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短時間の多量降雪による雪崩危険度評価に関する研究
Hazard Assessment for Avalanches Caused by Intense Heavy Snowfall

平成18年豪雪以降、北海道や東北、北陸、中国地方と各地で豪雪が続いています。特に、平成26年2月は雪の少ない関東甲信などの広い地域で、短時間の多量降雪により記録的な大雪となりました。短時間の多量降雪は、雪崩の多発につながり、豪雪地帯はもとより豪雪地帯以外の地域でも突発的に雪崩が発生する可能性が高くなります。

土木研究所では、短時間多量降雪による雪崩発生の危険度評価技術に関する研究に取り組みました。

Since the Heavy Snowfall of 2006, there have been heavy snowfall events in many areas of Japan, including Hokkaido, Tohoku, Hokuriku, and Chugoku. In February 2014, a record intense heavy snowfall occurred in large parts of the Kanto and Koshin areas, which ordinarily have little snow. Intense heavy snowfalls lead to many avalanches. In such cases, unpredictable avalanches become highly likely in areas within and beyond the areas of heavy snowfall.
The Civil Engineering Research Institute for Cold Region has been conducting research on technologies to assess the risk of avalanche occurrence from intense heavy snowfall.


短時間多量降雪による雪崩事例
An avalanche caused by intense snowfall

雪崩発生の気象・積雪条件
Weather and snowfall conditions for avalanche occurrence

平成26（2014）年2月の関東甲信地方の大雪事例や北海道野塚峠の雪崩事例等について、短時間多量降雪を12時間の最大降雪深を用いて表し、樹林帯における雪崩発生条件や同時多発するときの条件を明らかにしました。

For the heavy snowfall events in the Kanto and Koshin areas in February 2014 and the avalanches at Notsuka Pass in Hokkaido, extreme high-intensity snowfall was expressed using the maximum snowfall in 12 hours, and the occurrence conditions were clarified for avalanches in the forest zone and for multiple simultaneous avalanches.
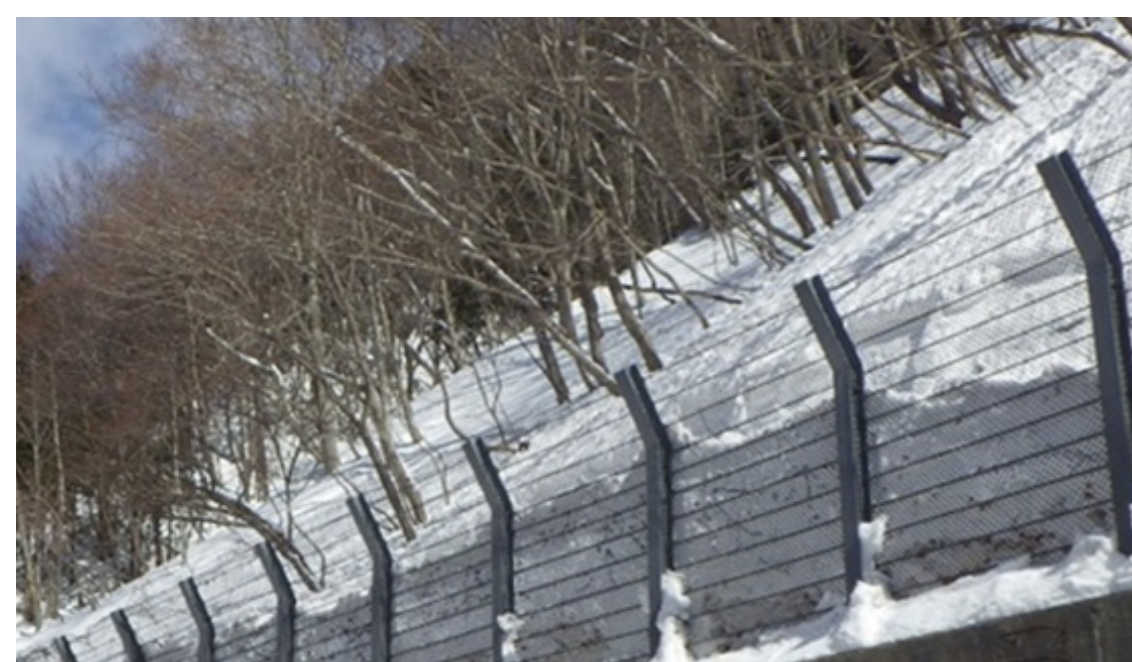
▲樹林帯での雪崩発生箇所の例
（平成26年2月、R48関山峠（宮城県））
Example of an avalanche site in a forest zone (February 2014, Sekiyama Pass on Route 48 in Miyagi Prefecture)
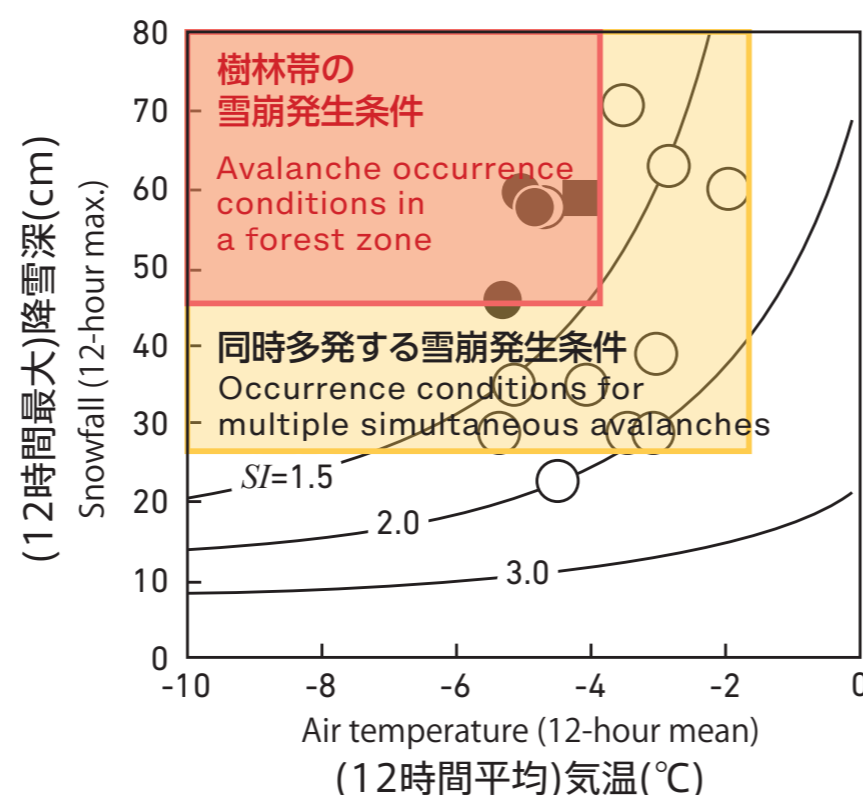
▲12時間降雪深と気温を用いた雪崩発生条件（SI: 斜面積雪の安定度）
Avalanche occurrence conditions expressed using 12-hour snowfall and air temperature (SI: stability of the snowpack on the slope)
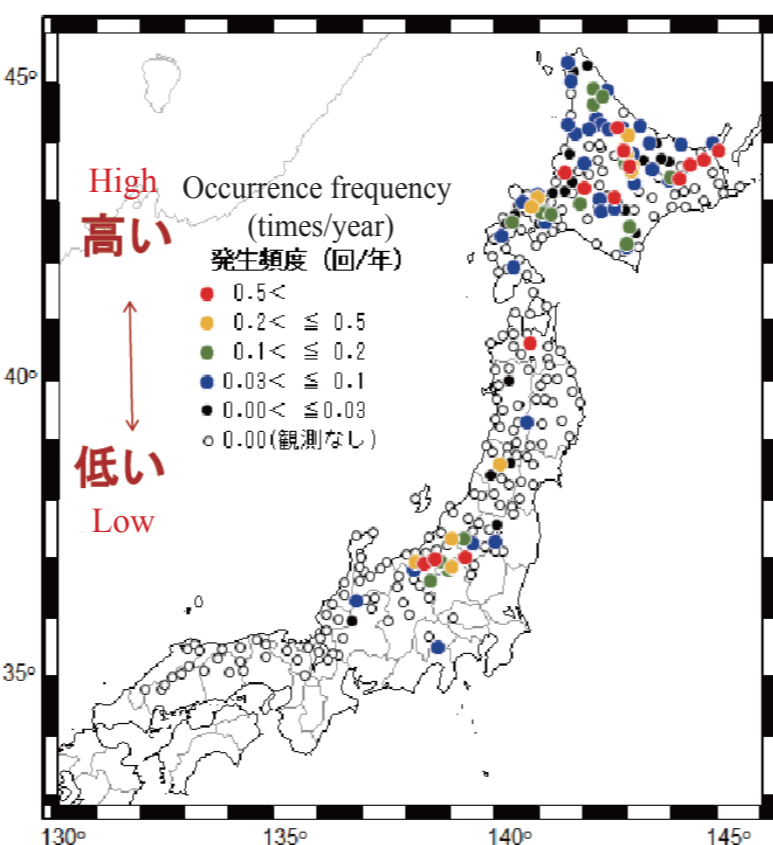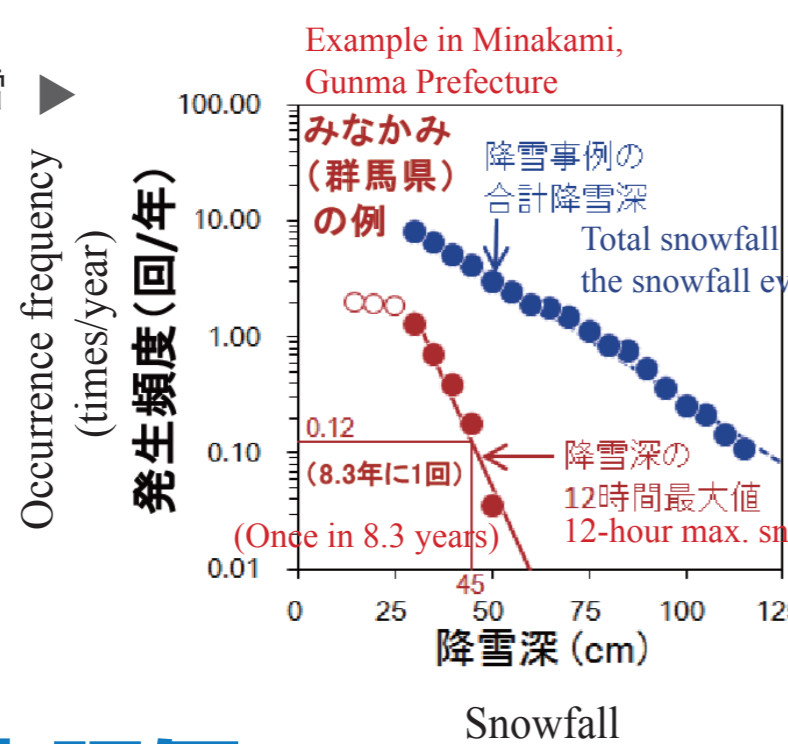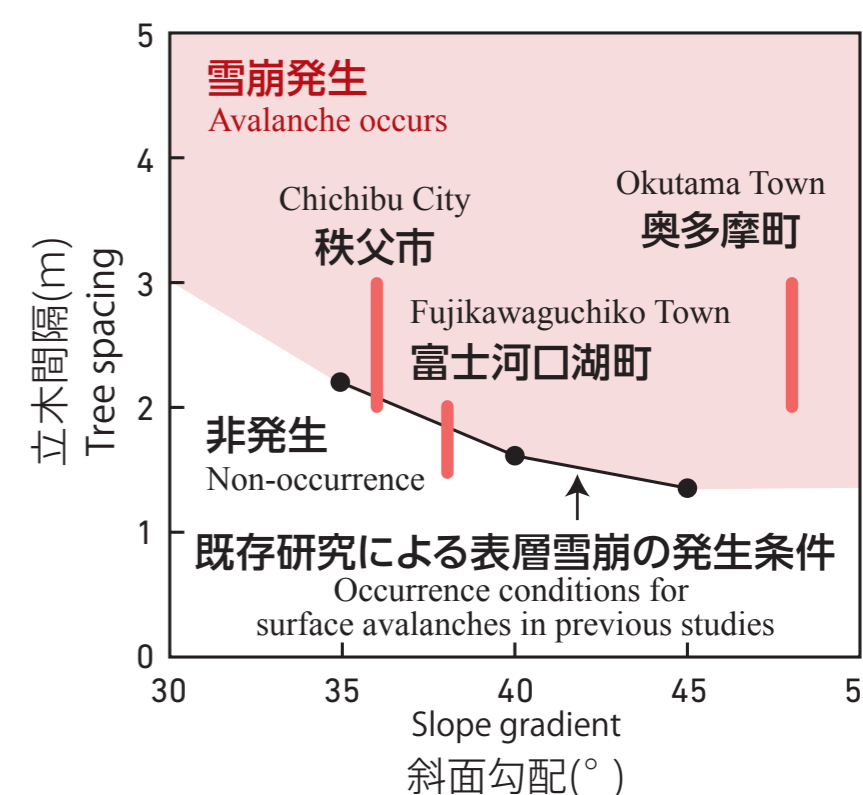
雪崩発生の地形・植生条件
Topographic and vegetation conditions for avalanche occurrences

雪崩発生箇所の現地調査と文献レビューの結果、立木間隔と斜面勾配の関係など、樹林内における雪崩発生の植生と地形の条件を明らかにしました。短時間多量降雪時は、樹木が密でも雪崩が発生する特徴があります。

As a result of the field survey and a literature review of the avalanche sites, we clarified the vegetation and topographic conditions for avalanche occurrence in forests. The findings included the relationship between tree spacing and slope gradient in the forest. Avalanches characteristically tend to occur even in dense forest when an area has extreme snowfall in a short period.

▲雪崩発生箇所の現地調査例（秩父市）
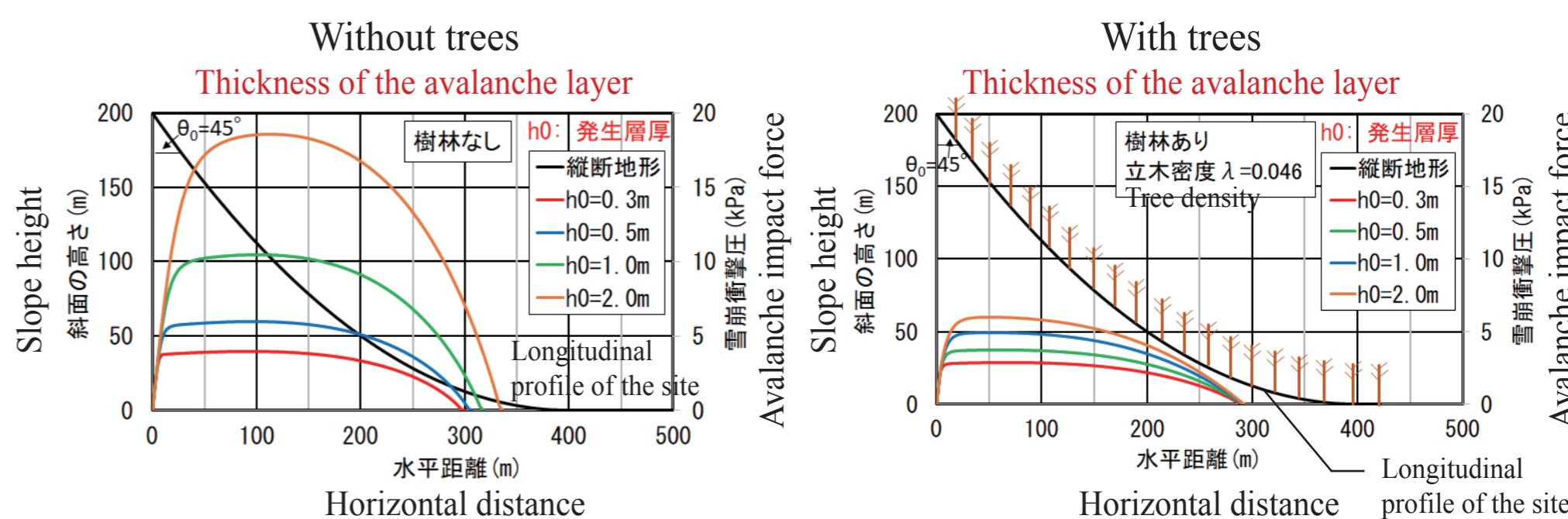A site of the onsite survey on avalanche occurrence (Chichibu City)

▲雪崩発生箇所の立木間隔と斜面勾配の関係
Relationship between tree spacing and slope gradient at avalanche sites

雪崩の発生頻度
Frequency of avalanches

気象庁アメダスと北海道開発局道路テレメータデータを用いて、雪崩発生条件を満たす降雪事例の発生頻度を解析し、樹林帯において雪崩が発生すると考えられる頻度の地域分布（雪崩発生危険度図）を提示しました。

Using AMeDAS data from the Japan Meteorological Agency and road telemeter data from the Hokkaido Regional Development Bureau, we analyzed the frequency of snowfall events that satisfied the avalanche occurrence conditions and presented the regional distribution of the frequency at which avalanches are considered to occur in forest zones (avalanche occurrence risk map).

雪崩発生条件を満たす降雪事例の発生頻度解析の例
Example of occurrence frequency analysis for a snowfall event that satisfies the conditions for avalanche occurrence ▶

▲雪崩発生条件を満たす降雪事例の発生頻度分布
Occurrence frequency distribution for a snowfall event that satisfies the conditions for avalanche occurrence

雪崩の到達距離と衝撃圧
Runout distance and impact force of avalanches

樹林の影響を考慮した雪崩運動モデルを考案し、樹林の有無、斜面勾配、発生層厚等の様々な条件で樹林帯を流下する雪崩の到達距離と衝撃圧を算出する手法を提案しました。

We devised an avalanche motion model that takes into account the effects of forests and proposed a method for calculating the runout distance and impact force for avalanches that flow through forest zones under various conditions, such as the presence or absence of trees, different slope gradients, and different thicknesses of the avalanche layer.

▲雪崩の到達距離と衝撃圧の算出例
Calculation examples for avalanche runout distance and impact force

雪崩の危険度評価
Risk assessment for avalanches

この研究により、短時間多量降雪時において、従来発生しにくいと考えられてきた樹林帯での雪崩発生評価が可能になりました。また、頻度解析から求めた降雪深を雪崩運動モデルの発生層厚に適用することで、対策施設の設計条件となる頻度（例：30年確率値など）で発生すると考えられる雪崩の到達距離と衝撃圧を算出（雪崩危険度評価）することが可能になりました。

This study enables avalanche occurrence assessment for forest zones, which had been regarded as areas with rare avalanche occurrence, when the area has extreme snowfall in a short period. This study also enables avalanche risk assessment, i.e., calculation of the runout distance and impact force of an avalanche with a probable occurrence frequency that is specified for the design conditions of avalanche control structures (e.g., an avalanche with a 30-year probability). In this calculation, the snowfall obtained from the frequency analysis was applied to the thickness of the avalanche layer in the avalanche motion model.

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