Landslide risk in the Kivu Rift: the legacy of a political and environmental crisis

Arthur Depicker[1]*, Liesbet Jacobs[1], Nicholus Mboga[2], Benoît Smets[3], Anton Van Rompaey[1], Moritz Lennert[2], François Kervyn[3], Caroline Michellier[3], Olivier Dewitte[3] & Gerard Govers[1]

ABSTRACT: — Scarcening land and resources in the tropics incite more and more people to resort to steep terrain where landslides inflict thousands of casualties every year. Landslides are particularly abundant in areas that experienced recent deforestation. Forest cover changes thus play an important role in assessing landslide activity, yet most landslide susceptibility research – focussing on the spatial likelihood of landslides – considers these environmental conditions to be constant. Moreover, although the impact of deforestation on landslide hazard and the resulting risk is often invoked as a plea for forest conservation, this argument is rarely supported by a quantitative foundation. In this work, we aim to quantify the evolution of landslide risk between 1973 and 2016 in the Kivu Rift, encompassing parts of Burundi, the Demographic Republic of the Congo (DRC, Nord & South Kivu), and Rwanda. In the past decades, this study area experienced widespread deforestation and large shifts in demography, a result of both the strong population growth and transnational refugee fluxes induced by conflicts.

In order to assess the landslide risk evolution in the Kivu Rift, we first reconstruct the forest cover changes since 1958 by using a unique catalogue of historical aerial photographs. Second, we incorporate these forest dynamics into a temporally dynamic landslide susceptibility assessment. We then use a logit function, calibrated with landslide data for our study area, to link susceptibility to the yearly proportion of the land affected by landslides (m^2/km^2/year), a proxy for landslide hazard. Finally, the landslide hazard allows for coupling with population density grids (inh./km^2). As such we obtain estimates of the landslide risk, reported as the number of cases whereby a person is exposed to a landslide, at different points in time (1975, 1990, 2000, 2015). Overall, the landslide risk is roughly twice as high in the DRC compared to Rwanda and Burundi. This difference is mainly due to the higher exposure of the Congolese population of which a larger proportion is located on hazardous terrain. Up to the 90s, the contribution of deforestation on risk in the DRC remained limited to ca. 21%. In the aftermath of the Rwandan civil war there was a strong influx of refugees in the Kivu provinces, leading to accelerated deforestation which contributed ca. 55% to the total risk between 2000 and 2015.

We statistically demonstrate that landslide risk exhibits a strong response to deforestation. This response is especially large in areas where deforestation patterns coincide with the allocation of livelihoods, for example in the eastern DRC where hundreds of thousands of refugees were resettled during the 90s. We show that the quantification of landslide risk at a certain place and time requires knowledge of prior environmental changes. In other words, landslide risk cannot be assessed accurately without understanding both the spatial and temporal context of the population and its environment.

[1] KU Leuven, Department of Earth and Environmental Sciences, Division of Geography and Tourism (Celestijnenlaan 200E, 3001 Heverlee, Belgium)

[2] Université Libre de Bruxelles, Department of Geosciences, Environment & Society (Av Franklin Roo-sevelt 50-1050, Brussels, Belgium)

[3] Royal Museum for Central Africa, Department of Earth Sciences (Leuvensesteenweg 13, 3080 Tervuren, Belgium)

*Corresponding Author. Email: arthur.depicker@kuleuven.be