Snow load on spruce trees (*Picea abies*) at different altitudes in Riisitunturi

Nils Dittbrenner and Karel Moravec

1 Introduction

Snow-packing, i.e. a mixture of ice, hoarfrost and snow attached to trees in winter, increases with altitude. In the northward extending parts of the Baltic Sea in Finland, at a distance of 100km from the coast, the lower limit of snow-packing may be as low as 200 m a.s.l. (Jalkanen, R. and Konopka, B., 1998)

The most favorable conditions for snow accumulations are falling air temperatures and no sunshine. Cohesion and adhesion of snow is greatest at temperatures just below freezing. Wind can lead to large accumulations of wet snow, rime or freezing rain. Wet snow is most likely in late autumn or early spring. (Nykänen et al., 1997)

On the one hand, snow-packing protects tress from low-temperature related injuries, when light, but on the other hand it can also cause severe damage to trees and forests when excessively heavy and can bring about great economic losses in forestry and disturbances in the ecosystems. (Jalkanen, R. and Konopka, B., 1998)

The most common form of damage is stem breakage, but tress can also be bent, uprooted and a consequential damage through insect or fungal attacks is more likely to happen. The severity of snow damage is related to tree characteristics, so that slightly tapering stems, asymmetric crowns and rigid horizontal branching are all associated with higher risk. (Nykänen et al., 1997)

In Northern Finland, where winds & storms are fed by moisture from the Baltic Sea, tree breakage under extreme snow loading is considered to be the major limiting factor at timberline. (Marchand, P. 1987)

As in the case of Riisitunturi snow damage is found from 300 m a.s.l. upwards and about 30% of the trees carry evidence of snow damage. (Eurola, S. and Huttunen, A., 1984)

In the future, assuming the global change in climate, both mean temperature and precipitation could rise in northern latitudes and the risk of snow damage could increase compared to the present day, because of an increased frequency of snowfalls at temperatures of around zero. (Nykänen et al., 1997)

2 Material and methods

Snow loads on spruce trees at three different altitudes (250 m, 340 m and 430 m a.s.l.) were measured on Riisitunturi on the 14th of March during the winter ecology field course in Oulanka National Park.

The altitude of each site was estimated according to the location on the map. At each site five spruce trees (*Picea abies*) were chosen to represent the average snow load in the area (except site 3, where the snow load on each tree was so heavy that we only had enough time to measure one tree) and the snow load was measured (see Fig 1.) as follows: All the snow from the lower part of the trees (<2 m) was collected by inserting each time one branch into a plastic bag and shaking the snow off. Each plastic bag was weighed and the value recorded. The number of branches was counted and the average length of the branches from each tree was calculated. The data from each tree was calculated to snow weight per branch length and recorded in kg/m.

Fig. 1. Measuring of the snow load. Some parts of the tree are already measured (left side); the rest will be measure. Against a background there are the trees with the heavy snow load.

3 Results and discussion

At Riisitunturi, as we expected, the snow load on spruce trees increased with altitude above sea-level. At the altitude of 250 m a.s.l. it was 0.297 kg/m, at 340 m a.s.l it was 0.354 kg/m and at 430 m a.s.l. it was 5.83 kg/m (see Table 1.).

Unfortunately, at the altitude of 430 m there was too high amount of the snow load so that, regarding to limited time, we did only measurement of one tree (for that reason, there is no standard deviation in the table and graph as well). However, for comparison of the snow load between different altitudes it can be sufficient.

Site	Trees *(Picea abies)*						
Lower site (250 m)	tree	tree 1	tree 2	tree 3	tree 4	tree 5	mean
	Branch length [m]	32.70	35.08	23.60	22.30	30.10	28.75
	Snow load [kg]	9.5	16.2	6.8	6.1	5.1	8.78
	kg/m	0.291	0.462	0.288	0.274	0.169	0.297
	Standard deviation						0.105
Central site (340 m)	tree	tree 1	tree 2	tree 3	tree 4	tree 5	mean
	Branch length [m]	7.15	66.76	19.92	36.50	20.60	29.58
	Snow load [kg]	21.40	19.18	7.19	14.12	8.90	14.16
	kg/m	0.304	0.287	0.361	0.387	0.432	0.354
	Standard deviation						1,194
Top site (430 m)	tree	tree 1					mean
	Branch length [m]	18.98					18.98
	Snow load [kg]	110.56					110.56
	kg/m	5.83					5.83

Table 1. Measured values of the snow load

Measured values corresponding with the values from previous years and with values mentioned in (Jalkanen, R. and Konopka, B., 1998) which were varied between 1000 kg and over 3000 kg at altitudes of 300-350 m a.s.l. The same source says pine belonging to trees resisting of the snow load good (0-46% of spruce at 290-350 m a.s.l., had broken tops, unlike the pine with 39-100%). In generally we can say damage of trees depends on the tree species.

This year we measured high values of the snow load in the top site as compared to previous years. Need to point out last year was different concerning condition of the weather and the snow loads.

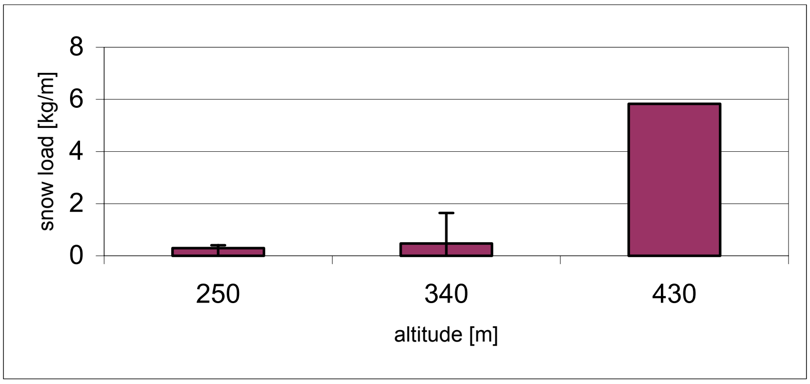

Fig. 2. Results of the snow load of spruce trees (Picea abies) in different altitudes

For more accuracy of measured values of the snow load we should measure the branch width as well. The unit will be changed to kg/m^2. As we mentioned above, not only snow is covering the tree, for more exact values we should measure the weight of ice. It will be more difficult because ice is frozen onto the branches. Of course, there were more sophisticate methods available for measurement of the snow load which were used in (Jalkanen, R. & Konopka, B., 1998) based on measurement of snow density (kg/m^3).

The measured and calculated results (see Table 1.) of the snow load of spruce trees are in the graph (see Fig. 2.). Values of the x-axis represent value of altitude in metres above the sea level.

4 References

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