Meta-analysis of snow disappearance dates in forest and open areas

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Tree crowns intercept snow falls and the amount of snow in the forest is less than that in an adjacent open area. However, trees block solar radiation and slow down the wind speed and thus the speed of the snow melts in the forest is usually slower than that of the open area. In this way, the snow accumulation is affected by the forest as well as the weather and the topography, etc. There are studies comparing the snow in the forest and the open areas, but most of them were conducted at a specific site. In this study, a meta-analysis focusing on the snow disappearance dates in the forest and open areas was carried out, and we tried to clarify the condition that the snow in the forest (open) remains longer than that in the open areas (forest).

We searched for research papers comparing snow in the forest and in the open and analyzed their results. Then, we analyzed which of the two snow accumulations (in the forest or in the open) remains longer. Information about forests, such as canopy openness, leaf area index (LAI), etc. could hardly be obtained from the research papers. Therefore, these research papers were classified as evergreen forests and deciduous forests. Moreover, we set up an evergreen forest (cedar) plot and an adjacent open plot in the Ishikawa prefecture in Japan and observed the snow disappearance dates. In these observations, we used small temperature loggers and measured the temperature at two-hour intervals. If the standard deviation of the temperature in a day is within 0.3 deg.C, it is inferred that there is snow on the surface. Using this criterion, the snow disappearance dates were estimated in the forest and open.

We obtained the snow disappearance dates in the forests (SDDf) and in the adjacent open areas (SDDo) from the collected research papers and our field survey. In this case, if the snow disappearance dates are not clearly stated in the table or sentences, the date has been visually read from the figures. Also, we estimated the differences of the snow disappearance dates in the forests and the open areas (DSDD). In other words, if DSDD is positive, the snow in the forest remains longer, while the snow in the open remains longer when DSDD is negative. DSDD is considered to be determined by conditions such as the weather, the structure of the forest, the topography, etc. However, it was difficult to extract the forest and topographical conditions from the research papers; so, only the weather conditions were considered in this study. We used precipitation, temperature, and wind speed in winter (Dec.-Feb.) as the weather conditions. If these values were indicated in the research papers, we used them; otherwise, we used the meteorological data from AMeDAS, which is close to the study sites. We corrected the temperature data of AMeDAS using the lapse rate but did not correct the precipitation and wind speed data.

We investigated the snow disappearance dates and found that there are sites where DSDD is both positive and negative. Thus, it was confirmed that it is not possible to decide which snow remains longer. The largest DSDD in evergreen forests is 31-day in Tsunan town, Niigata prefecture and the smallest DSDD in evergreen forests is -11.2-day in Hakusan town, Ishikawa prefecture. The largest DSDD in deciduous forests is 9-day in Shizukuishi town, Iwate prefecture and the smallest DSDD in deciduous forests is -2-day in Murakami town, Niigata prefecture. Moreover, we investigated the relation between DSDD and meteorological values. Hereby, we found that the snow in the forest remains longer as the winter temperature decreases and as the wind speed increases. The correlation between DSDD and winter precipitation is weak but a negative correlation was observed.

Furthermore, a decision tree model was applied using the DSDD as decision values and winter precipitation, temperature, wind speed as explanatory values. In the results from the evergreen forest, winter wind speed with 2.0 ms-1 is the first forking and the snow in evergreen forests remains longer than that in the open areas if the wind speed is higher than 2.0 ms-1. Next, the winter temperature of 2.3 deg.C is the second forking and the snow in the evergreen forests remains longer than that in the open areas if the winter temperature is lower than 2.3 deg.C. In the results of deciduous forests, winter temperature with -2.5 deg.C is the first forking and the snow in the deciduous forests remains longer than that in the open areas if the winter temperature is lower than -2.5 deg.C. Further, winter temperature with 0.15 deg.C is the second forking and the snow in deciduous forests last slightly longer than that in the open areas if the winter temperature is lower than 0.15 deg.C.

Keywords: Snow accumulation, Snow melt, Forested area, Mountainous area, Climate change

