Avalanche hazard and visitor numbers – a study in Lochaber, Scotland.

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ABSTRACT: Avalanche hazard in Scotland is characterised by rapidly changing weather, rugged topography and a snowpack shaped above all by wind. Avalanche forecasts are prepared in five popular winter mountaineering areas, primarily for those undertaking winter mountaineering, ice and mixed climbing.

In this paper we present results of a study into numbers accessing mountains in the Lochaber area of Scotland. Visitor counts are available for two contrasting mountains, Ben Nevis characterised by a wide variety of winter mountaineering and accessed on foot in 2-3 hours, and Aonach Mor, where climbing is primarily on a single set of cliffs of similar aspect and altitude, typically accessed by a combination of gondola and chair lift. Weather data were recorded on an ordinal scale, characterising conditions in terms of "visitor enjoyment" ranging from days with blue skies, through increasing precipitation and winds, to those on which the gondola could not operate.

These data were then compared with avalanche hazard over a number of winters. Initial analysis revealed that average visitor numbers to both venues decrease as avalanche hazard increases and weather deteriorates. To control for the effects of weather, we explored average visitor numbers on only days with good weather. Again a decrease in average visitor numbers was observed, suggesting that avalanche hazard (and thus potentially the avalanche forecast) influences behavior. However, by separating days into weekdays and weekends, it appears that this influence is less on weekend visitors (commonly considered to be under more pressure to achieve objectives on short visits).

KEYWORDS: Avalanche forecast, decision making process, Scotland, mountain visitor numbers.

1 INTRODUCTION

This paper compares the numbers of mountaineers visiting two popular Scottish mountains with the avalanche hazard forecast for individual days through out the winter. The relationship between these data sets is explored to see if the avalanche hazard forecast plays a significant part in the route planning of mountaineers in the winter time.

2 SCOTTISH AVALANCHE FORECASTS

Avalanche forecasts are prepared on a daily basis for five of the most popular winter mountaineering venues in Scotland. Each forecast is prepared for a specific mountain area by dedicated forecasters doing daily snow and meteorologic observations. These observations are supplemented by computer forecasting techniques (Purves et al. 2002).

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3 THE STUDY AREA

Two mountains are studied in this paper; Ben Nevis (1344m) and Aonach Mor (1221m). These mountains are adjacent to each other and situated in the Lochaber area of western Scotland, see Figure 1. Both are popular destinations for winter mountaineers and climbers. Both Mountains have very specific access and topographical features.

Figure 1. Location of study area

3.1 Ben Nevis

Ben Nevis hosts some of the finest winter climbing in Scotland. The approach to the crags is characterised by a 2-3 hour walk in from the road. All the crags are traditionally approached from below. The crags offer winter climbing on a wide variety of aspects, altitudes and difficulty.

Figure 2. North Face of Ben Nevis

3.2 Aonach Mor

The majority of the winter climbing on Aonach Mor is limited to one set of mountain crags with a predominantly easterly aspect. Access is via a mountain gondola and chairlift (ski area) with a thirty minute walk to the top of the crags. Access to the climbing routes is then by descending 35-45° snow slopes to the foot of the crag.

Figure 3. East face of Aonach Mor

4. DATA

Visitor number data has been gathered for both mountains. On Ben Nevis an automatic counter was placed at the main access route to the north face. These counters give reliable results in the Scottish environment (Dixon, 2004). On Aonach Mor, visitor numbers are based on ticket sales of the access gondola. The ticket operators distinguish between mountaineers, skiers and tourists.

Avalanche Hazard is based on The European Avalanche Hazard Scale. In Scotland there is also a split in the Considerable (Category 3) Hazard category. Within this category, forecasters differentiate as to whether natural avalanches are either more or less likely. There are no instances of Very High Hazard (Category 5). The reference scale is thus:

1. Low Hazard (Category 1)
2. Moderate Hazard (Category 2)
3. Considerable Hazard (Category 3), natural avalanches less likely
4. Considerable Hazard (Category 3), natural avalanches more likely
5. High Hazard (Category 4)

Weather data were recorded on an ordinal scale, characterising conditions in terms of "visitor enjoyment" ranging from days with blue skies, through increasing precipitation and winds, to those on which the gondola could not operate. Although this scale is subjective, it may better characterise conditions for mountaineers than individual parameters such as wind speed. The scale is:

1. Clear skies, light winds. dry
2. Cloudy skies, light winds, dry
3. Cloudy skies, some wind, light showers
4. Cloudy skies, some wind, significant precipitation
5. Strong winds, significant precipitation
6. Storm conditions

The data set contains 337 entries based round four winters between 2002 and 2009

5. USER NUMBERS

Figure 4 shows the average daily visitor numbers for both Ben Nevis and Aonach Mor. As would be expected there is an increasing number of visitors during the weekend period.

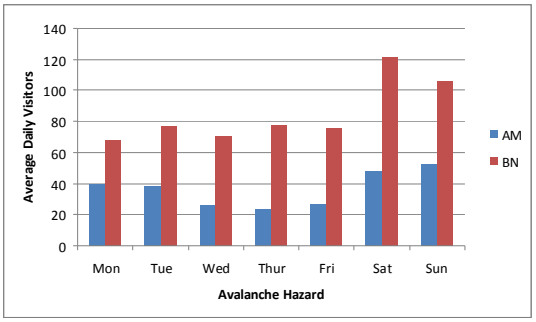

Figure 4. Average visitor numbers by day.

In Scotland, avalanche hazard forecasts are displayed in strategic places locally; on outside display boards at all of the mountain access points or in sports shops and climbers accomodation. In addition the forecast is available on the website (www.sais.gov.uk) It is difficult to estimate the number of people reading the forecasts that are displayed locally but a measure can be made based on the number of unique visits to the website. In Figure 5, these have been plotted against the forecast avalanche hazard. Also included are the visitor numbers to the accompanying blog which contains more informal information relating to the avalanche hazard.

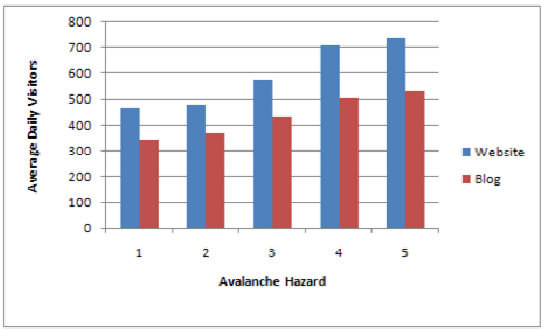

Figure 5. Website and Blog visits

It is interesting to note from the above graph that the number of people accessing the avalanche hazard forecast is related to the actual avalanche conditions. This would suggest that mountaineers have a general understanding of the avalanche conditions and increasingly access additional information as the avalanche hazard increases.

A summary of the visitor numbers for the winter 2008-9 is:

Website users: 60,500 visits
Blog users: 45,000 visits
Ben Nevis: 6,500 visitors
Aonach Mor: 3,360 visitors

6. RESULTS

The relationship between visitor numbers and avalanche hazard is explored for various options. In order to gauge if visitor numbers are increasing or decreasing with each variable. visitor numbers are expressed as a percentage above or below the average daily visitor numbers over the period. Owing to the size if the database, this method should reduce the influence of both weekly and seasonal variations in the visitor numbers. The results for Aonach Mor (AM) and Ben Nevis (BN) and presented on each graph

Figure 6 shows the relationship between the weather (based on the ordinal scale) and the number of users. Aonach Mor shows higher sensitivity to weather influences with a higher than average visitor count when the weather is good, and a lower visitor count as the weather deteriorates. When the weather is good, this could be explained by the relatively easy access to the climbing area which requires minimal effort. As access to the climbing area on Aonach Mor involves crossing a high plateau (1200m) this would become less attractive as the weather deteriorates. In poorer weather, the longer approach to Ben Nevis may get more attractive as it allows more sheltered and lower access to the bottom of the climbing venues. During storm conditions (6 on the scale), access to Aonach Mor is severely restricted and the gondola is closed.

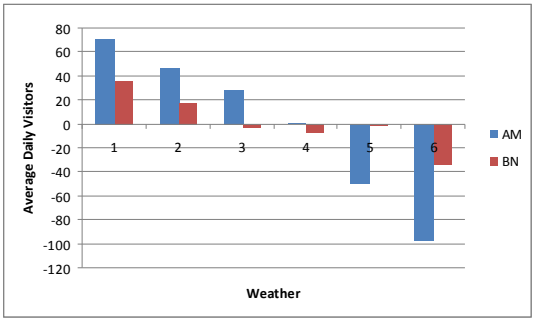

Figure 6. Behaviour based on weather

When behaviour is plotted against avalanche hazard (Figure 4) it can be seen that behaviour patterns are very similar.

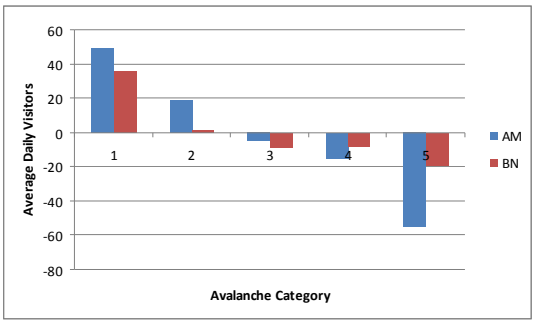

Figure 7. Behaviour based on avalanche hazard

Above average usage during periods of low avalanche hazard could be explained by the presumption that in these conditions, climbing con-

ditions are generally good. As the hazard increases, we see a general decrease in the number of users. When the hazard is high, there are fewer people on Aonach Mor. This could be explained by the lack of choice in climbing routes as they all tend to be on a very similar aspect, which happens to be the predominant aspect for avalanche hazard formation.

Comparing the behaviour based on weather and avalanches, there seems to be little difference in the usage patterns, although they could be explained in different ways. Due to the similarities of the above two graphs it is not possible to determine if the weather or the avalanche hazard is having the largest influence on behaviour patterns.

In order to try to remove the weather influences, days that are predominately "good" weather have been identified and studied in isolation. Good weather has been defined as days when the winds are generally light and there was no precipitation. This should remove the weather influence to the decision making process.

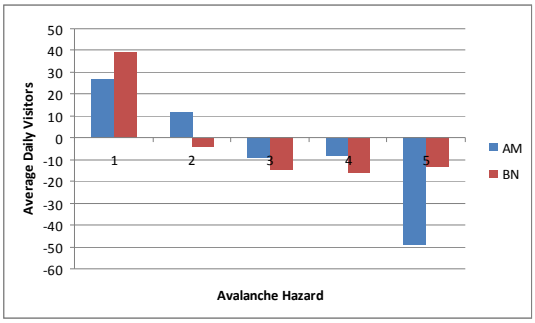

Figure 8. Behaviour based on good weather

When the avalanche hazard is 1 on the scale there is an above average number of people visiting Ben Nevis. These low hazard conditions would normally be associated with good climbing conditions ie very little fresh snow and a good covering of snow-ice. These would be ideal conditions for climbing on Ben Nevis and would appear to be fairly unique and worth the long walk in for.

When the hazard is 2-4 on the scale there is little variance between behaviour on the two mountains.

The most striking difference between the two mountains is when the avalanche hazard 5 on the scale. In this avalanche category, the report would normally state that "avalanches will occur". With the prevailing wind in this area being from the west or southwest, the majority of avalanche hazard tends to be on east and northeast aspects. This coincides with the main descent routes to the crags on Aonach Mor. The suggestion therefore is that there is an active decision making process based on this fact and mountaineers would tend to stay away from Aonach Mor in these circumstances. On Ben Nevis, in similar conditions there are many more route options due to the greater choice of aspect. Also, if mountaineers are visiting the area and decide not to go on Aonach Mor, the natural choice would be to go up Ben Nevis instead.

There is a perception that weekend mountain users are more prone to making decisions based on what they want to achieve and less on the prevailing avalanche hazard. To test this perception, both weekend and weekday usage are plotted against avalanche hazard, again only taking into account the days of "good" weather.

This weekend behaviour could be for many reasons, although the main factor could be lack of time/tight schedules and unrealistic expectations. McCammon, 2002 also identified similar behaviour as a heuristic trap. Comparing the results of Fig 9 and 10, these suggestions would seem to have a valid basis. Looking at the middle of the avalanche hazard scale, there is an above average number of users out at the weekend but this becomes below average during the week. This suggests that weekend users tend to have a bolder approach to mountain access when compared to midweek users with the same avalanche hazard.

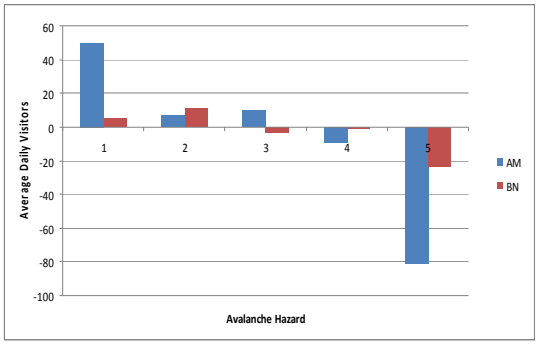

Figure 9. Weekend behaviour

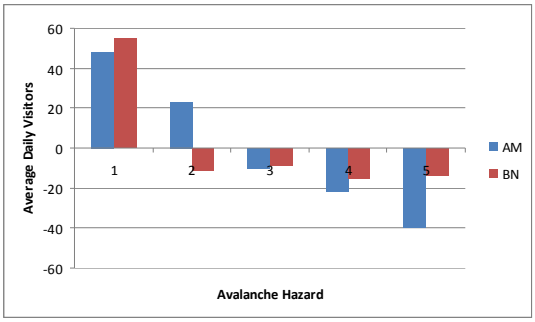

Figure 10. Mid week behaviour

7. CONCLUSIONS

It is clear from the datasets that there is a range of influences that affect the decision making process of the recreational mountaineer. Having filtered out bad weather as a factor, it would appear that reasonable decisions are being made with regard to route choice on a mountain specific scale. Local topography could play an important part in this process with specific access paths being important. Decisions like this must be based either on local knowledge or from knowledge acquired from guide books or other sources

If avalanche hazard is playing an important part in route choice, the interesting question is where mountaineers acquire this information.

In order for accurate route choice to take place before venturing out onto the hills, a certain amount of avalanche information needs to be available. As Barton and Wright, 1985 identify, this information is best obtained from day to day observations. This is one of the main functions of the Scottish avalanche reports as they provide a consistent record of snow conditions and these are widely available. They are also other sources of the same information including personal observations and various climbing conditions websites.

The avalanche hazard forecasts that are produced for the main climbing areas must play a significant part in providing information to mountain users but it remains unclear as to if this is their primary source.

8. REFERENCES

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