Quantitative risk analysis for evaluation of avalanche protection projects

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ABSTRACT

Questions on optimum protection measures have always been bound to economic considerations. This involves a comprehensive investigation and analysis of the effect of avalanche protection measures with an appropriate concept of risk, including the avalanche danger area and land use of the area.

Technical and economic methods and analysis are applied in methodical procedures in order to arrive at an assessment model for avalanche protection projects. From the technical point of view, the application of general risk analysis methodology and its adaptation to specific circumstances related to avalanche hazards are in the foreground. The quantitative risk magnitudes are supplemented by the aspects of risk awareness, in particular of risk acceptance and risk aversion.

The avalanche risk of specific protection projects in the sense of an expected annual value of damage is calculated as part of the total potential damage. The result of this risk analysis is shown in a quantitative risk - diagram with the outset risk without safety measures, the remaining risk and the risk reduction. By comparing the annual costs for measures and the expected risk reduction, it is possible to make comparisons between measures with a short-term and long-term effect. The targeted project selection for this paper takes the expected variability of the efficiency into account in order to be able to define the economical limits. It is also possible to deduce marginal costs which, in the past, were applied to prevent a statistical death occurrence.

1 METHODS OF QUANTITATIVE RISK ANALYSIS

1.1 Risk concept and avalanche risk

A risk situation can be related to a single person (individual), to the danger area of an avalanche or to other limiting factors (collective, perimeter). The analysis of a risk situation (Kaplan/Garrick 1981) should provide answers to three questions:

What (kind of damage) can occur?	(Scenario, S)
How often will this damage occur?	(Probability, P(s))
What is the extent of this damage?	(Extent, A_S)

In general, the risk R can be written (e.g. Starr 1969, Rowe 1977) as a risk value given by the product of probability of damage P(s) and amount of damage A_s caused with the basic risk formula:

$$R = P(s)\ A_S \tag{1}$$

If all the scenarios S_i (i = 1.2...n), which characterise a risk situation are described according to the probability of occurrence, p_i and the corresponding extent of the damage A_i, a simplified risk in a risk situation can be avaluated. If the scenarios are independent (e.g. from different natural hazards), the risk value $\overline{R}$ in the following represents a mean scenario where:

$$\overline{R} = \frac{1}{n} \sum_{i=1}^{n} p_i\ A_i \tag{2}$$

The scenarios can be plotted with the cumulative probability in a risk diagram (Fig. 1). The line joining the scenarios S_i - approximated with the function $P(s) = f(A_s)$ - represents the outset risk, R_o; the same method, carried out after the implementation of safety measures gives the remaining risk R_1. This risk, e.g. in the outset state t_O without safety measures, can be approximated with the integral under the function $P(s) = f(A_s)$ as a statistical value for expected damage per year:

$$R_O = \int f(A_s)\ dA_s \tag{3}$$

The main point of interest during evaluation of a risk situation is usually the probability of a certain amount of damage, A_i, or higher values then A_i, being reached. In the risk diagram, this can be read as the probability P_{i_0} (in the outset state) or P_{i1} (in the remaining risk state).

Joining the points with the same risk in a double logarithmic probability-extent-diagram (risk diagram) creates a straight line (Farmer-line). Parallel movement of the Farmer-line on the risk line (with the cumulative probability) shows that the scenarios S_3 and S_4 make the greatest contribution to the damage expectancy value.

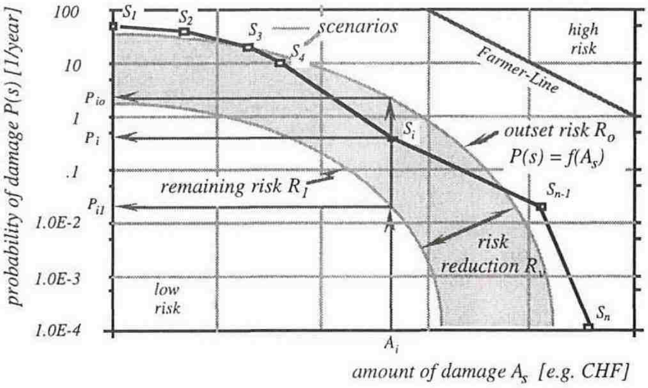

Fig. 1: Cumulative probability P(s) of the scenarios S_i (i = 1..n) and the approximated outset-risk R_o, remaining risk R_1 and risk reduction R_v (qualitative) in the risk diagram

Avalanche risk can be represented by temporal and spatial overlapping of the two independent processes of avalanche danger and land use of the area. The avalanche danger is described by the avalanche probability P(L) and the extent of the avalanche A_L [kN/m²].[1] The land use of the area corresponds to the probability of presence of objects P(O) and the value of these objects (or the number of people present), V_o. The probability of extent (vulnerability), P(A), is recorded as a conditional probability under the condition that the avalanche, L, has taken place as well as that the person (object), O, was present, P(A|L,O). For a risk to objects, the probability of extent, P(A), corresponds to a function of extent of the avalanche, A_L, and damage susceptibility of the objects, S_o, i.e. $P(A) = f(A_L,S_o)$ (see Section 1.2.2). Placed in the basic risk formula (1), this allows the general avalanche risk, R, to be generally described as:

$$R = P(L)\ P(O)\ f(A_L,S_o)\ V_o\ \gamma\ \delta \quad \text{[e.g. CHF/year]} \qquad (4)$$

γ is called the reduction factor (see Section 1.2.2) and δ the aversion factor (see Section 1.2.3).

The individual risk of death of one particular person, i, from an avalanche event, j, in a building category (Fig.4), k, can be obtained with:

$$r_{ijk} = P(L_j)\ P(O_i)\ f(A_{Lj},S_{ok})\ P(A_i)\ V_{oi}\ \gamma \qquad (5)$$

where i = 1,2,3.....m persons/objects, j = 1,2,3 .....n avalanche events, k = 1,2,3.......q category of buildings

From a general point of view, it can be seen (e.g. Slovic et al. 1982 p. 92) that, "... 'riskiness' means more to people than 'expected number of fatalities.' Attempts to characterize, compare, and regulate risks must be sensitive to the broader conception of risk that underlies people's concern."

1.2 Risk assessment in settlement protection

1.2.1 Danger assessment in time and space

The avalanche danger is taken into consideration with regard to time and space of the avalanche probability, P(L), and the extent of the avalanche, A_L. This approach is based on the Swiss guidelines for allocation of avalanche danger zones (BFF/EISLF 1984), whereby the limitation of the avalanche zones red / blue are basically carried out with a return period, T, of 30 years and the outside limitation of the blue zone with T = 300 years.

Avalanches which hit a community are rare, independent occurrences for which the same probability of occurrence can be taken each year. In one particular location in the flow area of an avalanche, the avalanche probability, P(L), can be approximated as a function of the time of investigation, n, with a binomial distribution (see also Fig. 2). For $n \rightarrow \infty$ and $P(L)=1/T \rightarrow 0$, the binomial distribution very closely approximates the Poisson distribution. According to the extremum distribution of fracture height and the proportionality of fracture height and run out distance (Salm et al. 1990) gives approximate extremal value distributed run out distances.

Using Gumbel's theory of extreme values (e.g. Mc Clung and Mears 1991), the run out distances can be weighted and offset against mean avalanche probabilities per avalanche danger zone and investigation time period (Wilhelm 1997, p. 43 f). Fig. 2 shows that this mean avalanche probability of the red zone, $P(L)_r$, is on the order of magnitude of an event - calculated with the binomial distribution - with a return period of T≈13 years. The probability $P(L)_{bl}$ in the blue zone corresponds to a value of T≈85 years.

The mean value of avalanche pressure per event, A_L, is taken as >30 kN/m² in the red zone and calculated as 10 kN/m² in the blue zone assuming that the avalanche pressure decreases linearly with the extremal-value-distributed run out distances (Wilhelm 1997, page 49 f).

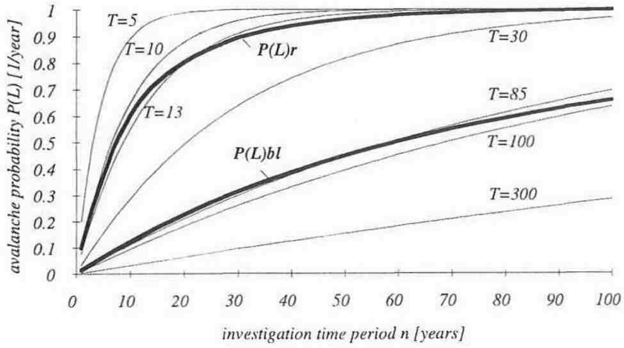

Fig. 2: Mean avalanche probability (averaged over the red and blue zone) $P(L)_r$,$P(L)_{bl}$, as a function of investigation time period

The complete risk situation is modelled as avalanche protection of settlements with 4 scenarios (Fig. 3). The scenarios S_1, S_2, S_3 and S_4 are chosen so that the mean values calculated above for avalanche probability P(L), the return period, T and extent of the avalanche, A_L, can be allotted to each zone for each scenario. (See also Table 1). The scenarios S_1 and S_4 are estimations and subject to uncertainties. However, this is not particularly important for calculation of risk as their risk contribution to the statistical

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[1] A calculation of the avalanche danger, L_G, suggested by the author, with multiplication of the avalanche probability, P(L), and extent of the avalanche, A_L ($L_G = P(L) \cdot A_L$), results in a straight line of points with the same danger, very similar to the danger limitation (BFF/EISLF 1984) when plotted in a probability-extent diagram.

value for expected damage is small compared to the scenarios S_2 and S_3. Fig. 3 shows the suggested scenarios in populated areas with the Swiss avalanche danger zones in the background.

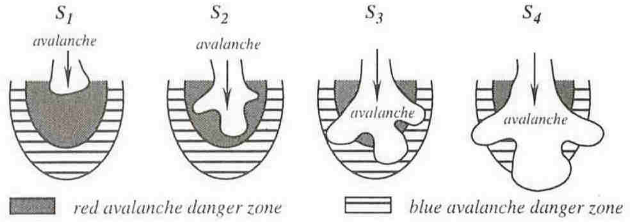


Fig. 3: Avalanche scenarios S_1, S_2, S_3 and S_4 with respect to the avalanche danger zones.

Table 1: Return period and mean extent of avalanche for the scenarios S_1, S_2, S_3 and S_4

scenarios	S_1		S_2		S_3		S_4	
avalanche danger zones	*red*	*blue*	*red*	*blue*	*red*	*blue*	*red*	*blue*
return period T [years]	< 5	--	~13	--	~85	~85	> 300	> 300
mean ext. of aval. A_L *[kN/m²]*	< 10	--	10	--	> 30	10	» 30	> 30

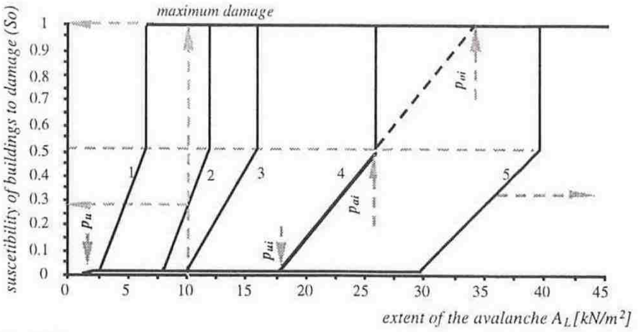
1.2.2 Damage potential and extent of damage

The term of damage potential alone is not explicit and must be defined with regard to the size of system being considered (e.g. total value of the use of the area in an avalanche path). The damage potential is a very well known quantity for the decision maker and here should be understood to be the total of the recorded and evaluated damage indicators of the red and blue avalanche danger zones. Damage indicators are considered to be damage to persons, cattle and horses, buildings, vehicles, infrastructure and natural resources (forest, grazing land etc.) (Wilhelm 1997).

In section 2, the risk of death for people, in contrast to all other damage or risks, is not monetarised, but is given separately in quantitative form during the evaluation of the projects. Because an avalanche scenario usually does not involve the entire damage potential area (e.g. red zone or blue zone), each avalanche zone is assigned a so-called reduction factor, γ. The reduction factors are taken as mean values of γ=0.8 for the red zone and γ=0.5 for the blue zone and are principally dependent on the topography of the avalanche area and the distribution of the potential damaged objects. The size of reduction factors must, in the end, be adjusted in each case.

If an avalanche, L, hits a person/object, O, a certain amount of damage must be expected with the conditional probability $P(A|L,O)$. The probability of fatalities inside buildings is calculated as a statistical mean value of avalanche damage events, whereby the susceptibility of buildings to damage, S_0, must be taken into consideration. A person in a building which is destroyed, is allotted an extent of damage probability (death) factor of 0.46.

In this case, the susceptibility to damage, S_o, is taken as a function of the extent of the avalanche, A_L [kN/m²], differentiated for five different categories of building (Fig. 4) and may vary according to avalanche danger zone and expected avalanche pressures, between 0 (no damage) and 1 (maximum damage). In this respect it is differentiated between a general damage threshold, p_u, a specific damage threshold, p_{ui}, a specific demolition limit, p_{ai} (which leads to maximum damage), and a specific destruction limit, p_{oi} (this is shown in building category 4 in fig. 4).[2] The mean avalanche extent, A_L e.g. in the blue zone with p = 10 kN/m² (Table 1) exceeds the lower damage threshold, p_u, for all building categories. In building category 1 (light construction) it causes maximum damage p_{oi} and causes damage to the buildings of category 2 (mixed construction) of about one third, $S_o \approx 0.3$.



Building category

1 = light construction, 2 = mixed construction ('chalets'), 3 = masonry, 4 = concrete buildings with reinforcement, 5 = reinforced buildings

Fig. 4: Susceptibility of buildings to damage, S_o, of five building categories as a function of the avalanche extent, A_L

1.2.3 Risk calculation and risk aversion

Using Eq. (5) the individual risks for each damage indicator can be calculated which, when added, give the collective risk. If this is carried out for each scenario (S_1, S_2, S_3 and S_4), the outset risk, R_o, can be approximated with linear interpolation between the scenarios as in Fig. 6. In order to calculate the outset risk, the series of scenarios i, i+1,...n (or S_1, S_2, S_3 *and* S_4) can be approximated either by interpolation in a double logarithmic risk diagram with a straight line, or with a power function (Basler&Partner 1995):

$$A_S = f(P(s)) = K \cdot P(s)^a \tag{6}$$

where K is a constant and $a = \dfrac{\log As_{i+1} - \log As_i}{\log P(s)_{i+1} - \log P(s)_i}$

The examined projects have shown that simplified linear interpolation results in an over-estimation of the outset risk by 15%. After protective measures have been carried out, the remaining risk, R_1, corresponding to the scenarios S_1*, S_2*, S_3* and S_4* and the risk reduction, R_v with $R_v = R_o - R_1$ is shown as the dark area in fig. 1 and 6.

The risks and their reduction are given separately in Section 2 for risk of human fatality and damage to objects. Both the costs for the protective measures as well as their effects of risk reduction are evaluated using methods and statements taken by Wilhelm, (1997) and Margreth, 1996. Aversion has to be taken in consideration.

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[2] It is emphasized that Fig. 4 must not be used as a basis for dimensioning, but only as a help in recording the possible extent of damage.

Human behaviour shows that risks are often not recognised as linearly as the Farmer line given in Fig. 1. Examinations (e.g. Munera 1987, p. 1094) have shown, that "natural catastrophes are perceived at least a factor of five worse than familiar technological risks." It can be observed that a risk with a large amount of damage, A_s, but low probability of damage, P(s), is much less easily accepted than an equally highly calculated risk with small amounts of damage but a greater probability of damage. An evaluation of avalanche deaths in populated areas in Switzerland carried out by the author (Wilhelm 1997, page 108 ff) shows that an aversion factor, δ, may be dependent on the extent of damage, A_s, where $\delta = 0.25 \cdot A_s$. In this way, an avalanche with a damage extent, A_s, of e.g. 16 deaths is considered four times as bad as 16 avalanches with one death each.

The different time periods in planning for which such aversion effects are justified must still be determined. The possibility of comparison of aversion factors from different risk categories must also still be examined. For this reason the quantitative inclusion of aversion effects for the economic calculation (Section 2) was not made.

1.3 Risks on transport routes

The parameters given in Fig. 5 are of significant importance for recording risk situations applying to transport routes (Wilhelm 1997). The avalanche probability P(L) can be calculated as the reciprocal of the mean return period T. The probability of the presence of vehicles P(0) is given by the average daily traffic DTV, the mean width of the avalanche in the area of the road, g, and the speed of vehicles, v, in the path of the avalanche. The maximum width of the avalanche path in the area of the road, g_{max}, is then decisive for the estimation of protective measures (e.g. snow sheds) and the allowed investment costs.

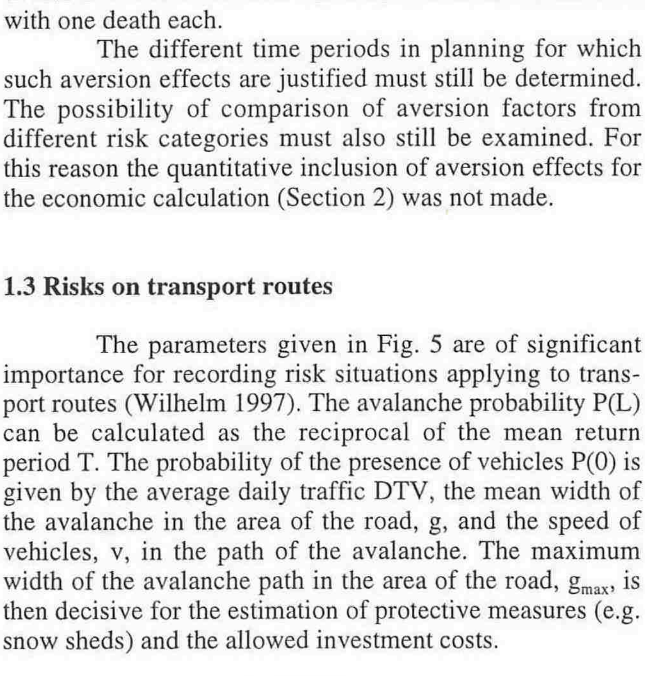

Fig. 5: Model for recording the risk of avalanches along transport routes

The collective risk [death/year] is calculated with the mentioned parameters and using Eq. (4) where:

$$R = \frac{DTV\ P(A)\ \beta}{24} \sum_{i=1}^{n} \frac{g_i}{T_i}\ v_i \qquad (i = 1..n \text{ aval. tracks}) \qquad (7)$$

The probability of extent for deaths in vehicle P(A) and the mean number of occupants ß [people/vehicle] are taken from statistical data; P(A) = 0.18 and ß = 1.61 were used. If a transport route is affected by more than one avalanche track, the risks for all avalanche tracks can be simply added using the model given here.

The individual risk r_j of death of one particular person can be calculated using Eq. 5 with a specific assumption of the number of journeys (passes) per day, z, and the potential avalanche time, d, per winter (e.g. 151 days) where:

$$r_j = \frac{1}{T}\ \frac{g\ z\ d}{v_j \cdot 24 \cdot 151}\ P(A) \qquad [1/\text{year}] \qquad (8)$$

Risk peaks, e.g. following an incident where a queue of vehicles is formed, and danger of avalanches next to each other, require extensive model assumptions (Schaerer 1989, Wilhelm 1997). Not yet resolved is the problem of the conditional probability of avalanches in the neighbouring avalanche track within a certain time (Armstrong 1981).

2. ECONOMY OF SPECIFIC PROJECTS

2.1 Characteristics of the projects examined

The release zone in project no. 1 is formed by 3 parallel depressions in the terrain which converge into a gully. The run out zone is densely populated with a considerable number of additional sport tourists on nice winter days.

In project no. 2 an avalanche starting above treeline broke a path through the trees, so that new potential starting zones have been formed. In the area of the avalanche track and the avalanche runout zone (both areas not channelled but flat topography) there are scattered communities not occupied in winter - mainly for agricultural use.

Project no. 3 is concerned with the Flüela Pass road in Switzerland which, along a stretch of 20 km is crossed by 47 avalanche paths, whereby, on average, approximately 50 spontanous avalanches hit the road each winter. On this road, leading from Davos into the Engadin, traffic flow in winter averages 1000 vehicles per day.

2.2 Results of the risk analysis

Project no. 1 with a damage potential of approximately 100 million Swiss francs and around 270 people permanently present represents a typical risk situation in settlement protection of large projects in Switzerland (Table 2). A relatively low damage potential with around 5 million Swiss francs (no people present in winter time) is given in the chosen project no. 2. The scenarios S_2 and S_3 show that above all, the extent of damage of scenario S_3, with around one third of the total damage potential to objects and one sixth of the total damage potential to people, would be considerable. It is also shown that the more often occurring scenario S_2 (from the risk point of view, just as important as the scenario S_3) only has a small extent of damage. The risk, R_o, with regard to the annual expected damage value (without projects) - as also with further examined settlement protection projects - amounts here to between 0.5% and 1% of the total potential damage.

On average, 3.3 vehicles are on a dangerous stretch of road (project no. 3) at any one time which, with ß = 1.61 person per vehicle, leads to 5 people permanently present. The outset risk of 0.70 deaths/year only applies to moving vehicles.

Table 2: Results of the risk analysis in form of damage potential, S_p, extent of damage, A_s, and outset risk, R_o

pro-	damage pot. S_p		extent of damage A_s of the scenarios				outset risk R_o	
ject			S_2		S_3		mio CHF	deaths
no.	mio CHF	persons	mio CHF	deaths	mio CHF	deaths	per year	per year
1	84.33	272	2.37	4	28.06	46	0.70	1.8
2	5.08	--	0.56	--	2.19	--	0.06	--
3	--	5*	--	--	--	--	--	0.70**

* *This is a mean value which may be up to 6 times higher on a weekend early in the year.*

** *This only includes moving vehicles (working phase). The risk may be up to 3 - 5 times higher for interruptions to traffic or queues of vehicles.*

The risk for objects in project 1 is shown in Fig. 6 for the scenarios recorded and the outset risk, R_o, in the risk diagram (probability-extent-diagram). In the outset risk state, events with more than 10 million Swiss francs worth of damage can be expected once every 30 years. Events with more than 10 fatalities can be expected to occur on average once in 20 years, those with more than 50 fatalities once every 100 years (not shown in Fig 6). The remaining risk and the risk reduction will be considered in the following.

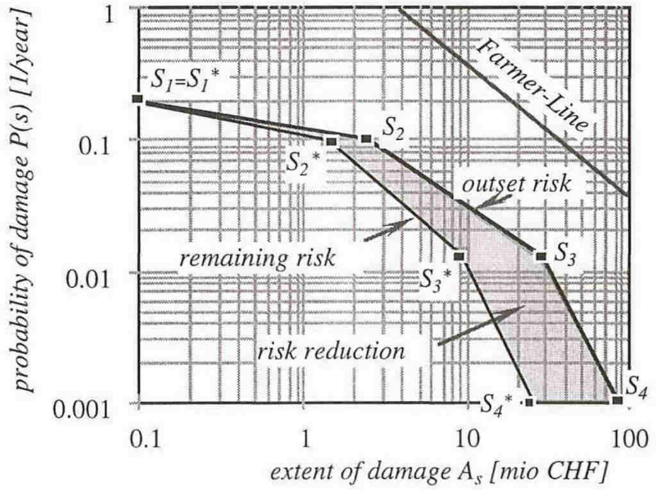

Fig. 6: Risk diagram for risk to objects for project no. 1

2.3 Economy of protective measures

In project no. 1 the construction of a permanent retaining structure in the middle ridge was carried out resulting in a remaining risk, R_1, (Table 3), of around one third. Using assumptions[3] the investment costs of 5.6 million Swiss francs were set against the calculation values such as overhead expenses, maintenance and repair costs, residual, interest rates and period of time of effectiveness to give annual costs, K_j, of 0.2 million Swiss francs.

In project no. 2, the permanent or, partly temporary construction of the complete starting zone caused investment costs, I_o, of 3.9 million Swiss francs ($K_j = 0.15$ million Swiss francs/year) after which the whole area can be considered to be protected. ($R1\approx$'0').

In order to make the pass road in project no. 3 safer, controlled release of avalanches in combination with temporary road blocks were used. In this way, annual costs, Kj of 0.22 million Swiss francs are incurred and on average, 25 days of road closure per winter are necessary. With this measures the remaining risk is still 20% of R_0.

For evaluation of the economics of protective measures a criterion of efficiency is used and is made up of the relationship between risk reduction, R_v and the annual costs, K_j. Even with separate reference of the annual costs [million Swiss francs/year] to the risk reduction for damage to objects [million Swiss francs/year], project no. 1 exhibits an efficiency > 2. In comparison to this project no. 2 with an efficiency value of 0.4 cannot be called economic. The protective measures taken for improving the safety of the pass road (project no. 3), show excellent results. On average, one fatality can be prevented for each 0.4 million Swiss francs invested.

Further examinations (Wilhelm 1998) have shown that the construction of an additional 2 - 3 galleries could further reduce the remaining risk very effectively and, furthermore, that the road cloasure time could be decreased (redundancy). The evaluation of a large number of projects with galleries or permanent retaining structures along transport routes in Switzerland results in a social willingness to pay, (WTP), average costs of 10 mio CHF and marginal cost up to 40 mio CHF to prevent one statistical fatality.[4] Such results could then be part of general decision-making analysis, like a weighted rate method (Norem 1990) or a cost-effectiveness analysis (Wilhelm 1998).

Table 3: Technical and economical analysis of the protective measures

pro-	technical analysis				economical analysis		
ject	remaining risk R_1		risk reduction R_v		annual costs	efficiency	
no.	objects mioCHF/y	persons death	objects mioCHF/y	persons death	K_j mioCHF/y	objects R_v/K_j	persons R_v/K_j
1	0.21	0.7	0.48	1.1	0.21	2.3	5.2*
2	'protected'	--	0.06	--	0.15	0.4	--
3	--	0.14	--	0.56	0.22	--	2.5

* *The separate risk reduction R_v of damage to people (fatalities) divided by the annual costs, K_j [million Swiss francs/year) results in 5.2 prevented statistical fatalities/million Swiss francs or, the other way round, 0.2 million Swiss francs/prevented fatality. (Corresponding to 0.4 million Swiss francs/prevented fatality in project no. 3).*

The individual risk can be a decision element on its own and is calculated in populated areas and on the examined transport route. Calculations of the individual risk of death in the outset situation were carried out in the red and blue avalanche danger zones with different categories of building and different examination time periods. The individual risk of death generally decreases along the the flow direction due to the decreasing probability of an avalanche occurring. The annual mean value for the

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[3] For calculation of annual costs, K_j, overhead expenses of 0 CHF/year, annual maintenance costs, K_u, and annual repair costs, K_r, of each 0.5 % of the investment costs, Io, a remaining value, $L_n = 0$ CHF, an interest rate of $p = 2\%$/year and a time period of $n = 50$ years are assumed.

[4] Moore and Viscusi 1990 received with a market approach for long-therme health risks amounts of \$ 5 to \$ 15 mio per statistical fatality prevented. A human capital approach, e.g. in Switzerland gives an amount of 1.2 mio CHF. Different approaches consider different cost elements and can not be easily compared.

individual risk of death (outset risk without any protection measures!) in non-reinforced buildings in the red zone is $r_{ij} = 2.8 \cdot 10^{-2}$, i.e. 2.8%. The annual mean value in the blue zone in a chalet is still $6.7 \cdot 10^{-4}$. The individual risk of death in a chalet in the blue zone within 70 years corresponds to $4.6 \cdot 10^{-2}$ i.e. 4.6%. These values are above the individual risk of death target value which is $< 1 \cdot 10^{-5}$ per year in populated areas, and can, therefore, give grounds on their own for the measures.

The individual risk for road maintenance personal (project no. 3) can, for example, be modelled on two journeys per day on a total of approximately 150 winter days. This results in $r_{ij} = 8.7 \cdot 10^{-4}$, a value which is also higher than the target risk value for the individual risk of death with $< 1 \cdot 10^{-4}$ per year for work risks.

3. SUMMARY AND CONCLUSIONS

The latest developments and discussions concerned with avalanche protection in Switzerland show a tendency towards structural measures from settlement protection to protection of transport routes and even to protection of people outside buildings. Within settlement protection, an increasing number of projects will have to be carried out under difficult conditions and with great uncertainties. Against this background, possible methods of economical analysis will be given a very critical evaluation, statements will be made about the results of the projects, and conclusions will be made about protection from avalanches.

From the methodical point of view, it can be seen that the analysis and evaluation of avalanche protection problems requires a multidisciplinary approach. Based on technical information (risk analysis), assessments can be made from an economical point of view although effects of aversion and acceptance would also have to be taken into consideration. In addition, significant questions with regard to the evaluation of fatalities and damage to objects, with the recording of the annual expected damage value or with the choice and summation of the avalanche scenarios have not yet been solved.

Avalanche protection for a densely populated area (project no. 1) provides excellent results even for the separate risk reduction of damage to objects. The relatively high remaining risk for fatalities, $R_l = 0.7$ fatality per year, will naturally not be accepted and could be further decreased in an economical way, through structural direct protective measures for exposed buildings and evacuation of the remaining risk area. Due to favourable topographical factors in project no. 1, an optimal (economical) combination of measures can be selected. For technical reasons this is often not possible in practice. Permanent protective measures in the fracture area of the avalanche cannot usually be carried out in an economical way if 'only' potential damage to objects (uninhabited scattered barns) is prevented (project no. 2).

The existing safety concept for the pass road (project no. 3) shows high cost-effectiveness for the reduction of fatalities but also includes both a considerable number of days where the road is closed and a relatively high remaining risk. Further optimization (minimization of the total costs based on road closures, cost of gallery construction and remaining risk) would still be possible from the point of view of the offer (safety production). The existing safety concept has, however, been accepted by the political decision-makers and this is what, in the end, is decisive for the extent of the safety measures.

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