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The (story-) line between numerical simulations for hazard assessment, visual communication, and risk perception

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Abstract:

The use of process-based numerical models for the simulation of mass movements is an important component of modern integral natural hazard management. When informed by high quality data and expert interpretation, numerical simulations aid process understanding, scenarios building as well as the design of mitigation measures. Despite a relatively long history and tradition in model development and application, problems still exist both in the expert's community and at the interface between policy makers and the public. Understanding the domain in which the model and its results can be validated, the sources and magnitude of errors and uncertainty or the physical and numerical approximations needed are only some examples of problematic topics.

A spectrum where people swing between systematic scepticism versus over-trust in the models and in their potential exist both amongst experts and the public. This paradigm has been exacerbated in the past few decades, with the fast development of computing power and numerical methods, which has led to an imbalance in what is technically possible and what the community can handle. A large gap appears in front of us with regards to the application of three-dimensional multi-physics models to engineering and geological problems. In this abstract, the authors propose to discuss one aspect of this impending challenge: results visualization and communication with stakeholders.

In particular, we use the case of the Material Point Method (MPM), which enables the simulation of elasto-plastic constitutive relations integrated within a hybrid Eulerian/Lagrangian numerical scheme. The method, initially developed for civil engineering problems involving large deformations, later gained widespread recognition in the movie industry, in particular after its use in Disney movie *Frozen*. However, its application to real-world physical problems soon revealed its significant research and engineering potential. In the years that followed, numerous highlighted its effectiveness in modelling snow, ice, rock avalanches and multi-phase process cascades at various scales (Cicoira et al., 2022).

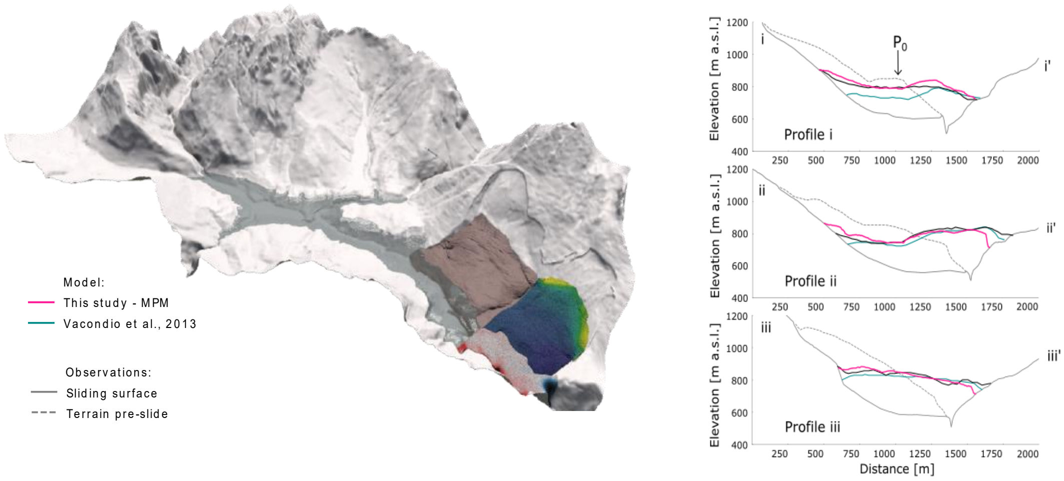

Figure 1. Simulation results for the Vajont rockslide and tsunami. (left) Rendering with landslide velocities and (right) elevation profiles at the deposit with comparison with measurements.

The application of MPM to alpine mass movements is emblematic in many ways, highlighting the complexities at both ends of the spectrum. The scepticism and the overconfidence in the model are both possibly driven by the animated movies and complex renderings that can be created from the results. On the one hand, the association with the movie industry misleadingly leads some to view the results as mere illustrations, lacking in scientific validity. On the other hand, the realistic representation of the results enhances the understanding of the process and builds trust in the model. Interestingly, in both scenarios, the visual graphics overshadow the model itself and its results.

With this abstract, we want to discuss some strategies and address open challenges in the communication of complex numerical simulations by means of cartography, three dimensional renderings and animations. With the anticipated rapid growth of such visual tools in the coming years, it is crucial to anchor these advancements in strong fundamental principles of research, engineering, and science communication.

References

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