COULD FATAL AVALANCHE ACCIDENTS IN NORWAY FROM 2005 – 2012 BEEN PREVENTED USING THE REDUCTION METHOD, THE BASIC REDUCTION METHOD AND THE ALPTRUTH METHOD?

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ABSTRACT: The number of people off-piste skiing in Norway is increasing (Odden, 2008). In the last few years the number of fatal avalanche accidents involving recreationist skiers has dramatically increased. The aim of this study is to investigate how many of the fatal avalanche accidents in Norway in the period 2005-2012 could have been avoided by using the Basic Reduction Method, the Reduction Method and ALPTRUTh. Quantitative methods on data from Avalanche Accident Reports gathered by NGI (Norwegian Geotechnical Institute) were used. Previous studies (McCammon & Hägeli, 2005; Hägeli, McCammon, Jamieson, Israelson & Statham, 2006) have been criticized for being methodologically unclear, for drawing conclusions based on missing data and for difficulties in getting access to accident databases (Gauthier, 2010; Uttl, Uttl & Meaghen, 2008; Uttl & Uttl, 2008; Uttl & Kisinger, 2010). To avoid these pitfalls, this study has used only publically available reports written by avalanche professionals. 100 % of the accidents within the given time period have been examined. Using the ALPTRUTh method on this material, we found that 100 % of the accidents would have been avoided if the skier had not skied with one or two clues present, and 50 % with more than four clues present. Using The Basic Reduction method, 90 % of the accidents would have been avoided, while 93 % of the accidents would have been avoided with a lower risk value than 1 had The Reduction Method been used. It was concluded that the ALPTRUTh Method in Norway would be the preferred method, based on the contents of the method, prevention value, learning possibilities and differentiating between user groups.

KEYWORDS: Decision Support Methods, Avalanche Hazard, Avalanche Accidents, Avalanche Risk

1. INTRODUCTION

Traditionally, avalanche education has hinged on a knowledge-based approach. The idea behind this was that the more knowledge people acquire, the fewer accidents they will be involved in. It is nevertheless unrealistic to assume that recreationists are capable of examining thoroughly all the factors involved that influence the complex nature of an avalanche. Towards the end of the 1980's, Werner Munter developed a framework for appraising avalanche danger known as 3x3. This was the first time a tool for systematic avalanche danger appraisal was available. In 1997, a method to double-check a decision based on the 3x3 was presented. Since then, several decision support methods have been developed. These methods were developed to systematize avalanche danger appraisal in order to help outdoor novices to make better decisions in avalanche terrain. Despite this, courses in avalanche awareness continued to emphasise a knowledge- based approach.

Avalanche accidents occur under conditions and in situations where clear signs of danger are present (Tremper, 2008). Ian McCammon (2000) led a research project that showed that individuals with basic avalanche awareness education were more often involved in accidents. Hägeli, Haider, Longland & Beardmore (2010) concluded that the use of a simple decision support method enabled novices to make decisions similar to those made by avalanche professionals in their weighting of relevant factors for making a decision.

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Previous studies have examined how many historical avalanche accidents may have prevented by the use of decision support methods. The Swiss and Canadian avalanche researchers Werner Munter and Ian McCammon (0McCammon and Hägeli, 2005) have conducted similar studies in respectively the Alps and Canada. Different descision support methods like the Reduction Method (Munter, 2003), Basic Reduction Method (Munter, 2003) and ALPTRUTh (McCammon & Hägeli, 2004) were used in the analysis. No such study on Norwegian accidents has to date been done.

Norway is a small country with a population of 5 million. Since the winter of 2005/2006, 22 fatal avalanche accidents have occurred during outdoor recreational activities, resulting in 29 fatalities. Between the winters of 2001/2002 and 2008/2009, an average of 2.9 avalanche fatalities have occurred each year. Since then, a marked increase has occurred. From the winter of 2009/2010 to the winter of 2011/2012 there has been an average of 8.7 fatalities per year.

Therefore the purpose of this study is to show that also accidents in Norway can be avoided through the use of simple decision support methods, and that such methods should be used and given more emphasis in Norwegian avalanche education. The study has looked at The Reduction Method, Basic Reduction Method and ALPTRUTh.

2. METHODS

To examine if by the use of simple decision support methods previous accidents in Norway could be avoided three models were applied: The Reduction Method, Basic Reduction Method and ALPTRUTh.

2.1 Reduction Method (RM) (Munter, 2003)

RM is based on a risk equation where avalanche risk is danger potential divided by the product of different reduction factors. This numeric value provides the basis from which one can make a decision as to whether to venture onto the slope or not. If the numeric value is lower than or equal to 1, the method allows the skier to make the descent (Munter, 2003).

This method was developed for use between latitudes 35° - 55° north. Norway lies between 58° - 71 ° north, so it is a matter for debate as to whether this method is suitable for midwinter conditions in Norway.

2.2 The Basic Reduction Method (BRM) (Munter, 2003)

BRM is a simplified version of RM (Munter, 2003). This method recommends a maximum gradient based on the current avalanche danger scale rating. Under moderate hazard rating no travel on slopes steeper than 39°, under considerable hazard below 35°, under high hazard below 30°, and no travel during high hazard conditions (Munter, 2003 and McCammon & Hägeli, 2004).

The Norwegian avalanche expert Kjetil Brattlien has developed a more conservative version of the BRM. This method is called the Afterski Method and recommends the following: Under moderate hazard rating no travel on slopes steeper gradients than 34°, under considerable hazard below 29°, under high hazard below 24°, and no travel during high hazard conditions (Brattlien, 2008).

2.3 ALPTRUTh (McCammon & Hägeli, 2004)

ALPTRUTh was launched in 2006 as a slope evaluation tool in The Avaluator (Hägeli et al., 2006). The intention here was to help recreationists recognise situations and conditions that had previously culminated in accidents. The method hinges on seven different danger signs, where danger increases corresponding to the number of signs present. The method name ALPTRUTh is an acronym for the seven danger signs. 1-2 clues present demands normal caution, 3-4 clues present demands extra caution and when more than 4 clues are present travel is not recommended at all (Table 1). The idea behind this model is that it should be simple to use, even for individuals with limited experience and for all user groups (skiers, snowboarders and snowmobile riders) (McCammon 2000; McCammon 2002; McCammon & Hägeli 2005).

Table 1. The ALPTRUTh acronym and description

Clue	Description
Avalanches	In the area in the last 48 hrs?
Loading	By snow, wind or rain in the last 48 hours?
Path	Identifiable by a novice?
Terrain trap	Gullies, trees, cliffs or other features that increase severity of being caught?
Rating	Considerable or higher hazard on theee current avalanche bulletin?
Unstable snow	Collapsing, cracking, hollow snow or other clear evidence of instability?
Thaw instability	Recent warming of the snow surface due to sun, rain or warm air?

2.4 Selection

The data for this study is based on accident reports recorded by the Norwegian Geotechnical Institute (NGI). NGI has been responsible for avalanche research in Norway since 1972. NGI has published reports from fatal avalanche accidents in Norway since 2002 on its website www.snoskred.no. These reports consist of data gathered by NGI during inspections of sites shortly after the accidents occur, and the accounts given by rescue personnel and eyewitnesses. The content of these NGI reports varies, but since 2005 they have become more standardised and are more comprehensive and contain more detail.

The accidents in the study have occurred whilst the victims have been engaged in outdoor activities. All decision support methods are developed for recreationists in avalanche terrain. Accidents caused by slush avalanches and cornice fracture are not included in this study because of the marked differences from other types of avalanche with regards to the physical variables and evaluation methods (Mytting, 2000). Reports submitted before 2005/2006 lack essential information such as grading on the avalanche danger scale and/or the steepest section gradient. For this reason, this study has not utilized data from winters preceding 2005/06.

The study data consists of 20 reports with 22 fatalities in total. Within the time span we have included all accidents for which use of the method will allow. In other words, 100% of the data available has been examined.

In some reports about the accidents not all all information was mentioned. Where reports lack necessary information, other data sources are used. Where meteorological data was absent, it has been acquired from the Meteorological Institute. Where information about terrain was absent, it has been acquired from the Norwegian Ordnance Survey (Statens Kartverk). In those instances where it has proved impossible to acquire data from other sources, the value is set to NO or NOT PRESENT. This applies to 16.8% of the data basis for ALPTRUTh, 0% for RM og 0% for BRM. There is a possibility that this may affect the result in such a way that ALPTRUTh has a lower preventative value than might have been possible if all information was accessible.

3. RESULTS

It must be emphasized that this is a study that has examined whether past accidents may have been avoided had the victims used one of the three rule-based methods in the study. This is therefore an examination of the hypothetical outcome of a contra factual event, a study of how the outcome could have been had the event unfolded in a different manner than it actually did (Kjeldstadli, 1999). This infers that the results of this study are not directly applicable to future situations.

3.1 The Reduction Method

Three ways of using this method have been explored. Absence of exposure reduction factors, exposure reduction factors on accidents occurred after the first of April and all exposure reduction factors (as the model is intended for use in areas of the same latitude as the alpine countries). The method is not applicable to snowmobile riders or at avalanche danger level 4 (Munter, 2003). After the omission of these particular accidents, the data basis included 14 accidents. Of these 14 accidents according to the method with and without exposure reducing factor respectively 3 (21%) and 1 time (7%) it

was found that the subject could go skiing (Fig. 1).

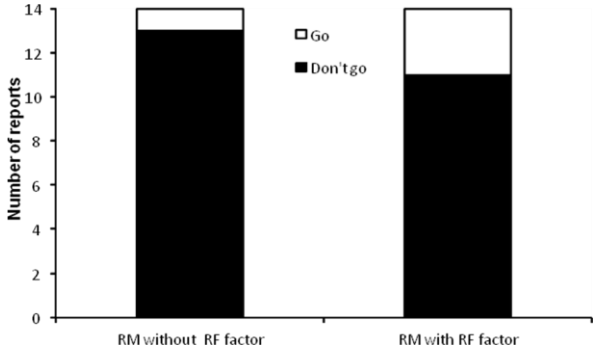

Figure 1: RM without exposure reduction factor, RM with exposure reduction factor (N=14).

3.2 The Basic Reduction Method

The Basic Reduction Method has two variables and two outcomes. The results of this study show that 18 of 20 accidents (90 %) could have been avoided had the victims been aware of, and used this method. Due to a lack of clarity as to which areas to apply the method to, two different results are given. One where snowmobile riders are included and one where they are left out (Fig. 2).

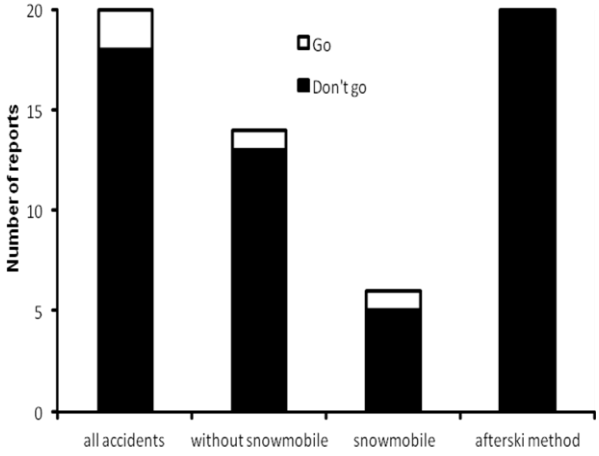

Figure 2: Accidents prevented (Don't go) and accidents not prevented (Go) where accidents involving snowmobiles are omitted (N=14), accidents prevented (Don't go) and accidents not prevented (Go) in reports where accidents involving snowmobiles are included (N=6), accidents prevented (Don't go) and accidents not prevented (Go) with complete sets of data (N=20) og accidents prevented (Don't go) using The Afterski method (N=20).

4.3 ALPTRUTh

None of the avalanche accidents we have examined have provided us with fewer than three clues. The distributions of the number of clues present in the 20 accidents are presented in detail in figure 3.

55 % of the accidents have occurred under conditions where three-four clues were present and 45 % of the accidents where five-six clues were present.

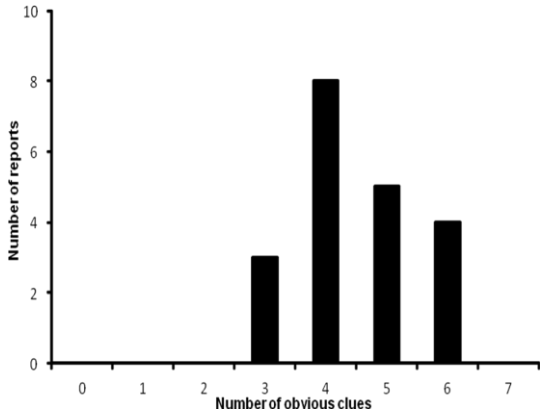

Figure 3: Number of obvious clues in accidents reported in Norway 2005/06 – 2010/11 (N=20).

4. DISCUSSION

Avalanche accidents occur mostly under conditions where avalanche risk is evident (McCammon, 2000; Tremper, 2008). The results of this study show that this is also true in Norway. The intention of this study was to examine whether use of the Reduction Method, the Basic Reduction Method and ALPTRUTh could have prevented fatal accidents in Norway between 2005/06 to 2010/11. A secondary goal was to discuss various aspects of the strengths and weaknesses of these methods for use in the ongoing Norwegian debate about the application of decision support methods.

If one is to use a decision support method, it is important that the method is highly preventive and is easy to use for all potential user groups. All three decision support methods included in this study would have prevented a large number of the accidents examined.

However, the Reduction and Basic Reduction Method are based upon a local avalanche forecast. This is not available in Norway, which

makes it difficult to use these two methods. Norway has a regional avalanche forecast where the danger grading will vary within each forecast region. This favors ALPTRUTh because it was developed with this in mind. The fact that there were terrain-traps in 19 of 20 of the cases examined shows how important it is that a decision support method includes more aspects of terrain than just gradient. RM and BRM are based upon local forecast. In Norway there is only a regional forecast. Norway is located at latitude of 58° - 71° North. The sun at these latitudes has little impact on snow cover in midwinter Kurzeder & Feist, 2003). For that reason will not reduce real factor in reducing risk exposure to the same extent as in the Alps. It is for this reason, controversial if RM should be used in Norway.

The authors believe that ALPTRUTh is most suitable method for Norway amongst the methods examined in this study. Under conditions when there are more than two clues prensent it is recommended that only experienced individuals travel in avalanche terrain. Such individuals are able to make qualified appraisals based on Bulls Eye data.

ALPTRUThs' weakness is that the terrain gradient is omitted, along with the fact that snowmobiles create a greater strain on the snowpack than a skier does.

5. CONCLUSION

This study implicates that fatal avalanche accidents in Norway could have been prevented by using the Reduction Method, the Basic Reduction Method and ALPTRUTh. Furthermore ALPTRUTh is the most suitable method in Norway since the country does not have local avalanche forecast on which the other two methods are based upon.

6. ACKNOWLEDGEMENTS

Thanks to Paul Hough for help in translating the article into English. Thanks also to Ian McCammon and Pascal Hägeli who kindly answered all our questions and clarified numerous points.

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