ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

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**Subject title: NumSlide – Landslide risk in Rwanda: numerical modeling of hazard and risk mapping**

Advisor: **JOLIVET MARC, DR CNRS, jolivet@ipgp.fr**
Supervisor:

Team: **IPGP- Team Tectonique et Mécanique de la Lithosphère – UMR7154**

Financing: Doctoral contract with or without teaching assignment

***Presentation of the subject:***

As the most densely populated country in sub-Saharan Africa, **Rwanda** is characterized by a humid tropical climate, a highly rugged mountainous terrain, significant seismic activity linked to the East African Rift, and massive deforestation. The combination of all these factors gives rise to **an extremely high risk of landslides**. Coupled with exponential population growth (2.3% per year and an average of 571 people per square kilometer) and an agricultural system consisting of a network of small family farms primarily engaged in subsistence farming, this hazard—in addition to the lethal risk associated with landslides—poses **a major economic risk to farming families**.

As part of the Gravity project (Principal Investigator: M. Jolivet (University of Rennes / IPGP) – D. Arvor (Univ. Rennes 2)), funded between January 2023 and September 2025 by the CNRS and in collaboration with the Ministry in charge of Emergency Management (MINEMA), our team conducted a multi-year geomorphological monitoring of major landslides in the Western Province. The objective was to understand the exact mechanisms triggering and driving these landslides in order to minimize risks to local populations and develop remediation solutions, particularly in the context of global climate change. The findings revealed that, in addition to the lethal risk during the initial triggering of a landslide, the long-term impact on farming families (loss of crops, destruction of arable land, destruction of homes) remains largely unknown. Furthermore, once a valley's topography has been destabilized by an initial major landslide, the re-equilibration of slopes triggers cascading landslides over several years. As such, the activity of certain landslides sometimes continues for decades.

As such, some landslides can continue for decades.

Following this initial study, the EcoRisq project (funded by CNRS and MITI, 2025–2026, Principal Investigators: S. Veljanoska (University of Rennes) – M. Jolivet (IPGP)), conducted in collaboration with MINEMA, the Ministry of Agriculture (MINAGRI), and the Rwanda Space Agency, aims to model economic vulnerability to

landslides and to develop decision-support tools for public stakeholders. In a context of high population density and intensive land use, the effectiveness of risk management decisions depends on a detailed understanding of the hazard, particularly the propagation characteristics (extent, volume, speed) of gravity-induced events.
Building on the work carried out in the Gravity and EcoRisq projects, this thesis aims **to develop a detailed numerical model (SHALTOP code developped at IPGP) of potential landslides in key areas selected for their vulnerability in terms of local populations and infrastructure**. These predictive models will be cross-referenced with maps of agricultural parcels and logistical infrastructure (roads, bridges, homes, public buildings, etc.) to **create operational risk maps**. Initially, the models will attempt to reproduce the various landslides documented by the Gravity and EcoRisq projects. These test models will aim to constrain the mechanical parameters to enable the most realistic possible modeling of landslides in different regions (notably, the thickness and type of materials involved in landslides vary from one region to another). These parameters will then be used to develop the predictive models.
The NumSlide project is highly multidisciplinary, involving researchers from IPG Paris, CREM, MINEMA, and MINAGRI. The numerical modelling will be conducted in collaboration with **A. Mangeney** (DR CNRS, Seismology team, IPGP). Tthe thesis work will also include fieldwork, specifically valley mapping, soil characterization, and data collection from various local and national stakeholders. Fieldwork will be organized in collaboration with Ms **C.H. Niyotwambaza**, General Director “Surveillance and Preparedness) and her team at MINEMA.

## Profile of the ideal Candidate

**Master’s degree or engineering degree in geosciences or environmental sciences**. Skills in numerical modeling of geological processes and geomorphology are required. Proficiency in GIS (Geographic Information Systems) is preferred. **The work will involve field missions lasting several weeks in Rwanda**. The **ability to work and live effectively in a group is required**. Communication with Rwandan project participants will be conducted exclusively in English, and a **strong command of spoken and written English is required**.
The candidate will be attached to the Tectonics and Mechanics of the Lithosphere team (IPG Paris) and will collaborate with the Seismology team at IPGP (co-supervisor: Anne Mangeney).
The candidate selection process will consist of three steps.

1-The **application package, to be submitted by 12:00 PM on May 7** to the project team, consists of a detailed resume and a cover letter, along with transcripts from your bachelor’s and master’s degrees (or equivalent), including your class rank and the total number of students in your graduating class, and one or two letters of recommendation.
2-Candidates shortlisted based on their application materials will be **interviewed by the supervisory team on May 11.** The supervisory team remains available for any discussion outside of this date.
3-Shortlisted candidates must present their research topic and academic profile in **an oral defense on June 15, 16, or 17 before a panel from the STEP’UP Doctoral School**.