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Risk analysis for dry snow slab avalanche release by skier triggering

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Risk analysis is of primary importance for skier triggering of avalanches since human triggering is responsible for about 90% of deaths from slab avalanches in Europe and North America. Two key measureable quantities about dry slab avalanche release prior to initiation are the depth to the weak layer and the slope angle. Both are important in risk analysis. As the slope angle increases, the probability of avalanche release increases dramatically. As the slab depth increases, the consequences increase if an avalanche releases. Among the simplest risk definitions is (Vick, 2002): Risk = (Probability of failure) x (Consequences of failure). Here, these two components of risk are the probability or chance of avalanche release and the consequences given avalanche release.

In this paper, for the first time, skier triggered avalanches were analyzed from probability theory and its relation to risk for both the D and ψ. The data consisted of two quantities : (ψ, D) taken from avalanche fracture line profiles after an avalanche has taken place. Two data sets from accidentally skier triggered avalanches were considered: (1) 718 for ψ and (2) a set of 1242 values of D which represent average values along the fracture line. The values of D were both estimated (about 2/3) and measured (about 1/3) by ski guides from Canadian Mountain Holidays CMH). I also analyzed 1231 accidentally skier triggered avalanches reported by CMH ski guides for avalanche size (representing destructive potential) on the Canadian scale. The size analysis provided a second analysis of consequences to verify that using D.

The results showed that there is an intermediate range of both D and ψ with highest risk. For$D$, the risk (product of consequences and probability of occurrence) is highest for D in the approximate range 0.6 m – 1.0 m. The consequences are low for lower values of D and the chance of release is low for higher values of D. Thus, the highest product is in the intermediate range. For slope angles, the risk analysis showed there are two ranges: $\psi \leq 32^0; \psi \geq 46^0$for which risk is lowest. In this case, both the range of ψ and the consequences vary by about a factor of two so the probability of release dominates the risk analysis to yield low risk at the tails of the distribution of ψ with highest risk in the middle $(33^0 - 45^0)$ of the expected range $\psi \quad (25^0 - 55^0)$.