EGU2020-4204
https://doi.org/10.5194/egusphere-egu2020-4204
EGU General Assembly 2020

Demonstrating granular flow characteristics easily using LEGO bricks

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Landslides, rockfalls, and avalanches are re-occurring natural hazards in many parts of the world. Especially snow avalanches are triggered by unaware skiers and hikers. Hazard mitigation technologies are visible to the public in many places, such as along roads or train tracks. To raise awareness of the hazard and to boost acceptance for mitigation strategies, public education about initiation and dynamics of gravitational driven granular mass flows is required. Due to the importance and commonness of those hazards, granular flows are part of the curriculum for geoscience and civil engineering students. In this work, I present an experimental approach using LEGO bricks to educate and talk about granular flow dynamics without oversimplification or a trade-off in scientific value. The chosen setup is highly flexible, allows easy testing of various scenarios and parameter variations, and provides high-quality, scientifically profound data at the laboratory scale. The separate pieces are almost unbreakable and can be reassembled in various combinations. Release height, released amount of mass, flow material, surface roughness, slope shape, channel width and length, as well as position or shape of one or more obstacles can be easily modified. Measurements can be taken using video recordings at high speed from various angles as well as through quantitative analysis of the mass deposit. The presented design is approximately 80 x 60 x 20 cm in length, height and width with material costs less than 50€ without a camera. Flexibility and data quality make the chosen approach a good alternative to handcrafted, single-piece laboratory setups. However, in terms of outreach, science communication, and education, the toy-based approach shows its strongest benefit. Due to the very popular and well-known toy's character, the presented experimental design allows easy interaction with a low inhibition threshold. Due to the easy brick-combining technology of LEGO effects of various protection designs can be quickly tested and visualized. The presented setup has successfully been used in consecutive years in higher education for geoscience and geophysics students as well as on public science fairs. Cameras of commonly available smartphones have been given satisfying results for education purposes. Experience shows that the presented setup stimulates creativity in the user group, as for example with regard to parameter variation, improvements of the experimental design and protection constructions. The practical experience at the laboratory scale facilitates understanding of complex mathematical flow models and the governing parameters of granular flow. Further, the practical work can be used for an introduction into image-based evaluation and analysis techniques and to illustrate scientific methodologies. At a broader public audience, especially children up to the age of 14 seem attracted by the use of a

familiar toy system but also for adults the flexibility of the design has been found useful for demonstrations. In this work, the chosen experimental design, its benefits and drawbacks, and its scientific quality are presented.