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Landslide resilience in Equatorial Africa: Moving beyond problem identification!

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Introduction

1 Landslides (LS) are a major hazard in many mountainous and hilly regions. Their impact on the environment and humans depends mainly on their size and speed, the elements at risk and the vulnerability of the affected populations. Recent evaluations of LS susceptibility at a global scale (Kirschbaum *et al.*, 2010; Petley, 2012) highlight that LS susceptibility is especially high in active tectonic settings such as the Himalayas. The

number of fatalities caused by wet or dry LS amounts to over 4000 per year, making it one of the most severe natural hazards (Petley, 2012).

2 Although Africa does not appear as a LS hotspot at a global scale, nevertheless, the limited number of scientific publications (e.g. Igwe *et al.*, 2014; Che *et al.* 2012; Che *et al.*, 2011; Claessens *et al.*, 2007; Kitutu *et al.*, 2009; Knapen *et al.*, 2006; Davies, 1996; Davies *et al.*, 2013; Ayonghe *et al.* 1999; Ayonghe *et al.*, 2004; Zogning *et al.*, 2007; Mugagga *et al.*, 2012b; Ngecu *et al.*, 2004; Broothaerts *et al.*, 2012; Van Den Eeckhaut *et al.*, 2009) and our field experience suggest that LS are responsible for acute problems in Equatorial Africa. This is a region characterized by steep slopes, intense rainfalls, deep soil profiles and populations highly vulnerable to geohazards. Every year LS cause fatalities and structural and functional damage to infrastructure and private properties, as well as serious disruptions to the organization of societies, that affect local livelihoods.

3 The contrast between the limited number of reports on LS in Equatorial Africa and field observations might be attributed to the under-reporting of non-fatal LS and LS affecting marginal regions. The very limited data on LS occurrence (i.e. date, location, types), their impacts and controlling factors is the greatest impediment to identify and implementation of effective mitigation measures in Equatorial Africa.

4 Although few have been undertaken in Africa (Knapen *et al.*, 2006; Broothaerts *et al.*, 2012; Che *et al.*, 2012), many studies have investigated how natural processes and human activities control the location or timing of LS occurrence (e.g. van Westen *et al.*, 2006). These studies typically produce susceptibility maps highlighting factors controlling slope instability (van Westen *et al.*, 2006; Claessens *et al.*, 2007; Che *et al.*, 2012) but most fall short in identifying the triggering factors that control the timing of LS and do not consider strategies to reduce LS impacts.

5 According to Wisner *et al.* (2004), LS risk is controlled by the hazard characteristics and the vulnerability of people exposed. People’s vulnerability is constrained by unsafe living conditions, which are themselves the results of dynamic pressures and root causes that act at larger geographical and temporal scales. In order to implement feasible, efficient and locally acceptable risk reduction practices, it is important to identify the underlying drivers of the unsafe conditions.

6 Building LS resilience not only require accurate hazard estimates that account for the spatial distribution of future LS, their temporal frequency and the hazard intensity, but also quantitative assessments of their socio-economic impacts, as well as the evaluation of current social and cultural structures affecting the vulnerability and resilience to LS. This is essential to identify effective adaptation strategies that are cost-effective, technically efficient, culturally acceptable and adapted to the livelihoods of the vulnerable populations. Such interdisciplinary analysis is crucial to providing practical recommendations for households and policy makers at various administrative levels. This is the objective of the interdisciplinary AfR*e*Slide project, funded by the Belgian science policy and targeting several landslide-prone regions in Cameroon and Uganda. The AfR*e* Slide consortium is a multi-disciplinary research team gathering expertise in earth science, environmental economics, political ecology, anthropology and risk management to address the various aspects of the issue of resilience to LS impacts in the context of Equatorial Africa.

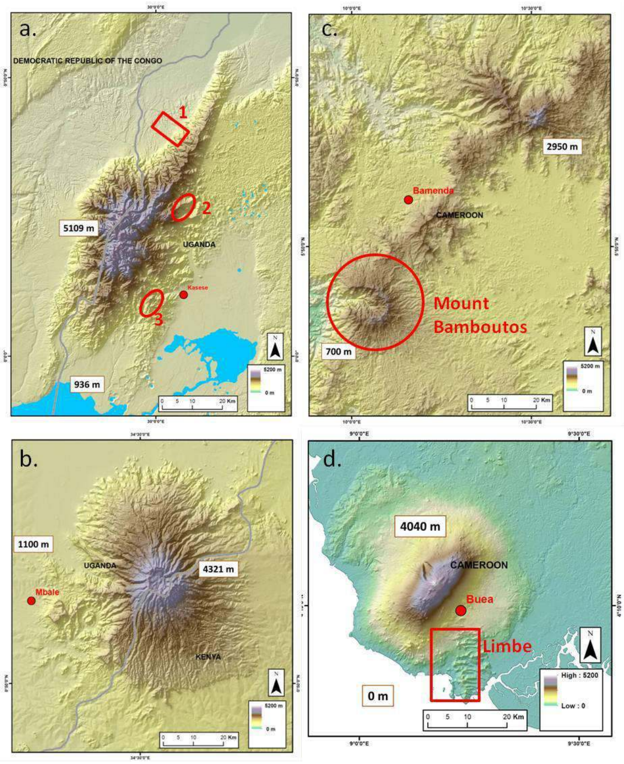
7 This article illustrates the relevance of this integrated approach through findings from stakeholder’s workshops organized in the different study areas during the initial phase of

the project. Its aim is to demonstrate how essential information can be gained through the early involvement of local stakeholders and more generally to argue for the usefulness of an integrated and community-based approach in risk reduction research.

Study areas

8 AfReSlide focuses on 4 study areas known for being affected mainly by rainfall-triggered, and potentially earthquake-triggered, LS in Uganda (Mt Elgon and Mt Rwenzori regions) and NW, W and SW Regions in Cameroon (Limbe at the foot of Mt Cameroon, Bamenda region; Fig. 1). In these regions, there have been few previous studies of LS characteristics and susceptibility mapping so hazard maps, socio-economic impact analyses, a picture of cultural features and explanations for natural disasters and risk reduction strategies are mostly lacking. The study areas have been selected because 1) they are representative for the physical processes of slope failure in Equatorial environments, 2) LS have caused important damage in the past, highlighting an urgent need to develop local resilience, and 3) some preliminary research had already been conducted in some of these regions (Mt Elgon, Mt Cameroon), providing a base for this interdisciplinary project (Che *et al.*, 2012; Che *et al.*, 2011; Claessens *et al.*, 2007; Knapen *et al.*, 2006).

Figure 1. AfReSlide study areas.



A. RWENZORI MOUNTAIN, UGANDA, WITH APPROXIMATE LOCATION OF THE THREE FOCUS AREAS; B. UGANDAN PART OF MOUNT ELGON; C. MOUNT BAMBOUTOS, NW PROVINCE OF CAMEROON; D. LIMBE AT THE BASE OF MOUNT CAMEROON, SW PROVINCE, CAMEROON

9 In the densely populated (up to 1000 inhab/km²), Ugandan footslopes of Mt Elgon, both shallow and deep-seated LS occur frequently. From 2010 to 2012, over 500 people were killed by dramatic deep-seated LS in this region: the largest events occurred on March 1st,

2010 (> 300 fatalities), and on 25[th] June 2012 (> 100 fatalities) (e.g. Jenkins *et al.*, 2013; Mugagga *et al.*, 2012a). To date, LS susceptibility has been studied only for the Mbale district on the border between Uganda and Kenya (Claessens *et al.*, 2007; Knapen *et al.*, 2006). However, LS also occur frequently in other districts and the local perception is that the frequency of LS events has increased in recent decades (Aryamanya-Mugisha, 2001; Kitutu *et al.*, 2009).

10 Mt Rwenzori is also an area with steep slopes, high population density and seismic activity, making it potentially susceptible to LS. A recent preliminary inventory of LS based on scientific reports and website search (Jacobs *et al.*, 2015) identified 48 LS and flash flood events from the last 100 years, most occurring in the last 15 years. These caused 56 fatalities, considerable damage to road infrastructure, buildings and cropland, and rendered over 14,000 people homeless. No systematic inventory of LS exists for this region nor do any scientific studies of their causes, triggering factors or impacts.

11 Along the Cameroon Volcanic Line in the NW, W and SW Regions of Cameroon, dominantly shallow translational LS affect the steep and highly weathered residual soils formed on dominantly volcanic rocks (Zogning *et al.*, 2007; Ayonghe *et al.,* 1999; Ayonghe *et al.*, 2004; Che *et al.*, 2011; Che *et al.*, 2012; Guedjeo *et al.*, 2013; Nyambod, 2010; Wouatong *et al.*, 2014; Zangmo *et al.*, 2009). Several events caused dozens of fatalities (Wouatong *et al.* , 2014; Zogning *et al.*, 2007; Ayonghe *et al.*, 2004). The area is characterized by large (up to 4200 mm/yr) and intense rains thought to be the main LS trigger, although seismic triggering has been proposed for specific LS swarms (Ayonghe *et al.* 1999). Demographic pressure on steep slopes and uncontrolled urban sprawl are key factors proposed to cause the recent increased impact of LS (Zogning *et al.*, 2007; Che *et al.*, 2011). A LS susceptibility map has been recently published for the Limbe-Buea area which lies at the base of Mt Cameroon (Che *et al.*, 2012).

12 The Ugandan case studies are characterized by a rural context, despite the high population density, whereas the Cameroon cases of Limbe and Bamenda are urban to sub-urban environments. These case study areas are representative of other regions of Equatorial Africa being affected by LS, such as the Western (DR.Congo, Rwanda, Burundi; Moeyersons *et al.*, 2004; Moeyersons *et al.*, 2010) and Eastern branches of the East African Rift system (Ethiopia, Broothaerts *et al.*, 2012; Van Den Eeckhaut *et al.*, 2009, Kenya, Tanzania; Ngecu *et al.*, 2004; Davies, 1996; Temple and Rapp 1972) or Nigeria (Igwe *et al.*, 2014).

Figure 2. Typical landslides features in the study areas.

a) Deep landslide scarp (and several in the background) in the lowlands of Katumba parish, Bundibugyo district, Rwenzori Mountains (Uganda); b) 8m deep translational landslide reactivated in September 2014; Bushyi sub-county, Bududa district, Mt Elgon (Uganda); c) Landslide of March 2014 stabilized with terraces and retaining walls along the Bamenda – Mamfe road, Cameroon; d) small shallow landslides within a larger landslide, Magha, Bamboutos Caldera, West Region, Cameroon; e) Debris slide into Nyamwamba river, Kilembe sub-county, Kasese district, Rwenzori Montains (Uganda).

Methodology

13 This contribution reports the outcome of 5 stakeholders' workshops that were conducted in 3 of the 4 study areas during the first year of the Af*Re*Slide project (Fig. 3). Three workshops were organized in each of the three administrative districts of the Rwenzori region (i.e. Kasese, Kabarole, Bundibugyo) and in main cities of the NW and SW provinces of Cameroon (Bamenda and Limbe, respectively). For each workshop, 20 to 35 stakeholders, representing district and city counsellors, members of risk management committees, environmental officers, local or international NGO's involved in environmental and risk management (Uganda Red Cross Society, Oxfam, WWF...), media and community leaders were invited.

14 First, a local leader or scientist introduced the natural hazard characteristics of the region with specific attention to LS and the Af*Re*Slide project. The main part of the workshop was dedicated to focus groups among the stakeholders. Stakeholders were invited to share their opinions and raise questions on separate topics:

1. the identification of zones affected by LS and the determination of the types of LS (*What are the main types of LS processes? Which are the most affected communities or parishes?*);
2. the perceived causes of LS (*What are the main drivers of LS?*);
3. the experienced impacts (*What are the most severe impacts of LS?*),

4. the implemented and desirable risk reduction measures (*What are currently applied, and potential alternative, adaptation strategies and actions against LS impact?).*

15 Concerns for sustainability and empowerment in contemporary research literature is increasingly leading to a shift towards more interdisciplinary research which go hand in hand with new methods such as focus groups (Stirling, 2008). Focus groups are '*a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research*' (Powell *et al.*, 1996, p. 499). The multi-disciplinary potential of focus groups has been widely recognized in scientific literature and is increasingly being used as a qualitative research method (Scott, 2011).

16 Focus groups are here considered as an appropriate approach to interact with community stakeholders in the initial stage of the project to develop and adjust the project's research questions. Focus groups have proven their exploratory capacity to generate further research opportunities (e.g. Powell and Single, 1996; Race *et al.*, 1994). They have often been staged as a platform offering opportunities to empower and give voice to marginalized groups or silent voices (e.g. Leyshon, 2002). In this line, we also use these workshops for their participatory potential.

17 The discussions took place in groups of 7 to 10 people addressing each question separately. The group were composed in such a way that each of them was heterogeneous, representing as much as possible the diverse opinions of the different groups of stakeholders. Participants used printed maps extracted from Google Earth or Google Maps with simple spatial reference features (e.g. roads, main villages, ...) at a scale of about 1:100.000 to highlight specific locations recently affected or prone to LS (Fig. 3c-d). Each group was moderated by one local and one Belgian scientist. One stakeholder participant noted the key points raised by participants on a flip chart (Fig. 3e). The findings of each group for the different questions were presented by a stakeholder in a final plenary session during which a final discussion between the groups could take place (Fig. 3f). Each workshop lasted from half a day to a full day.

18 In addition to identifying the concerns and expectations of the local stakeholders relative to the LS risks, these workshops aimed at establishing constructive connections with local actors to facilitate research actions and to ensure long-term communications between scientists and stakeholders in order to maximize the impacts of the research outcome. The similarity and contrast between these different workshops are highlighted in the next section. These workshops were complemented by preliminary field reconnaissance of the LS-affected areas in each of the study areas. This led to the definition of a new classification scheme of identified LS risk reduction strategies adapted to the context of developing countries.

Figure 3. Pictures taken during workshops organized in Uganda and Cameroon.

a) Presentation of LS issues in SW Cameroon by V.B. Che (Limbe, May 24, 2014); b) group discussion on the types of LS in Kasese district, Rwenzori region (January 8, 2014); c-d) identification of zones affected by LS on printed maps (Kabarole district, Rwenzori; August 8, 2014); e) flipchart summary of LS impacts (Kasese district, January 8, 2014); f) reporting of group discussions by a stakeholder in a plenary session (Kasese district, January 8, 2014).

Initial results

Landslide occurrence and types

19 During each workshop, stakeholders expressed a high level of concern about LS events. Most stakeholders could easily name areas or villages badly affected by LS. In Bamenda city (Cameroon), while LS events with visible impacts were identified by stakeholders both group discussions and field visits highlighted that such events are less common than in other study regions. This contrasts with other areas in NW and W Cameroon, such as the Mount Bamboutos caldera, where shallow LS are frequent (Zangmo *et al.*, 2009).

20 In contrast to field observations, the accounts of stakeholders were often biased towards the most recent LS events (i.e. last couple of years) that caused significant impacts, i.e. casualties, house destruction and road blockage; this emotional charge probably played a role for some stakeholders to mistake other natural disasters for LS as described below. It was also mentioned that the identification of LS-prone areas was biased by the fact that some local leaders were more active than others in reporting these events and requesting support from higher administrative levels. Regions with a better political representation at national level were also receiving more attention, as it is the case for the Mt Elgon region compare to the Mt Rwenzori, and between the different districts and sub-counties

within the Rwenzori area. In NW and SW Cameroon, knowledge of LS-prone areas led to the identification of 'risk zones' by the city authorities.

21 When participants were asked to characterize LS processes, it appeared that, despite being introduced to the definition of LS, stakeholders had very diverse representation of what LS were. This comes from the fact that the LS types occurring in a given region can be highly variable, ranging from rock fall to translational and rotational earth slides and mudflows, but also to the fact that other land degradation and natural hazard processes are experienced in these regions and are confused by stakeholders with limited earth science backgrounds. During field visits, it appeared that gullies resulting from concentrated surface runoff and flash floods transporting large boulders were also considered LS by local stakeholders.

22 This was for example the case for the flood that affected the Kilembe valley in the Kasese district on May 1st, 2013: the peak flow discharge of one of the main rivers draining the East flank of the Rwenzori carried meter-size boulders down to the lower valley, flooding the densely inhabited valley, causing destruction of houses, roads and utility lines and few casualties. Although being associated with transport of large boulders, this event was predominantly of hydrological nature and, apparently, did not directly involve mass movement. Nevertheless, it was interpreted by the local population as a LS. Although LS are present in the local discourse, several key stakeholders acknowledged that they had never visited LS-affected areas and therefore had a poor representation of them.

23 Based on the outcome of the focus groups, LS in the Rwenzori Mountains and Limbe area are small to moderate scale processes, dominated by shallow translational LS, but they have a high frequency. The exception is the Bundibugyo district in the NW of the Rwenzori where a high density of deep-seated rotational LS is reported to occur in sedimentary sandy to clayey deposits at the foot of the mountain.

Knowledge of landslide causes

24 Despite their sometimes broader definition of LS, most workshop participants could list the main factors controlling LS occurrence (Table 1). Natural factors, such as slope gradient and soil/rock characteristics, were generally mentioned first but then, typically more numerous, human-induced instability factors were listed. The occupation of steep slopes for human activities, associated deforestation and unplanned construction of houses requiring slope excavations, were stressed as a key drivers of the perceived increase in LS activity. These were, in turn, linked with increased population pressure, non-existent or poorly enforced land-use planning, and land scarcity in urban or peri-urban environments that forced the poorest population or newly immigrants to settle in unstable zones. Specific agricultural practices that favour water and sediment harvesting and prevent surface erosion such as digging of trenches, but also slash-and-burn and overgrazing, were also considered to contribute to slope instability. Slope cutting for road construction was also mentioned as a common process destabilizing slopes, especially when stabilization measures, such as retaining walls, terraces, drainage systems, or gabions, were insufficient.

Table 1. Summary of natural and anthropogenic factors identified as factors causing landslides during the stakeholder's meeting in Ugandan and Cameroon. No distinction was made between controlling and triggering factors.

Natural Factors	*Anthropogenic factors*
• 'Fragile' soil type	• Deforestation of slopes
• Rock, geology, lithology	• Agricultural practices: Soil and water conservation methods (i.e. aiming to reduce erosion), crop type, bush burning, overgrazing
• Slope	• Slope excavation for construction
• Rainfall – Rain season	• Non-existing/enforced land use planning
• Seismic activity	• Unplanned settlements on steep slopes/risky areas due to: o land scarcity, population pressure o poverty o cultural reasons: migration from mountainous rural areas to the city
• Water accumulation (in concavities)	• Poor maintenance of drainage channels
	• Inadequate sewage disposal
	• Breakdown of cultural beliefs

25 Population increase was generally associated with an increased pressure on natural resources, including arable land. In Limbe (SW Cameroon), the role of water management, i.e. the maintenance and dredging of the river and drainage network and the inadequate management of sewage water, was also identified as contributing to floods and LS within the urban environment. In addition, interactions between flood and LS events, being potential mutual causes of each other, were also highlighted during several workshops.

26 Interestingly, cultural aspects were also put forward as contributing to LS occurrence. For example, in SW Cameroon, populations migrating from rural mountainous areas would favour settling on steep slopes at the city margin. In the Rwenzori Mountains, the Bakonzo ethnic group is known to favour settlements at high elevations in the mountains. This ethnic group was poorly represented during the workshops, indicating that they have limited political power. However workshop participants mentioned that the breakdown of the traditional belief of the Bakonzo people in 'natural' spirits and the disappearance of ritual performances may have contributed to the occurrence of more LS. This cultural change was also associated with abandonment of the planting of specific plants and trees that favour slope stability.

27 Regarding LS triggering factors, there was a consensus among participants that rainfall, especially intense rain events clustered during the rainy seasons, was the main factor. Climate change was, however, not mentioned as a process increasing LS hazard, despite being a living topic among the national and international stakeholders. In the Rwenzori and the Limbe areas, seismic activity was also mentioned as a factor favouring the occurrence of LS swarms, especially during 'large magnitude' earthquakes, e.g. Mw 6.2 earthquake of 1994 in Kabarole district, Uganda (Jacobs *et al.*, 2015). Earthquake-triggered LS was confirmed in several locations in the Rwenzori Mountains but remains a matter of debate in SW Cameroon where seismic activity is less (Ayonghe *et al.*, 1999; Ayonghe *et al.*, 2004).

Impacts of landslides

28 Table 2 presents a classification of the LS impacts that were listed during the workshops. The first impacts mentioned were obviously the tangible and direct ones, i.e. loss of lives, the destruction of houses and of community infrastructures such as roads and schools. The number of casualties was limited to a few tens of persons over the last decades in each study area (e.g. Che *et al.*, 2011; Jacobs *et al.*, 2015). In contrast to the areas were workshops were organised (NW & SW Cameroon, Mt Rwenzori), the Mt Elgon region suffered several hundreds of LS-induced fatalities in 2010 and 2012 (e.g. Jenkins *et al.*, 2013; Mugagga *et al.*, 2012a). However, participants insisted that LS have far-reaching and long-lasting impacts on the local population beyond these direct impacts.

Table 2. Summary of direct and indirect, tangible and intangible impacts of landslides identified by stakeholders during workshops in Uganda and Cameroon.

Direct Tangible Impacts	*Indirect Tangible Impacts*
• Loss of lives • Damage to infrastructure: roads, schools • Economic losses: houses, land, crops, animals • Disturbance of surface water	• Loss of soil fertility; Soil degradation • Reduced crop yields; Food insecurity • Income and labour loss • Decreased land values; Land conflicts • School drop outs; Disease; Migration • Displacement; Poor living conditions • Reduced mobility; • Off-site effects: sediment deposition, flash floods
Direct intangible Impacts	***Indirect intangible Impacts***
• Psychological suffering: fear, frustration • Waste of time: rebuilding house • Loss of biodiversity, destruction of ecosystems • Loss of cultural sites	• Loss of landscape aesthetic beauty • Stigmatization of victims • Strengthening of social relationships • Relief support from external donors • Opportunity to raise awareness

29 Specific attention was drawn to the impacts of LS on the livelihoods of the predominantly rural population of the Rwenzori Mountains. Here, losses of houses and land lead to population displacement, degradation of the living conditions and outbreak of disease. LS cause the direct loss of crops and animals, but also the loss of fertile soil and a decrease of land productivity. This can induce loss of work, income and a local shortage of food production. LS can also result in a decrease in land values and a destruction of parcel boundaries which can lead to land conflicts. The financial burden is not only carried by direct victims but also by friends and relatives providing relief. Blockage of the road network, affecting people and good mobility, is frequently experienced in the days following a LS, as well as the cutting of water pipes supplying larger settlements. Off-site LS impacts, especially related to high sediment loads in rivers, and downstream sediment deposition,, especially in irrigated lands, but also flash floods after a river has been temporary dammed by a LS, are also considered major problems.

30 Participants also pointed to less or non-tangible impacts such as psychological consequences and fear during the rainy seasons, the waste of time spent on damage

repair and house reconstruction, or the loss of sites with high ecological or cultural value. Locations affected by LS were perceived as non-aesthetic and people affected by them were sometimes stigmatized due to the cultural interpretation of LS events, i.e. LS being interpreted as the consequence of misbehaviour of the affected households. Those most affected are generally the most vulnerable inhabitants that were living on marginal lands, i.e. women, children and disabled. In Limbe, however, higher social class inhabitants also build large houses on the hills and were therefore also affected by LS.

31 LS events may also have some positive outcomes such as the strengthening of the family or community relationships as relatives are the main actors providing support to affected families. LS events also triggered financial or material help from external institutions, such as national or international NGO's. Finally, LS events are also seen as an opportunity to raise awareness about LS risk in general among the affected communities.

Landslide risk reduction strategies

32 The workshop's participants were introduced to the concepts of LS prevention, mitigation and adaptation measures. They were then asked to mention which strategies had already been implemented for reducing LS risks, what the problems in the implementation were and what potential alternative strategies they could think of.

33 In terms of prevention, engineering measures such as gabions, retaining walls or terracing had been implemented in a non-systematic way at local scale, by authorities or individuals, typically along main roads or around houses. The design and long-term maintenance of these structural measures was often sub-optimal.

34 Stakeholders identified land use and environmental plans as key prevention strategies. In order to reduce risks, the Ugandan government for example envisaged massive population displacement from the slopes of Mt Elgon to less steep regions of the country (e.g. Vlaeminck *et al.,* 2016). However, this plan faces major opposition from the local population and therefore the authorities are looking for alternative solutions (M. Kitutu, pers. comm.). In the cities of Bamenda and Limbe in Cameroon, stakeholders mentioned the existence of mapped risk zones, which could be used to prevent the construction of houses in LS-prone areas. However, it was difficult or impossible to get access to these maps and the methods by which they were produced was not known. Quarter heads highlighted that existing land use planning regulations were not enforced and that illegal construction still occurred in high LS risk areas (e.g. Diko, 2012). City stakeholders recognized that it was not part of the local culture to destroy illegally-constructed houses. Chiefs complained that no alternative land or housing was proposed to inhabitants that were forced to leave high risk zones, causing them to stay or to return later on when the hazard ebbs. Living in an illegal settlement was, however, used as an argument by the authorities not to provide support to LS-affected households.

35 In the environmental plans, the afforestation was emphasised as a key strategy to prevent LS. Tree planting or seedling distribution actions were implemented in the Rwenzori and the Limbe regions by several NGOs. Quarter heads in Limbe however mentioned a lack of involvement of the local population in the selection of tree species and implementation of the actions, which led to poor maintenance and the rapid decline of the plantations.

36 Educating the population about LS hazards was considered an important risk prevention strategy. This might induce a change in construction practices, such as the avoidance of

cutting into unstable slopes for house construction, but might also foster the recognition of precursory evidence of ground instability (e.g. crack development), which could be reported to the community leaders and trigger temporary evacuations.

37 Mitigating the impacts of LS was mostly interpreted by local stakeholders as action to enhance preparedness and effective rescue and recovery operations. This included the establishment of disaster management committees at the local to provincial (or district) scale. Although the policy frameworks of Cameroon and Uganda foresee the setting up of such committees, their effective role is questioned by the lack of means to implement risk reduction actions and provide significant support to LS victims. In case of a large disaster, these local committees would mostly serve as intermediaries in any call for assistance from national authorities. Financial and material support from outside the community, provided by the national government or non-governmental organizations, were often seen as the main strategies to relieve LS impacts.

38 Specific practical actions were also implemented at local level to mitigate LS impacts, such as community-scale management of catchments or the maintenance and restoration of wetlands and river banks, although most of these actions appear, mainly, to address the risk of flooding. Sensitization was already carried out at community level, using music or theatre plays as support to communicate about LS hazards and risk reduction strategies.

39 To help affected households to cope with LS impacts, workshops' participants highlighted the need to provide compensation for suffered damage. Although such financial compensation took place in several cases, the compensation was not always based on a systematic and fair identification of victims and assessment of damage. The lack of legal rights of the victims on the impacted land was used as an argument to refuse compensation. The alternative housing provided was often insufficient or not adapted to local needs.

40 In order to adapt to LS hazard in the region, stakeholders identified that it would be useful to promote the diversification of livelihoods in order to reduce the dependency of people on agricultural land. The establishment of roads and bridges in safe locations or with implemented slope-stabilizing measures would reduce the chance of LS impact on the transport network. Changing the construction technology could also reduce the occurrence of LS or reduce their impacts. Such actions were however not systematically promoted nor implemented due to the fact that LS impacts were not a political priority and due to a lack of financial means and technical expertise.

Discussion

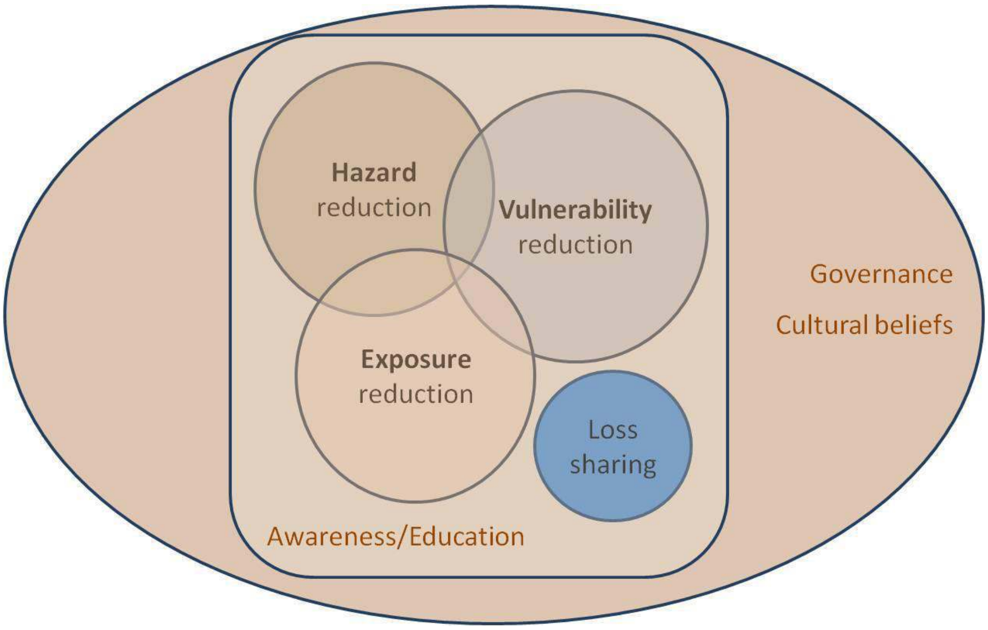
LS hazard, impacts and adaptation strategies

41 The workshops and field reconnaissance confirm that LS are more widespread in Equatorial Africa than generally thought, and specifically in the Rwenzori and the Limbe regions where Af*Re*Slide project focuses. LS are generally of small to moderate scale (<1 ha) but they have a high frequency. The perception of local stakeholders about LS origin agrees with the literature (Claessens *et al.*, 2007; Knapen *et al.*, 2006; Che *et al.*, 2011; Jacobs *et al.*, 2015; Crozier, 1986): they are mainly controlled at the local scale by an interplay of slope gradient, lithologies and human interventions.

42 In West Uganda and West Cameroon, the focus group workshops highlighted that stakeholders and the exposed population, have a high awareness of LS hazard and some understanding of the processes. This observation is in line with landslide research performed in other landslide-prone developing regions, e.g. Malaysia (Motoyama and Abdullah, 2013), St. Lucia (Anderson *et al.*, 2007) and Colombia (Hermelin and Bedoya, 2008). LS can have significant impacts, even if they do not lead to disasters with large numbers of casualties. Local stakeholders stress the long-term and indirect impacts of LS on the livelihood of local communities. This is in line with previous studies stressing the long-lasting consequences of risks in developing countries (Dercon, 2006). Beyond these descriptive accounts, there is a need to develop methodologies to assess quantitatively the total impacts, in order to value the impacts relative to investments required by adaptation strategies (e.g. Klose *et al.*, 2014; Vranken *et al.*, 2014; Glade and Crozier, 2005). To a certain extent quantitative assessment of disaster impacts have been attempted for other disasters, such as floods, in developing countries, but not for landslides (e.g. Arouri *et al.*, 2015).

43 The connection between the different strategies mentioned by the participants, led to the proposal of a new classification scheme of LS risk reduction strategies (Figure 4) which is adapted from Vaciago (2013). This indicates that risk reduction includes measures that can help reduce the probability of the hazard, the exposure of the elements at risk or the vulnerability of the affected people, but that some measures might actually contribute to several of these processes. Planting trees, for example, could reduce the hazard by stabilizing the slope (Petrone and Preti, 2013), but could also reduce LS runout distance (Vaciago, 2013), therefore reducing exposure, as well as provide a complementary and less vulnerable source of income to local inhabitants. Local leaders highlighted that any specific action should be supported by long-term awareness raising and education actions among the local population to gain community-support for the implemented measures. A policy framework that supports the implementation of these actions, and which is properly enforced, is essential for the large scale and long-term implementation of LS risk reduction strategies. The process leading to the implementation of LS risk reduction strategies is a complex one and is limited by cultural, knowledge, and financial aspects (see also Wisner *et al.*, 2004).

Figure 4. Classification scheme of different landslide risk reduction strategies.



Adapted from Vaciago *et al.*, 2013

44 Local stakeholders are generally aware of the main LS risk reduction strategies but struggle to implement them due to a lack of means, the lack of enforcement of land use plans and the high pressure on the land. So far, LS risk reduction strategies are mainly limited to poorly-coordinated rescue and recovery actions after LS events, although some actions are taken for afforestation, improvement of drainage and raising awareness. Financial compensation, alternative housing and post-event stabilization measures are implemented in a non-systematic manner, and access to this help is affected by large inequalities in political power and social status which is not uncommon in a disaster-prone Global South context (Collins, 2009). An analogy can be drawn between these observations and what has been observed on the implementation and adoption of measures for the prevention of soil erosion in developing countries (Blaikie, 1985).

45 Beyond the financial limitations, the need to raise the level of awareness among the local population extends to the training of local technical experts in the identification of efficient risk reduction strategies (Mechler, 2008). These are both necessary first steps, which are needed to gain local support and build local capacities to translate the current national policies and plans into effective measures. This activity needs to be supported by a proper evaluation of the impacts of LS and the cost-benefit evaluation of risk reduction measures, as LS are often only one of the many pressing issues within these communities.

46 As for any hazard (Krüger *et al.*, 2015), implementation of an effective LS risk reduction plan requires that the operator takes into account local livelihoods, the cultural representation of natural processes, land tenure and ownership, and the power relationships that control which persons are most badly affected by LS and who is capable of implementing LS mitigation measures.

Stakeholders' workshops to steer AfR*e*Slide project

47 Although the use of focus groups within social science research has been criticized due to its methodological limitations, they demonstrated their potential for interacting with a range of actors (Scott, 2011). Nevertheless, we acknowledge the fact that any research is a politicized process (Scott, 2011). Critical reflection on the different factors that influence discussions, like the positionalities of researcher and researched, is needed but strikingly lacking within the literature (Hopkins, 2007). We are aware of the fact that often stakeholders viewed the AfReSlide project as a potential funding source. It is therefore crucial to analyse the data bearing in mind this context.

48 The results of the 5 workshops illustrate the wealth of information that can be obtained through stakeholders' workshops and how it delivers essential information at an initial phase in a risk management policy-oriented research project such as AfR*e*Slide. Due to the limited available data and literature on LS risk management in Equatorial Africa, the design of such a project rely on fragmentary information available in scientific and grey literature, personal contacts with local scientists and field experiences. The workshops organized in the first year of the project enabled us to have much better insights into the type, spatial distribution and frequency of LS in the project study regions. In the Rwenzori, it contributed to the identification of three specific case study areas for which a detailed inventory of LS events and impacts is being conducted, allowing to constrain susceptibility, hazard and risk maps. In North West Cameroon, the workshop provided evidence that the Bamenda urban environment was not a priority target for research on LS risk and led to the re-orientation of the research to the nearby Bamboutos caldera, a rural area with intensive agricultural production, frequently hit by LS during the last 15 years.

49 In addition, the workshop enabled to identify the relevant stakeholders and the structures in place for risk management at the provincial to local level. The presentation of the project and the relationships established with the stakeholders during these workshops will facilitate further research aiming at evaluating the function and relationships between these different institutions and the efficiency of their action using social approaches such as focus groups. In Cameroon, the workshops evidenced that a risk zonation policy is already available and seemingly implemented at local level. This led to the definition of more specific research questions regarding the level of implementation of these land use policies and their implication for socially vulnerable populations.

50 The group discussions highlighted that LS risk cannot be studied as an independent issue for which a purely economically rational and technical solution can be found. LS risk is intimately connected to the relationship between the population, their land and their perception of hazardous events. This has led us to give more attention to the understanding of the environmental governance, the description of land rights, and the perception and management of LS risk by leaders and local communities (Krüger *et al.*, 2015).

51 Finally the workshops highlighted the high expectations of stakeholders from scientists and their eagerness to be provided quickly with both practical recommendations and also the financial and logistic support to implement them. AfR*e*Slide will aim at integrating the findings of the hazard, impact and risk reduction analyses into risk mapping and the identification of the most suitable risk reduction strategies. Through a multi-criteria

analysis based on cost-benefit and community ranking assessments of the potential risk reduction strategies, taking into account the cultural context, Af*Re*Slide ambitions to provide recommendations on the most effective strategies.

52 The challenge remains that obtaining reliable scientific results is a long-term process and, hence, communication with stakeholders will have to be sustained throughout the 4 year of the project using a range of channels (i.e. newsletters, website). In addition, the implementation of these recommendations will not be directly supported by financial means nor supervised by the Af*Re*Slide scientists. The findings of Af*Re*Slide will thus be summarized in a *Manual of Do's and Don'ts for Enhanced Landslide Resilience: Lessons learned from Failures and Successes* based on results from the several case study areas. This will ensure long-term and large scale impacts of the research results and could serve local policy makers to apply for financial support. Assessing the actual implementation and the effectiveness of these mitigation measures would be important directions for future inter-disciplinary research.

Conclusions

53 Cameroon and Uganda stand as examples for the steep, highly weathered zones of the wet tropics that face a high population pressure. People encroach on steep slopes and clear forest to get access to land for building their houses and generating a livelihood through agriculture. These anthropogenic factors greatly contribute to the occurrence of LS with devastating impacts on people and their livelihoods (Che *et al.*, 2011). Therefore, to arrive at a sustainable development of the area, one absolutely needs to minimize or avoid LS-related damage.

54 The local stakeholders that were involved in the initial workshops demand, urgently, the prescription of efficient strategies that would be acceptable for the local population, adapted to their livelihood and enabling a safer and sustainable development of the region. An effective LS hazard assessment system is required that accounts for not only the spatial and temporal distribution of future LS but also their intensity, that permits the quantitative estimation of the socio-economic consequences of LS and identifies effective risk reduction strategies, which are cost-effective, technically effective, culturally acceptable and adapted to the livelihoods of the vulnerable populations.

55 This article demonstrates that much essential information can be obtained from focus groups that involve a wide range of local stakeholders at an early stage in any LS assessment project. Focus group activity helps identify priority areas, establish the baseline of existing knowledge and existing systems for risk management and help grasp the complexity of actors and cause-and-impact relationships involved in LS risk reduction. Community involvement is essential from the start of any such project and must be maintained throughout the project to create the minimum conditions for empowerment of the research results and the will to implement the recommendations.

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ABSTRACTS

Landslides (LS) impacts are acute in Equatorial Africa, which is characterized by mountainous topography, intense rains, deep weathering profiles, high population density and high vulnerability. This study aims to move beyond the recognition of landslide occurrence and investigate effective risk reduction strategies. Based on 5 workshops with local stakeholders, we illustrate the widespread occurrence of LS on 4 representative study areas known for being severely affected by rainfall-triggered LS in Uganda (Mount Elgon, Mount Rwenzori) and Cameroon (Limbe and Bamenda urban regions). The findings highlight the good knowledge of local stakeholders on factors controlling the timing and spatial distribution of these events. Stakeholders identify a wide range of direct, but also far-reaching indirect and intangible cumulative impacts of LS. Finally, the project inventoried and categorized risk reduction strategies currently implemented in the targeted regions, as well as the factors identified by stakeholders as bottlenecks in the implementation of potential alternative strategies. The experience underlines the usefulness of involving stakeholders at an early stage in selecting study areas and defining specific research objectives.

En Afrique Équatoriale les glissements de terrain ont des conséquences très lourdes en raison de la topographie montagneuse, des pluies intenses et d'épais profils d'altération, ainsi que d'une densité de population élevée et d'une grande vulnérabilité. Cette étude a pour objet de dépasser la simple identification des occurrences des glissements de terrain et de rechercher des stratégies efficaces de réduction des risques. En nous basant sur 5 workshops organisés avec des acteurs locaux, nous montrons la fréquence générale des glissements de terrain sur 4 zones d'étude sévèrement impactées par les précipitations en Ouganda (Mount Elgon, Mount Rwenzori) et au Cameroun (zones urbaines de Limbe et Bamenda). Il ressort de nos résultats que les acteurs locaux ont une bonne connaissance des facteurs qui déterminent la distribution de ces évènements dans le temps et l'espace. Ils identifient toute une série d'impacts directs mais aussi d'impacts indirects intangibles d'une grande portée.

Enfin, le projet a inventorié et catégorisé les stratégies de réduction des risques habituellement mises en œuvre dans les régions touchées, ainsi que les facteurs identifiés par les acteurs comme des obstacles à la mise au point de stratégies alternatives. Cette expérience souligne l'utilité d'engager des acteurs locaux à un stade très précoce de la sélection des zones d'étude et de la définition d'objectifs de recherche spécifiques.

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Mots-clés: glissement de terrain, workshop, acteurs locaux, résilience, réduction des risques, Afrique Équatoriale
Keywords: landslide, workshops, stakeholders, risk reduction, Africa

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