Evaluating the link between snowfall and avalanches

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Credit: Benoît Crouzy

Ski resorts and researchers could potentially rely on statistics to evaluate the long-term avalanche activity on their slopes with a simple webcam, a weather station, and several years' worth of observations. Researchers from EPFL have validated a statistical avalanche model that translates observations into an assessment of the link between snowfall and avalanches.

Some places are avalanche magnets; consider the Vallée de la Sionne on southern flanks of the Sex Noir in Valais, where about one hundred avalanches come rumbling down every year. But evaluating which slopes are most prone to avalanches remains as much an art as it is a science. Today's most advanced models simulate the physics of avalanches and aim to provide a short-term estimation of the risk for specific slopes. Two years ago, researchers from EPFL proposed a model based on statistics to assesses long-term avalanche activity and quantify the statistical link between snowfall and avalanches. Using observations of close to 550 avalanches collected in the Vallée de la Sionne over six years, the researchers have now validated their model. They published their findings in the *Journal of Geophysical Research – Earth Surface*.

According to Benoît Crouzy, co-author of the study, the long-term assessment of the avalanche activity requires statistical methods. Today's physics-based models are particularly suitable to make operational predictions several days into the future. But like weather forecasting models, they need to be fed with vast amounts of data and their accuracy tapers off after a few days. The statistical model Crouzy and his colleagues validated seeks to answer questions of a different nature. Rather than simulating the detailed mechanics of avalanches and the events that lead up to them, it focuses on their frequency and on their synchronization with snowfall. It further quantifies the degree of certainty associated to avalanche prediction from snowfall.

The model simplifies the dynamics behind avalanches as much as possible, says Paolo Perona, who initially developed the model two years ago. As opposed to methods that simulate the detailed physics of avalanches, this statistics-based approach needs only few parameters to calibrate: the average amount of snow per snowfall, the average time between them, and the rate at which the snow is compacted. The triggering of avalanches is modeled using probabilities, taking into account snow depth and a measure of the steepness of the terrain.

Data gathered by the WSL Institute for Snow and Avalanche Research SLF in the Vallée de la Sionne provided Crouzy and his collaborators with the above-mentioned values needed for calibration. Combining this information with photographs taken before and after around 550 avalanches geo-referenced on a highly accurate 3D model of the topography, the researchers obtained previously unavailable data on the frequency of avalanche detachment, the expected time delay between snowfall and natural avalanches, and their long-term incidence in a given terrain.

Statistical approaches to evaluate avalanche risk require observations of hundreds of individual avalanches to be calibrated accurately. But because avalanches are relatively rare – only few occur at the same place in a given year –, this data is often not available, which is one reason why these methods are less common than for the analysis of conventional hydrological hazards such as floods, says Crouzy. The availability of webcams and weather stations could now change that.

More information: Paolo Perona, Edoardo Daly, Benoît Crouzy, Amilcare Porporato (2012), "Stochastic dynamics of snow avalanche occurrence by superposition of Poisson processes," *Proc. R. Soc. A*:2012-;DOI: 10.1098/rspa.2012.0396

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