Avalanche risk assessment, adaptation and mitigation in Iceland – a case study

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Snow avalanches have caused many catastrophic accidents and severe economical losses in Iceland since the country was settled in the ninth century. The first reported avalanche accident dates back to 1118 when a snow avalanche killed 5 people in western Iceland. Altogether about 680 deaths by avalanches have been reported in Iceland since then. Unaccounted deaths may be assumed to have been several hundreds, especially during two gaps a total of 250 years in the written records before 1600. Since 1901 altogether 196 persons have been killed in avalanche and landslide accidents in Iceland. Catastrophic avalanches in the villages Súðavík and Flateyri in 1995, which killed 34 people and caused extensive economic damage, totally changed the view regarding avalanche safety in Iceland.

These avalanches made it clear that a substantial number of people in several Icelandic towns and villages live in areas where avalanche risk is unacceptable. Although extensive evacuations may be used to reduce the risk to some extent, this can only be viewed as a temporary measure. Avalanche protection measures or land use changes are necessary for a permanent solution to this problem. Direct economic loss due to avalanches and landslides in Iceland since 1974 was about 40 million USD. The total cost of defence structures, which have been constructed since 1995 in many towns, including Flateyri, Siglufjörður and Neskaupstaður, together with the cost of relocation in endangered areas is about 70 million USD. Other economic losses, especially due to avalanches in rural areas, are substantial, but may be assumed to be much smaller than the loss estimated above. A total of 53 people have been killed by avalanches in buildings, at work sites or within towns since 1974, while 18 people have been killed by avalanches and landslides outside populated areas during the same period.

A new hazard zoning method was developed in Iceland after the snow avalanche accidents in 1995 and in 2000 a new regulation on avalanche hazard zoning was issued. The method and regulation are based on individual risk, or annual probability of death due to avalanches. The major components of the method are the estimation of avalanche frequency, run-out distribution, and vulnerability. The frequency is estimated locally and the vulnerability is estimated using data from the 1995 avalanches. Under the new regulation, new hazard maps have been prepared for the most vulnerable villages in Iceland. Hazard zones are delineated using risk levels of $0.2*10^{-4}$, $0.7*10^{-4}$ and $2*10^{-4}$ per year, with risk less than $0.2*10^{-4}$ per year considered acceptable.

The experience in Iceland since 1995 indicates that comprehensive hazard management can be used to reduce the number of accidents and the economic loss due to snow avalanches and landslides. It also demonstrates that planning mistakes due to lack of awareness of natural hazards are very costly to compensate or correct by technical means after settlements have been constructed in exposed areas.