Application and Limitations of Dynamic Models For Snow Avalanche Hazard Mapping

Bruce Jamieson [1] Stefan Margreth [2] Alan S. Jones [3]

1 Dept. of Civil Eng., University of Calgary, Calgary, AB, Canada; 2 WSL Swiss Federal Institute for Snow and Avalanche Research SLF, Davos, Switzerland; 3 Chris Stethem & Associates Ltd., Revelstoke, BC, Canada

Dynamic models, initially based on fluid flow, have been used since the 1950s for modelling the motion and runout of extreme snow avalanches. The friction coefficients cannot be directly measured. They can, however, be calibrated to reproduce an extreme runout that was observed or statistically estimated in a particular path, and the resulting modelled velocity can be used to calculate impact pressures in the runout zone. Alternatively, the friction coefficients can be obtained from extreme avalanches in similar nearby paths and used, often with estimates of available snow mass, to estimate extreme runout in a path that threatens proposed development. This method is controversial because with average values of the friction coefficients, runout estimates from dynamic models are more variable than estimates from statistical runout models. However, uncertainty in the release mass and friction coefficients can be simulated with dynamic models, improving confidence in the runout, impact pressures and return intervals, all of which are required for risk-based zoning. Also, various scenarios can be modelled to see which yields reliable impact pressures for a given position in the runout zone. We argue that dynamic runout estimates can complement estimates from statistical models, historical records and vegetation damage, and be especially useful where some of these estimates are not available or are of low confidence. Limitations of dynamic models involving friction coefficients, snow mass estimates, number of variables and dimensions, entrainment and deposition as well as flow laws are reviewed from a practical perspective.