THE AVALANCHES OF GALTÜR AND VALZUR IN FEB. 1999

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ABSTRACT: The avalanche of Galtür (Feb.23 1999) was the most serious single accident in Austria since 1954. There were 31 fatalities, 6 buildings destroyed and 18 buildings damaged. Due to an area of high pressure over the Bay of Biscaya and an area of low pressure over Scandinavia the Alps received moist air from the Atlantic and cold air from the Arctic. This situation leaded to intensive precipition in the Arlberg- Außerfern- and Paznaun area in February 1999 and to many large avalanches.
Calculations with the Samos Avalanche Model showed some interesting results. The pressure (which was calculated for those sites where most of the buildungs were destroyed) was in the order of 100 kPa. About 26 % of the totally released snow mass (136 kilotons) was transferred to the powder part of the avalanche.
As a result of the avalanche the Austrian Government spent about 130 Mio ATS (about 10 Mio $) for different protection measures (supporting structures in the release zone, two catching dams....) in this area.The two accidents (Galtür and Valzur) leaded to new design criteria for hazard maps in Austria. While the old decree determined 25 kPa for the Red Zone the modified guidelines have extended it to 10 kPa (valid since July 1999).

KEYWORDS: Avalanche Disasters, Avalanche Zoning, Simulation of Avalanches

1. METEOROLOGICAL CONDITIONS

The synoptic situation in January and February 1999 was characterized by an area of high pressure over the Bay of Biscaya and an area of low pressure over Scandinavia. The resulting northwesterly oriented frontal zone did not cause very intensive daily snowfalls but leaded to three storm periods; the first one end of January (from 26th to 31st) with about 100 cm of new snow, the second from 5th to 9th of February (appr. 130 cm of new snow) and a third period (from Feb. 17th to Feb. 24th) with more than 200 cm. Especially the Arlberg-, Außerfern- and Paznaun Area received plenty of snow. Fig 1. shows the height of new snow at the observation site Galtür in about 1600 m (Jan 26. To Feb. 28, 1999); the total height of precipitation in February 1999 was 245 mm, which is about four times as much than the average (Gabl, 2000).

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As shown in Fig. 2. the total depth of snow at the observation site Madlein/Ischgl (this is very close to Galtür and Valzur) in 2280m increased from about 80 cm (end of January) to 300 cm (Feb. 22nd); due to low air temperatures in February 1999 the settlement of the snowpack was relatively slow (Fig. 2).

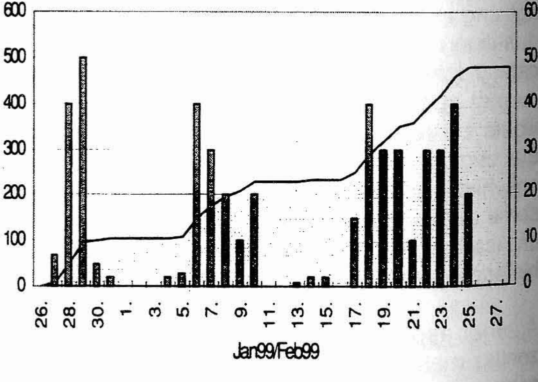
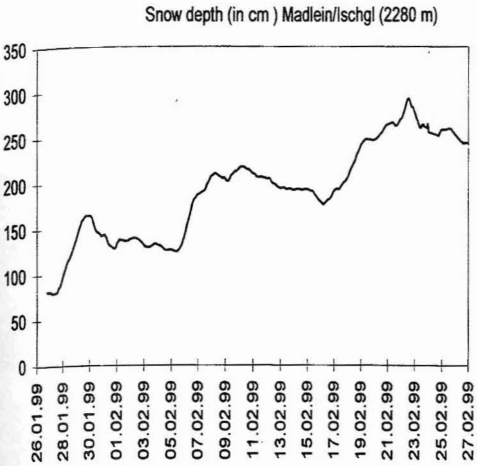


Fig.1 Height of daily new snow in cm (right axis) at the observation site Galtür in about 1600 m from Jan 26. to Feb. 28, 1999 (Gabl, 2000); the left axis shows the sum of new snow (in cm).



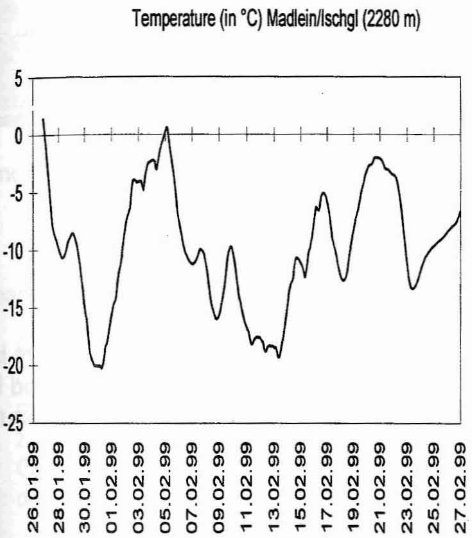


Fig. 2. Snow depth and air temperature at the observation site Madlein/Ischgl in about 2280 m from Jan. 26 to Feb. 27, 1999 (MAP Data Centre, 1999)

2. THE AVALANCHES OF FEB. 23 AND FEB. 24

On Feb. 23rd, 1999 (4pm) a dry-snow slab avalanche released on the south facing slope just above the village of Galtür (which is situated in the Paznaun valley in the western part of the Tyrol). The starting zone of the two avalanches („Weiße Riefe“ and „Äußere Wasserleiter“) was near to the Grießkogl in about 2700 m (inclination 38 to 50°) and reached Galtür in about 1580 m above sea level. There were 31 fatalities, 6 buildings destroyed and 18 buildings damaged (also outside the actual hazard zones). The damage was estimated with about 72,5 millions ATS (appr. 5 Mio $).
The avalanche was running longer than expected (see Fig.3); the deposition area reached into a part of the village (appr. 250 m from the Red Zone). A look to the avalanche statistics (Höller, 1997) shows that it was the greatest avalanche disaster in Austria since the 1950s.

Fig. 3. View from the starting zone of the avalanche to Galtür. The damage area is in the middle of the photograph.

One day later (Feb.24) there was a second accident only a few kilometers from Galtür. The avalanche („Innere Riefenbachlawine“) starting zone was in 2700 m and reached Valzur (appr. 3 km northeast of Galtür) in about 1480 m.
7 persons were killed, 7 buildings destroyed and 1 building was damaged. The damage was estimated with about 56 Mio ATS. The main flow was running straight on the alluvial cone (inclination 11 to 14°) and did not follow the gully which was formed by the torrent (Fig. 4). The avalanche was totally different from the avalanches in Galtür. While the avalanche path in Galtür was on a open slope and the deposition zone in the valley floor the path of the Riefenbachlawine was in a channel and the runout zone on a debris cone.

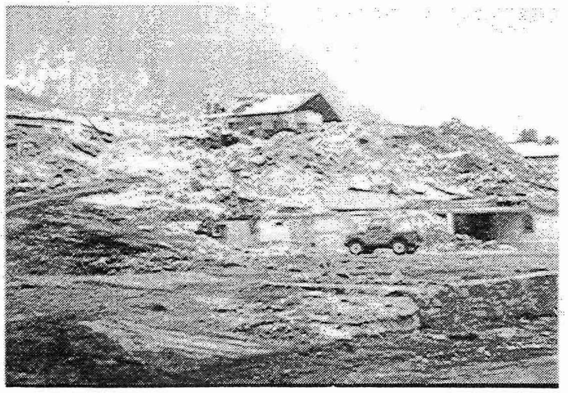


Fig. 4. Alluvial cone of Valzur and avalanche deposit (Feb. 24, 1999).

The reasons for the great avalanches in February 1999 can be found in the extreme values of snow depth and fresh snow (three storm periods) as well as in the low temperatures (almost no settlement of the snow pack) during Feb.99

3. THE SAMOS MODEL, A SHORT DESCRIPTION

Generally the so called „catastrophic avalanche" is described as a dry dense flow avalanche with a high powder component. Due to their completely different physical behaviour of both components a two dimensional granular flow model and a three-dimensional turbulent flow (Powder part) were generated under coupling of a mass transfer model. On the example of the Galtür disaster 1999 it is reported about the application of the SAMOS (Snow Avalanche Modelling and Simulation, Sampl, Zwinger 1999).

4. RESULTS OF THE SAMOS-GALTÜR SIMULATION

The area of the release zone was determined by the field observation of the Austrian Federal Service for Torrent and Avalanche Control. Based on the before mentioned meteo-data and own field studies directly in the starting zone (snow profile measurement) a total snow mass of 136 kts was calculated (Sampl, Zwinger, Schaffhauser 1999). In figure 5 it is represented the terrain model, the outlined release areas and the maximum impact pressure over the whole sphere of action of the dense flow part with a scaling from 0 to 250 kPa. In direction of the avalanche centre line

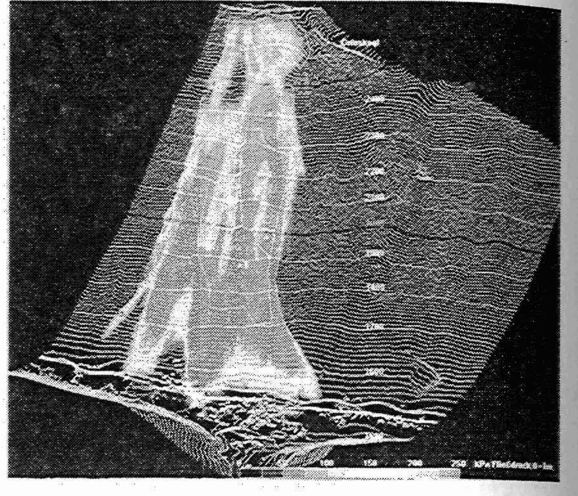


Fig. 5: Distribution of the max. pressure from the dense flow part of the avalanche

the dense flow part thrusted forward, crossed the road and destroyed with a calculated pressure round about 100 kPa the building in front of. The mapped damages are in good line with the computed presentation. The same rule will be applied to the deposition heights between 0 to 5 meters. From figure 6 the

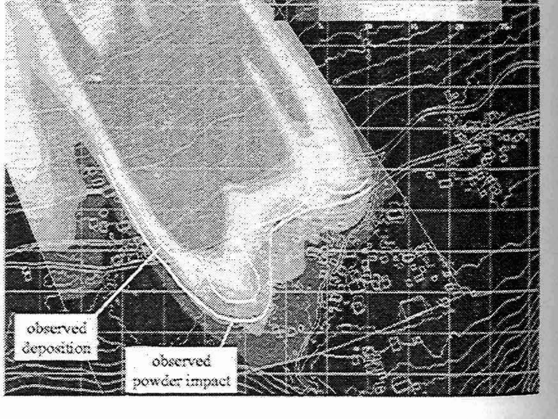


Fig. 6: Distribution of the max. pressure from the powder part of the avalanche (2.4 m above the ground)

influence of the powder snow impact is drawn in a scaling range betwen 0 to 25 kPa. The recalculation of load limits of destroyed or damaged roof frameworks corroborated also theese results and are consequently useful data for the verification of the SAMOS-model.

One month before the disaster in Galtür the SAMOS-project-financed by the Ministry for Agriculture and Forestry in Austria – was successfully brought to a close. In the case of Galtür it is always again a tragic fact that such disaster open up rare and important possibilities for the research work to verify the results and the usefulness of avalanche dynamics modelling. This mathematical model is used to forecast the run-out distances of avalanches, the flow height, the height of deposition, as well as the vertical distribution of densities, velocities and total pressures. For the last year the SAMOS model got an important tool in the frame of the authorities hazard zoning and to solve engineering problems.

5.CONSEQUENCES

As a result of the avalanche accidents the Austrian Government spent about 130 Mio ATS (about 10 Mio $) for different protection measures (supporting structures in the release zone, two catching dams....) in this area. In Galtür two avalanche catching dams were designed which are already finished (Fig.7); the houses were allowed to be rebuilt on the same place. Supporting structures in the starting zone are planned and will be done in the next years.

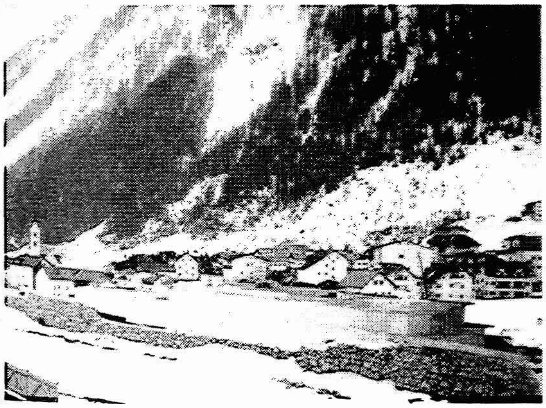


Fig. 7. Avalanche catching dam in Galtür

In Valzur it was decided to have no buildings on the alluvial cone in future; the houses will be rebuilt on a safe place, appr. 300 m up the valley.
However, the two accidents leaded to new design criteria for hazard maps in Austria. While the old decree determined 25 kPa for the Red Zone (Höller, 1997) the modified guidelines (Tab.1) have extended it to 10 kPa (valid since July 1999).

	Return period 150 y (design event)	Return period up to 10 y
Red	$p > 10$ kN/m²	$p > 3$ kN/m²
Yellow	$1 < p < 10$ kN/m²	$1 < p < 3$kN/m²

Tab.1. New guidelines for avalanche zoning in Austria (BMLF, 1999)

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