Geophysical Research Abstracts
Vol. 20, EGU2018-19323, 2018
EGU General Assembly 2018

Optimizing rockfall simulations by combining high-resolution gridded digital terrain models with 3D point clouds

François Noël (1), Cécile D'Almeida (1), Michel Jaboyedoff (1), Catherine Cloutier (2), and Jacques Locat (2)
(1) Risk Analysis Group, Institute of Earth Sciences (ISTE), University of Lausanne, Switzerland , (2) Département de géologie et de génie géologique, Université Laval, Québec, Canada

To correctly evaluate the rockfall hazard for large sites involving many cliffs, it is needed to evaluate the local probability of rock failure and the propagation that follows. However, both analyses are usually performed separately, and linking them for a quantitative hazard evaluation is not easy using conventional rockfall simulation programs. Indeed, sources cannot be spread uniformly over the 3D surfaces when they are distributed on gridded (rasterized) digital terrain model (DTM). It is then hard to adjust their number corresponding to the local varying susceptibility to failure.
Furthermore, many observed that the impact angle of the particle with the ground has a great effect on the energy absorption that occurs during impacts. This angle is strongly affected by the size of the particle and the encountered terrain surface roughness. However, this effect is greatly reduced when using low resolution terrain model, so it is common to add artificial random surface roughness. Choosing the right values for terrain becomes very subjective.
Also, Monte Carlo simulations are needed for a correct probabilistic rockfall hazard mapping, but may require a phenomenal amount of time to perform if the model is not optimized. This can be problematic when time matters, like in crisis situations. And simplifying models is not always a good solution if the results move away from reality.
In order to overcome these different limitations, we propose to combine the use of high-resolution DTM with 3D point clouds for rockfall simulations and hazard mapping. Distributing the sources in 3D makes it possible to place them in larger numbers at the critical points in order to link the probability of failure to the propagation.
The impact model presented here last year can work with very detailed terrain model. It has been updated to also work on highly detailed gridded DTM (eg. 2x2 km with 13 cm pixels), and in the process got a considerable speed boost while using less memory and resources, so larger area could be studied and the algorithm may be parallelizable with further development. Also, It has been fine-tuned with 3D data acquired from a real sized rockfall experiment we performed where many existing impact models where benchmarked.
The key element that allows the model to operate on a detailed gridded data is to pretreat the DTM by geometrically displacing a particle in contact over the terrain while filling in the asperities that are too small to be reached by the particle. The operation can be repeated to generate multiple custom DTMs for different particle sizes. This transparent operation is done in background for a few minutes as soon as the DTM is imported, allowing the user to define the other parameters of the simulations during this time.
With these manipulations, the different issues aborted are overcome; the results are more objectives and quantifiable; and with further collaborative development, block fragmentation could easily be incorporated in the model because the size of the particle with the terrain roughness are correctly considered geometrically.