Geophysical Research Abstracts
Vol. 21, EGU2019-11476-1, 2019
EGU General Assembly 2019


# Jumps, impacts and run-out of rockfall trajectories

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In order to keep the impact of rockfall events as low as possible and to take precautionary measures, rockfalls are simulated using simulation programmes. Although the results of such numerical models are quite reliable, they often do not correspond to reality. It is therefore important that these simulation programs are compared and calibrated with results from tests that are as realistic as possible.
For this reason, in summer 2014 over 100 artificial rockfalls were carried out along a grass slope (Volkwein et al., 2018). During these rockfalls, a probe built into some stones was used to measure various parameters such as acceleration or position. 78 experiments generated useful data with three different stones (stone 1, stone 2 and stone 4). The accelerations were tested in various contexts. For example, how the data distribution of the individual stones looks like. Are there similarities? Is it possible to recognize a pattern? It was also analyzed whether the duration of the preceding flight phase has an influence on the acceleration of an impact or whether the duration of an impact depends on the flight phase.
Comparisons between the horizontal ranges showed that the stone with the roundest shape (stone 1) also had the greatest ranges, the stone with a flattened appearance (stone 4) the shortest. The starting point had no influence. In the comparisons with the accelerations there were, if available, mostly only similarities between stone 1 and stone 2 which also had a rather round shape. There were rarely similarities to stone 4. However, clear patterns could not be recognized. Also with the remaining questions mentioned above no connections were visible. This means that each stone can behave differently. These results are only valid for a grass slope like the one in Tschamut. They are not transferable to stony or rocky slopes. It must also be mentioned that the soil conditions as well as the slope inclinations were not included in the evaluations.
Further, the in-situ position measurement during the rockfalls allows an analysis of the run-out phase of the blocks till their full stop in flat terrain. This process is separated into the phase where the block already slows down but its trajectory still is composed out of jumps and impacts. In the final phase of the brake down process no jumps are observed anymore but only rolling movements. The duration of the total run-out phase depends on the the entrance speed that block has when entering the flat run-out area. Again, blocks 1 and 2 – due to their more spherical shape – show longer run-outs as block 4.

Volkwein, A., Brügger, L., Gees, F., Gerber, W., Krummenacher, B., Kummer, P., Lardon, J. & Sutter, T. (2018). Repetitive Rockfall Trajectory Testing. Geosciences, 8(3), 88.