USE OF DAISYBELL AND SNOW PROFILES TO INVESTIGATE THE EFFECT OF ALPINE BIRCH ON AVALANCHE RELEASE

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ABSTRACT: Through a field study in Abisko, northern Sweden, we have used the artificial avalanche release system DaisyBell together with snow profiles to study the effect of alpine birch forest on avalanche formation. Evergreen conifers have long been known to reduce avalanche formation probability, however, in Scandinavia, the small birch type Alpine betula is the most common tree species in mountainous regions. Its effect on snow stability has been unknown, but of crucial importance for backcountry recreationists and for housing and mountain cabin planning. This paper presents the results from the field campaign. We show that triggering of avalanches was much more successful in open terrain than inside the birch forest. Crack propagation was significantly hindered in vicinity of trees and the snow pack layering differed to a large degree when moving few meters from inside the forest to open terrain nearby. The use of DaisyBell inside forest is novel, and experience with this practice can also be transferred to other types of demanding terrain.

KEYWORDS: birch, forest, DaisyBell

1. INTRODUCTION

Forest influences the development of the snow cover and it is well established between recreationists as well as avalanche professionals that forest reduces avalanche release probability. Especially conifers like pine and spruce are known to reduce avalanche formation due to their physical anchoring effect and their influence on snow pack layering through changed temperature, radiation, wind speed etc. Forest also protects the snowpack from wind, reducing snowdrift and resulting layering.

Most research on forest as a protection measure has been done on evergreen conifer forests. The effects are mainly influenced by the forest's crown cover (i.e. Gubler and Rychetnik (1991), Bauerhansl et al. (2010)). In Norway however, the deciduous tree species birch (Betula pubsens, subspecies alpine betula) is the most common tree species at higher elevations, and their effect on the snow pack is less studied.

Our work throws light upon avalanche release and crack propagation abilities in mountainous birch forest compared to in open landscape, and is a continuation of our earlier work (Breien and Høydal (2012) and Breien and Høydal (2013)). In the present study we used DaisyBell (Berthet-Rambaud et al (2008)) to artificially release avalanches inside and outside birch forest at one occasion in winter 2014 in Abisko, Northern Sweden. This paper is only a first and brief description of some of the results from the field mission. Note that the study is not done systematically throughout the whole winter, but is the result from one field mission. The results should thus only be looked upon as a contribution to the question on avalanche formation in birch forest. In the future systematic field missions throughout the winter, in different climates, should be carried out to get a more complete picture.

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2. FIELD MISSION

2.1 Area and climate

The area chosen for the field mission was Abisko, located in northern Sweden, close to the Norwegian border. The area is situated 68 degrees north, and is remote and sparsely populated, with large mountainous landscape. The large lake Torneträsk is found at 341 masl. Even though the elevation is not very high, there is only mountainous birch forest in the area. There are three ski resorts in the area, in Abisko the resort is called Nuolja Off Piste. Around this resort and the mountain Nuolja, two test sites with different aspects were selected.

The climate is dry and cold – most of the precipitation falls on the Norwegian side of the border. During winter months, precipitation is normally 20 mm/month and the normal temperature around -10°C.

2.2 The DaisyBell

The DaisyBell is a remote avalanche-release system, mostly used for protecting objects where fixed avalanche protection structures cannot be installed, or for temporal security. It is transported by helicopter to the chosen site, and the avalanche expert pinpoints the explosion point to the hotspot of the starting zone.

As of our knowledge, the Daisybell has not been used to a large extent within forest before. However, it turned out to be easy to position the DaisyBell between trees, and the space between helicopter and bell allowed a good safety margin.

2.3 Weather and snow pack

During the winter 2013/2014, the weather was representative for the region. However, there were three occasions of mild temperatures and rain in early winter, causing crusts in the snow pack, later buried by new snow. Due to cold temperatures, persistent weak layers of faceted crystals formed in connection to these crusts.

During the second week of March 2014 a large snowfall in the area raised the avalanche danger significantly, and several avalanches were released, the faceted layers around the crusts working as weak layers.

Our field mission was carried out on the 24th to the 26th of March 2014, and the avalanche danger was generally decreasing, however, the weak layers of faceted crystals were still there, ready to be triggered by the DaisyBell.

3. RESULTS

3.1 DaisyBell results

Around 35 DaisyBell explosions were released in the area, spread out in open landscape and in small open pockets inside the birch forest.

Our experience is that as the impact of the DaisyBell-explosion is limited, the placement of the bell at the time of explosion; height above the snowpack, the terrain shape and snow pack depth, is of crucial importance. Thus, the avalanche expert has an important job to do when placing each explosion.

There was a significant difference in avalanche release success in the open landscape compared to inside the forest. Even on hills with the same exposition and more or less the same elevation, the difference was significant. Only very small avalanches were triggered inside the forest, and only in the past night's wind deposited snow (Fig. 1). The crack propagation was thus very limited, and stopped when hitting a tree or branches.

In the more open landscape just above the tree line (only a few trees), several large (size 3) avalanches were triggered by just one DaisyBell shot (Fig. 2). These avalanches involved the weak layers of faceted crystals at different depths, and the crack propagation ability was high. As seen from Fig. 3, the crack propagation was also here to a certain degree limited by trees.

Fig. 1: Example of a result of DaisyBell explosion in a pocket inside birch forest. Only very small, near surface avalanches were released.

Fig. 2: Avalanche released just above the tree line. Helicopter with DaisyBell can be seen in the upper right corner. Photo: Odd Are Jensen, NVE.

Fig. 3: Crack propagation detail from the avalanche in Fig. 2.

3.2 Snow pack characteristics

Snow profiles from the crown confirmed that the avalanche (Fig. 2) was released in the weak, faceted layer above a crust (Fig. 4). These avalanches were hard slab avalanches due to heavy winds, and the weak layer was buried relatively deep (from 50 cm to 1.5 m). The avalanche trigger spot was at a point where the snowpack was thin, thus the weak layer was closer to the surface. Due to heavy crack propagation, the avalanche became large.

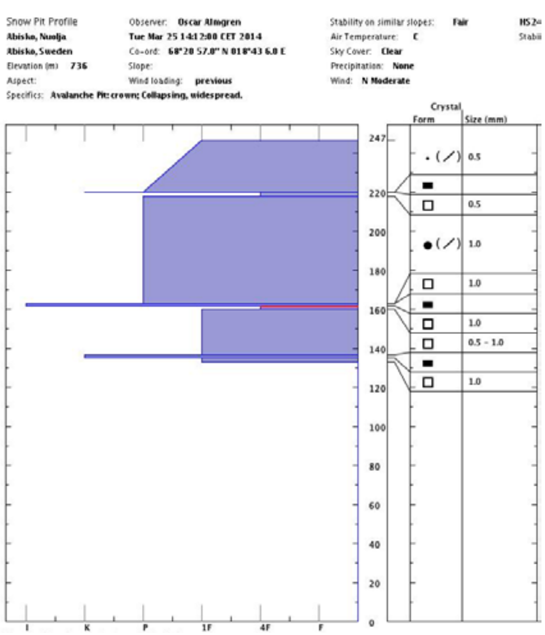

Fig. 4: Example of snow profile from the avalanche crown in large avalanche released above tree line.

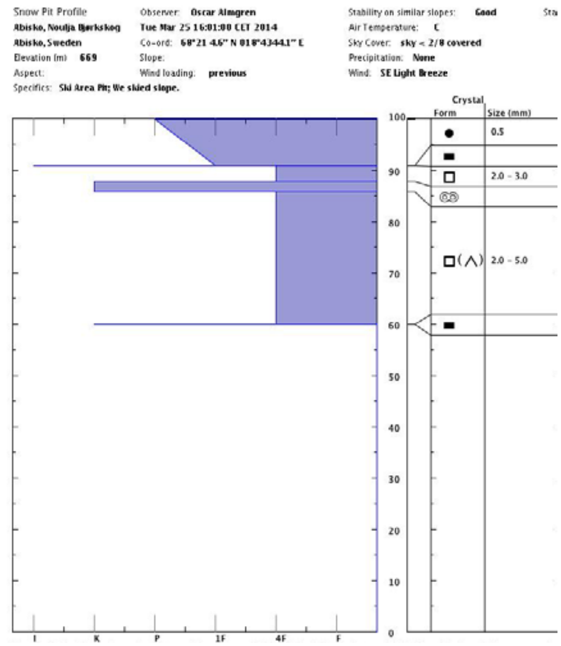

Fig. 5: Example of snow profile from inside the birch forest.

When examining the snow pack inside the forest or in the vicinity of a group of small trees at the margin of the avalanche crown, more or less the same layers were found, however, the faceted layers had taken over much of the snowpack (Fig. 5). The snow felt almost rotten under the surface, thin layer of wind deposited snow. The layer of faceted snow was many places as thick as 1 m. When faceted layers are as thick as this, they do not work well as weak layers and crack propagation is not possible.

Snow submerged branches and small trees also cause temporary surface undulation, air pockets and later settlements. The crust layers are bent around stems and other obstacles, reducing crack propagation.

Rain and mild weather causing the crusts, also resulted in melting along stems and branches, later causing ice to reinforce the snowpack and anchor it to the branches. In Fig. 3, we can see crack propagation around the small trees, but the snow pack still resting on residual friction and anchoring. This kind of crack structure around trees was observed around all the triggered avalanches. A similar observation was done last winter (Breien and Høydal, 2013) where thin stems completely nailed the snowpack due to ice formation along the branches.

4. CONCLUSIONS

Using DaisyBell as a way to artificially release snow avalanches, we have seen a clear difference in the ease of releasing avalanches inside mountainous birch forest compared to in the open landscape. Even though our study is limited, we propose that even small, deciduous trees like mountainous birch reduce the possibilities of avalanche release and the ability of crack propagation, especially when it comes to avalanches triggered on persistent weak layers like faceted crystals. We have not studied the effect of birch in more maritime climates, and suspect that avalanche danger due to heavy snowfall may not be as significantly altered by the birch forest as avalanche danger caused by such persistent weak layers.

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