Post-doctoral position in Natural Hazards with a focus on Landslide modeling

Discrete element modeling of slow moving landslides

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Introduction

In mountainous landscapes, bedrock landslides represent a major natural hazard that threatens the safety of populations and infrastructure. They are also widely recognized as the primary erosion mechanism driving hillslope erosion and landscape evolution in active mountain regions (e.g. Burbank et al., 1996). Diversity in rock weakening and geologic setting leads to a large diversity of landslides types, involving distinct depths and geometry of the failure surface. It also leads to a wide range of deformation rates, from rapid and catastrophic landslides to extremely slow deformations (a few m/kyr) (Hungr et al., 2014). In this project, we hypothesize that the contribution of slow-moving landslides (SML) represents an underestimated, if not the missing, source of long-term erosion in mountainous landforms. If this hypothesis is verified, it should represent a significant paradigm shift in our view of how mountain hillslopes are eroded. With this project, we aim to improve our knowledge on the response of slow landslides to climatic, seismic and anthropogenic forcing, and to explore the insufficiently-estimated hazard induced by SML.

Research program

The processes that control the deformation rate of the SMLs are complex and not fully understood. However, phases of deformations usually involve major groundwater forcing (e.g. Agliardi et al., 2020). Hence, the control of cyclic pore pressure increase must be introduced in any numerical model that aims at representing SML behaviour. Currently, discrete element model seems to provide the critical features needed to describe many of the mechanisms and deformation processes at the origin of landslides. Building upon our recent work (Huber et al., 2024), we propose to explore the SML response to hydrological forcing using the open source code YADE-DEM (Angelidakis et al., 2024). The modeling strategy will follow several steps: 1. Introducing pore water effects in the existing model; 2. Introducing time-dependent deformation processes; 3. Reproducing the behaviour of different landslides based on their respective geometry/structure, rheology; 4. Exploring the sensitivity of SMLs to varying forcing parameters, for example varying the amplitude of the seasonal water table rise as well as considering seismic shaking; 5.Extending the study from 2D to 3D. Selected sites will be used to calibrate the model.

Context

The position is open as part of the collaborative research project SLIDE: Assessing the contribution of slow moving landslides to erosion in the Himalayas, funded by the French National Research Agency (ANR) for 4 years. The SLIDE project has started in November 2024 and involves 20 researchers from 3 research institutes (CRPG, ISTerre, ECGS in Luxembourg). It is structured in 3 work packages (WP):
- WP1: Assessing the comprehensive dynamics over time and space of a selection of different types of SMLs, using a multi-faceted approach (remote-sensing, GPS, seismic and climatic monitoring)

- WP 2: Mapping at broad scale the SML activity and velocity in central Nepal from remote sensing and machine learning
- WP 3: Assessing the erosional flux of the SMLs in central Nepal, and exploring the sensitivity of the SMLs to forcing using numerical modelling

The proposed position takes part in WP3. However, the post-doc will be involved in project discussions, participating in team meetings and, if desired, in field instrumentation of active slow-moving landslides in the Himalayas of Nepal.

The applicant

The applicant should hold a **PhD degree** in **geosciences**, **engineering** or **computational mechanics**. The degree needs to be obtained by the time of the decision of employment. The applicant should have **a solid base in mechanics** as well as **experience in numerical modeling and scientific programming**. We seek a highly motivated researcher with a strong background in quantitative modeling and a keen interest in interdisciplinary approaches to natural hazard prediction. We also strongly encourage the postdoctoral candidate to bring their own ideas, methods, and perspectives to the project.

The application

The application should include **a cover letter** of max 2 pages, shortly describing her/his personal motivation for applying to this postdoctoral position and how she/he sees her/his role in contributing to the project, as well as her/his relevant skills, qualifications and research interests. The application should also include **a CV (with a full publication list)**, **PhD degree certificate**, **PhD thesis, and other relevant documents**, as well as the **contact details of 2-3 referees**. The application should be sent to Dr Luc Scholtès (luc.scholtes@uca.fr) and Dr Jérôme Lavé (jerome.lave@univ-lorraine.fr).

About the employment

The employment is a full time position of **up to 18 months**. Starting date **2026-01-01** or as agreed.
Gross month salary **between 3k€/month and 4.5k€/month** depending on experience. Location : Time will be shared **between CRPG, Nancy, France and LMV, Clermont-Ferrand, France**: this has to be discussed with the applicant.

For further information about the position, please contact: Dr Luc Scholtès (luc.scholtes@uca.fr) and Dr Jérôme Lavé (jerome.lave@univ-lorraine.fr)

References

- Agliardi, Federico, et al. 2020, Slow-to-fast transition of giant creeping rockslides modulated by undrained loading in basal shear zones, *Nature communications* 11.1:1352.
- Angelidakis, Vasileios, et al. 2024. YADE-An extensible framework for the interactive simulation of multiscale, multiphase, and multiphysics particulate systems. *Computer Physics Communications* 304:109293.
- Burbank, Douglas W., et al. 1996. Bedrock incision, rock uplift and threshold hillslopes in the northwestern Himalayas." *Nature* 379.6565:505-510.
- Huber, Marius, Luc Scholtès, and Jérôme Lavé. 2024. Stability and failure modes of slopes with anisotropic strength: Insights from discrete element models. *Geomorphology* 444:108946.
- Hungr, Oldrich, Serge Leroueil, and Luciano Picarelli. 2014. The Varnes classification of landslide types, an update. *Landslides* 11.2:167-194.