in all of Switzerland is estimated to have been more than 600 million CHF and to movable property 125 million CHF. As with the forest damage, the canton of Nidwalden suffered the greatest damage relative to its size. More than 20% of all buildings in this canton were affected (WSL and BUWAL 2001).

Damage to transportation facilities resulted in several hundred blocked roads, over 80 cut-off railway lines, and damage to boats and aircraft costing in total around 200 million CHF. Besides this direct damage there were also indirect consequences, such as disruption to computer systems, refrigeration plants, light, heating, and lower earnings for transport companies and losses for companies where production broke down. These cost about 60 million CHF. The cost of fewer overnight stays as well as lower day-time earnings in the winter sports sector cannot be quantified. Therefore it must be assumed that the real indirect costs were much higher (WSL and BUWAL 2001).

4 Measures

Generally speaking the measures for dealing with natural hazards can be subdivided into three classes: prevention, intervention, and recovery. In the case of Lothar prevention means mainly meteorological forecasting and preparation for crisis situations in the forest and other sectors. The intervention phase was very short during Lothar. The recovery in the forest sector started soon after the event but will still take several years, whereas recovery in the other affected sectors was completed within a few months.

4.1 Meteorological warning

Meteorological warnings in Switzerland are published by MeteoSwiss which has an established infrastructure. It provides the media with information as well as the police and other involved parties. However, in the case of Lothar a precise forecast was extremely difficult since even the large forecast models of international weather services initially overlooked the small disturbance above the Atlantic Ocean. Consequently, the power and extent of the storm was only recognized in the early morning of 26 December, which resulted in shorter warning times. Moreover, in a number of places the addresses failed, presumably due to the holidays, to recognise the importance of the warnings and to pass them on properly. As a result, in many places people were not aware of a storm warning.

4.2 Intervention and recovery by companies, local authorities and cantons

The intervention phase was very short because the event crossed Switzerland within 2.5 hours and most of those responsible were surprised by the event. So the main storm-related activities began after the storm. Insurance companies and power stations had to cope with a flood of damage reports by telephone, which partly overloaded the telecommunication network. Repair work in numerous areas was started immediately, which meant that over 90% of the damaged power lines were working properly within one day, and the insurance for damage could be paid out within a couple of weeks.

In most rural areas the responsible organizations, e.g. the fire brigades, managed the situation in collaboration with other organizations. In some cases the communication between the various emergency services and the local authorities' crisis teams responsible for, among other things, informing the local population proved to be a critical factor. Due to power failures, damaged or overloaded telecommunication networks, information was difficult to pass on.

4.3 Recovery in the forestry sector

In the forestry sector the recovery was a great challenge for all parties involved. The first step was to survey and to estimate the damage. After the immediate clearance and stabilization work, especially along the roads and railways, the next step was to make plans for exploiting the timber of the areas affected by windthrow. Since most of the damage was located in the easily accessible forest in the Swiss plateau, much of the clearing was conducted by machines such as harvesters and forwarders. The situation after Vivian was different as the clearing work had to be carried out manually and the transport of the timber from the stand to the next road was often only possible with support of cable cranes and helicopters.

The policy of the cantons concerning the financial support for clearing varied greatly. Even taking into consideration the amount of damaged timber (Fig. 8), subsidy rates ranged from zero to more than 90%. In general, federal subsidies were markedly less than during Vivian.

Because of the potential threat posed by decaying timber and in order to sell it at reasonable prices, the timber had to be sold and transported very quickly. There were substantial deficiences in the transportation capacity, especially in the early stage. The delay by the national railway company, SBB in supplying additional capacity led to a bottleneck in wood transport.

In addition the large supply of timber resulted in a decrease in the price of timber by more than 35% within half a year (STREIFF 2000). As far as possible the timber was sold rapidly, sometimes at any price. Another strategy was to store timber. Here, some new techniques, like storage under plastic film, were applied for the first time on a large scale.

Important decision tools for dealing with the diverse aspects of windthrow are contained in the "Handbook for forest damage" (BUWAL 1993) and the "Decision support tool for windthrow damage in forests" (BUWAL 2000), which were produced after the storm Vivian and which summarize current knowledge (see also ANGST and VOLZ this issue). There are still, however, many gaps in knowledge, so that further research is necessary. The steps taken after Lothar must be evaluated during the coming years.

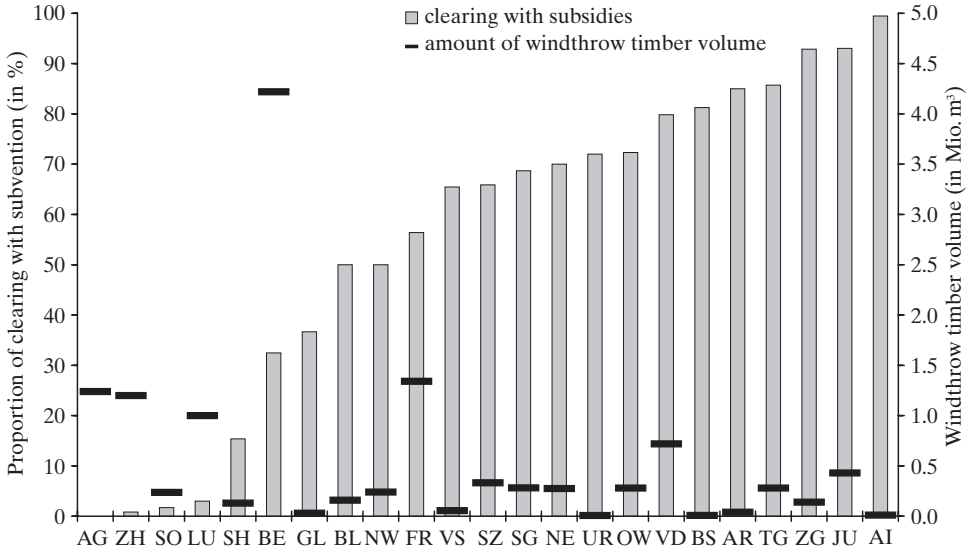

Fig. 8. Proportion of windthrow timber to be cleared with subsidy compared to the total amount of damaged timber in the cantons after Lothar 1999. The figure shows the different policies of the cantons concerning the financial support of the owners. Source of data: Swiss Forest Agency, 2000.

5 Conclusions

In summary we can conclude that the Swiss and the Swiss economy coped well with Lothar, which was an extraordinary event. Despite this overall positive assessment, a number of areas can be identified in which improved organisation, planning and deployment could result in better handling of a future natural disaster of storm Lothar's magnitude.

1. The meteorological warning system could be improved, in particular by developing more accurate forecasting models and better methods for distributing warnings.
2. A well-functioning information and communication system for handling natural hazards could play a significant role in dealing with events of the magnitude of Lothar. Good personal contacts between the individuals and institutions involved are essential for efficient crisis management.
3. It is very important, especially for the forest sector, that politicians and government authorities can make rapid decisions according to clear criteria. This will have a decisive impact on the ability of those affected to carry out the necessary work in the forests quickly. Information and communication among the people involved could be improved by setting up new communication channels and clear deployment structures.

In order to be well prepared for the next such event, improvements must be started immediately.

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