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Full Length Research Paper

Community engagement in landslide risk assessment in Limbe, Southwest Cameroon

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This paper presents preliminary findings on community engagement in landslide risk assessment and inventory mapping in Limbe, Southwest Cameroon. Emphasis was placed on collection of disaster experiences, training and skills development of the locals in identifying and characterising landslides and landslide contributory factors. Despite a number of challenges ranging from lack of incentives, proper communication channels and workshops/seminars, the project recorded a number of successes. As project partners, community members developed an awareness and basic understanding of the landslide phenomenon and contributed towards updating the landslide inventory map of the area. Given these positive outcomes, a Community-Based Disaster Management Approach is considered a plausible solution towards effective mitigation and management of geohazards especially in developing countries.

Key words: Landslide risk assessment, community-based disaster management approach, capacity building, Cameroon.

INTRODUCTION

With recurrent extremities in weather and climatic regimes observed across the globe over the past decade, many nations are increasingly being plagued by natural hazards (Anbalagan, 1992; Barro, 2009; Gokceoglu and Ercanoglu 2002; Ercanoglu et al., 2004; Micheal-Leiba et al., 2003). For developing countries like Cameroon, which are less equipped technically and financially to handle natural hazards (Ngole et al., 2007) the effects are even greater on their economies and welfare of the citizens (Barro 2009). In most instances, hazard management is considered the sole prerogative of local governments, with communities/citizens mainly perceived as victims. In view of such perceptions McEntire et al. (2002) and Trim (2004) argued that hazard management as such needs to be placed within a holistic setting to ensure that each and every disaster is viewed as a shared responsibility.

Most disaster response can be characterised as command and control structure with more or less a top down approach (Pandey and Okazaki, 2006). Because of this, there is often a lack of community participation resulting in; failures in meeting the appropriate and vital humanitarian needs, unnecessary increase in requirement for external resources, and general dissatisfaction on overall performance (Pandey and Okazaki, 2006). Recognizing these limitations, the Community-Based Disaster Management Approach (CBDMA) promotes a bottom-up framework, in harmony with the top - down approach to address the challenges and difficulties of hazard management. For hazard management to be effective, local communities must be encouraged to analyse their hazardous conditions, vulnerabilities and capacities (Pandey and Okazaki, 2006). Against this background this paper reports on the role of the community in landslide risk assessment (LRA) and inventory mapping in Limbe, Southwest Cameroon. Given that this paper focuses on the role of the community, emphasis is placed on capacity building as opposed to quantitative estimates of the landslide risk.

Study area

Limbe with an estimated population of about 85,000 inhabitants (Bureau Central des Recensement et des

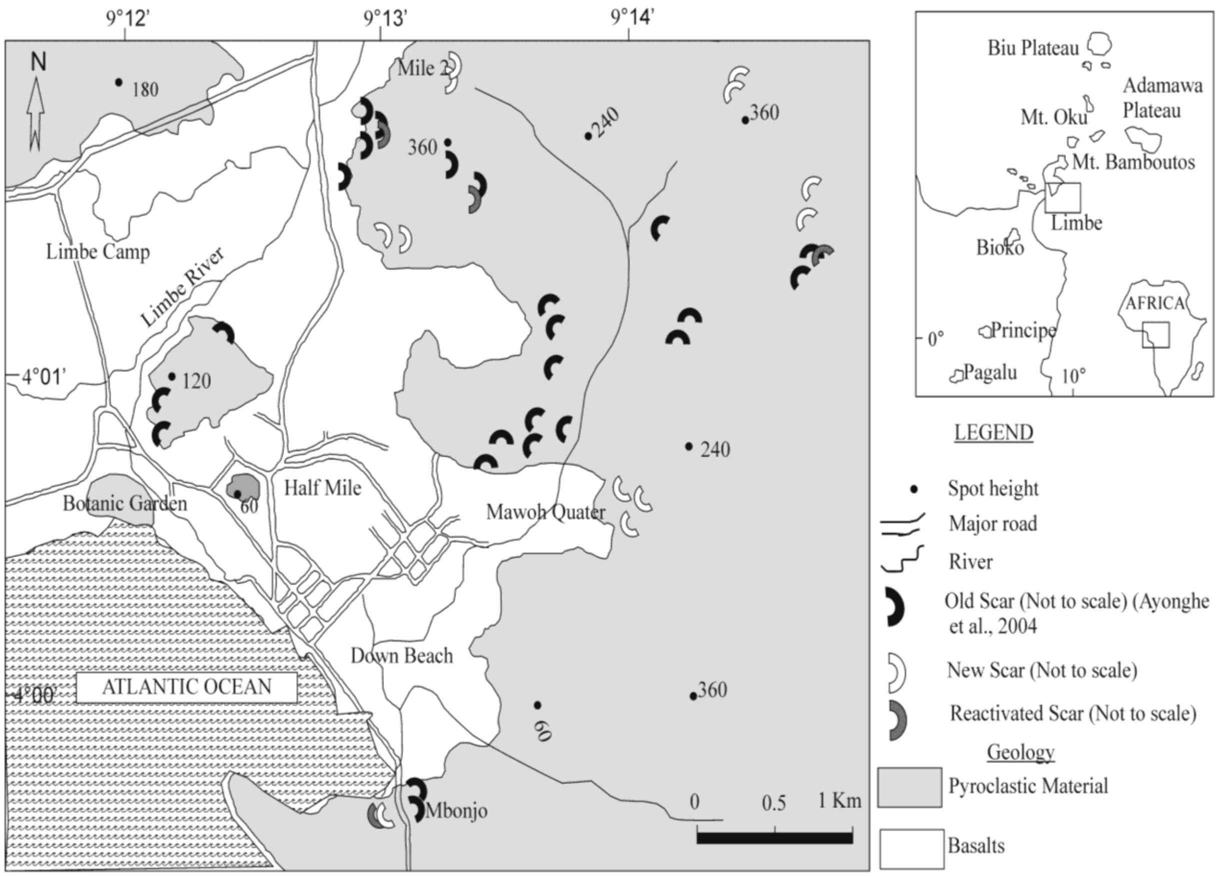

Figure. 1 Location of study area and updated landslide inventory map.

Etudes de Population 2010), is a coastal town situated on the SSE foot slopes of Mount Cameroon, a 4,100 m-high active volcano along the Cameroon Volcanic Line (CVL) (Figure 1). Most of the inhabitants are low income earners involved primarily in subsistence farming, hunting, fishing and petty trading.

Geomorphologically, the study area is made up of ridges and deeply incised ravines with a W–E orientation at high angle to the general NE–SW orientation of Mount Cameroon (Che et al., 2011). Elevations in the study area range from 0 m to about 1,200 m above sea level with slope gradients ranging from 0^o to 43^o (Che et al., 2011).

The foot slopes of Mount Cameroon are composed of multiple porphyritic basaltic lava flows, punctuated by several strombolian pyroclastic cones to the W and NW and lahar deposit to the E of the study area (Diko et al., 2011; Suh et al., 2003).These ridges form part of the Limbe-Mabeta Volcanic Massif, made up of degraded and deeply weathered tertiary basaltic lava flows (Diko et al., 2011; Suh et al., 2003). The main rock types within this area include basalts, basanites, lahar deposits, and pyroclastic materials (Che et al., 2011; Suh et al., 2003). These rocks either lie exposed at the surface or are covered by extremely fertile dark brown, reddish brown, yellowish and/or pale yellow sticky, clay, silt and silty clay soils derived from *in situ* intense weathering. Soil thicknesses ranges from a few centimetres to more than 10 m in some areas (Che et al., 2011).

The vegetation is mainly secondary tropical forest made up of deep rooted trees with heights ranging from 3 m to over 10 m. It is characterized by interrupted canopy, banana, rubber and palm plantations, as well as indigenous subsistence farms and fruit trees (mango, plum, and avocado). Only a small portion (5%) of the study area is covered by mangrove forest (Che et al., 2011).

The climate is tropical with mainly two distinct seasons; rainy season between April and September and a dry season from October to March. During the dry season daily temperature rises above 25^oC. Rainfall in the area varies from 2085 – 9086 mm with peak values obtained in the months of June and July (Ayonghe et al., 2004).

Background on Limbe landslides

Over the past two decades, Limbe has played host to a number of landslides (Table 1), resulting in loss of lives and significant damage to property (farmlands and

Table 1 Date of landslide occurrence, associated damage and slide characteristics in the Limbe area over the past decade.

Location name	Year of occurrence	Nature of damage				Casualty /injury	Slide type	Triggering mechanism /general observation
		Farmland	Building	Road block	Other			
Cassava Farm	27 June 01	X	–	–	*	–	T	Seismic and/or rainfall triggered (Ayonghe et al. 2004).
Chop Farm	27 June 01	–	–	X	*	–	T	Rainfall triggered (Ayonghe et al. 2004).
Mabeta	27 June 01	X	X	–	*	23 died	T	Seismic and/or rainfall triggered (Ayonghe et al. 2004; Che et al. 2011).
Makuka	27 June 01	X	X	–	*	–	T	Che et al. (2011)
Towe	27 June 01	X	X	–	*	–	T	Seismic and/or rainfall triggered (Ayonghe et al. 2004;
Mile 2	27 June 01	X	X	–	*	–	T	Seismic and/or rainfall triggered (Ayonghe et al. 2004).
Mawoh Quarter	27 June 01	X	X	–	*	–	T	Seismic and/or rainfall triggered (Ayonghe et al. 2004; Diko, 2006).
Mbonjo	2004	–	X	–	–	–	–	Che et al. (2011)
Mbonjo	26 Sept. 2005	X	–	X	–	–	R	Heavy rainfall (Diko 2006; Che et al. 2011).
Mbonjo	June 2008	X	–	–	–	–		Reactivation of 2005 scar following rainfall event (Che et al. 2011).
Unity Quarter	29 June 09	–	3 destroyed	–	Total cost; ~ € 3000	2 died, 1 injured	T	Rainfall triggered (Che et al. 2011).
Mile 1	29 June 09	X	–	–	–	–	T	Rainfall triggered (Che et al. 2011).
Kie Village	6 Aug. 09	X	X	X	Electricity supply interrupted	1 died	R	Rainfall triggered (Che et al. 2011).

(X) Damage noted but extent not reported; (–) not reported; (*) The 27 June 2001 landslide events occurred almost simultaneously resulting in 120 houses destroyed and 2800 people left homeless; (T) translational; (R) rotational.

Table 2. Factors and criteria for evaluation of landslide susceptibility.

Major category	Secondary factor	Criteria for evaluating secondary factor
Geology	Inherently weak layer	- Slide surface - Stratigraphic contact - Soil creep
	Structural control	- Fault - Incised valley - Tension crack
	Scar size	- Large - Small
	Hydrogeology	- Stream/slope toe interception
Topography	Gradient	- > 45 ^{o} - 30 – 45 ^{o} - < 30 ^{o}
	Relative relief	- High - Medium - Low
Anthropogenic Factor	Vegetation cover	-Secondary succession - Forest - Cultivated land
	Land-use	- Road cutting - Settlement - slope toe/ foundations

infrastructure) (Ayonghe et al., 2002; Ayonghe et al., 2004; Che et al., 2011). Although most of the landslides documented along the CVL are of hydrologic, seismic and tectonic origins (Ayonghe et al., 2002), those in Limbe have been triggered principally by heavy rainfall. Despite low-intensity earth tremors, lava flows and toxic ash falls (Suh et al., 2003), recurrent small-scale landslides have been the main cause of fatalities and destruction of local community livelihood. Despite their frequent occurrence and dramatic impact for local communities, very little systematic data on this geo-morphic process has been collected for the Limbe region (Che et al., 2011).

METHODS

The project involved two main phases; (1) establishing factors, weightings and criteria for evaluating landslide risk, and (2) community engagement characterised by orientation, collection of disaster experiences as well as training and skills development for identification of landslide contributory factors

Landslide triggering and contributory factors

Factors and criteria for assessing landslide susceptibility in the study area (Table 2) were determined based on a review and critical analysis of literature on landslides in Limbe and along the Cameroon Volcanic Line (Ayonghe et al., 2002; Ayonghe et al., 2004; Che et al., 2011; Ngolle et al., 2007; Suh et al., 2003). Such detailed review was vital for establishing and elaborating on landslide precursors in the area. Geology (inherently weak layers, structural controls, scar size and hydrogeology), topography (gradient and relative relief) and human impacts (vegetation cover and land-use) were considered contributory factors whereas rainfall and earthquakes were triggering mechanisms. An important aspect of capacity building centered on identification and characterization of these landslide contributory factors.

Community engagement

The participating community members were of three distinct age groups; 17 – 35 (55%), 36 – 55 (35%) and > 55 (10%). They were school drop-outs, farmers, hunters or involved in petty trading. Recruitment was based solely on degree of interest and enthusiasm displayed towards the project. Data collection was mainly through interviews with members of randomly selected households. The participants were engaged at three levels thus:

Orientation: This addressed the objectives of the project, its implementation and expected outcome.

Collection of disaster experience: Information on past landslide experiences were sought. Given that a number of landslide events in the past were not documented, this provided an opportunity to enrich the landslide data bank of Limbe. Questions on triggering mechanism (rainfall/earthquake), location and year of landslide occurrence as well as resultant damage and/or casualties were posed.

Training and skills development: Finally the participants were trained on how to identify and characterise landslides (with a focus on contributory factors as shown in Table 2). Where scars were at proximity to settlements, they served as training ground. Alternatively, picture/charts/monographs were used as didactic materials. The participants were then required to apply the skills and knowledge learnt.

RESULTS AND DISCUSSION

Limited technical resources (GIS/remote sensing laboratories) and/or skilled personnel are drawbacks to attempts aimed at assessing and mitigating geohazards not only in Limbe, but the country as a whole. At the time this study was undertaken formalities on establishing a remote sensing unit at the University of Buea (South West Region, Cameroon) were being finalised between the latter and the University of Ghent – Belgium through the VLIR – OUS; Flemish Interuniversity Council – University Development Cooperation).

The participating community members served princepally as informants. Through exchanging information, participants could understand information about the natural hazards in their community (e.g., frequency of occurrence, areas likely to be affected most, magnitude and intensity, spatial extent, duration and seasonal patterns) (Chen et al., 2006).

Given that their main activities were hunting and farming, they were able to report old and new scars far afield not previously documented. Significant updates were thus made on the landslide inventory map (Figure 1) proposed by Ayonghe et al. (2004). In addition, potential landslide contributory factors were reported to the researcher, who organized confirmatory visits to the said locations. Following their training and skills development, participants were able to identify physical processes as soil creep (evidenced by outward and upward growth of a coconut tree), stratigraphic contacts (characterised by development of a weathering front at a pyroclast – basalt interface), and anthropogenic activities such as burning of vegetation cover on slopes for agricultural purposes as landslide precursors (Figure 2).

On the whole, the participants developed a sense of involvement, awareness and gained basic knowledge on landslide as a geohazard. Their overall perceptions shifted from being considered as victims to key partners in hazard mitigation and management process. Despite these positive outcomes, there were a number of setbacks associated with the project:

1. Lack of incentives: Not all community members were willing to take part in the project. Incentives ranging from financial to material things (t-shirts, caps, hats, pens *etc*...) would have enhanced community involvement. For those who participated (especially youths), working with researchers from the university was the only incentive – it was more or less a social status amongst their peers.
2. Absence of workshops/seminars: No workshops or seminars were organized prior to or during the project. Although the door-to-door visits adopted for this study enabled the researcher to meet respondents in the comfort of their homes, interviews as well as training and skills development sessions were inconsistent. The fact that no platform was crated for all stakeholders to share experiences, apprehensions and suggestions for efficient hazard management, this was considered a drawback.
3. Lack of proper communication channels: communication was a major challenge. Most of the participants were low income earners (leaving on <1USD/day) and could not afford communication via cell phones. Weekly visit by the researcher to the respective communities were often fruitless (either the person who reported an observation was not available or there was no new information).

With regards to the above challenges the following recommendations are put forth:

1. Government should introduce the concept of Community-Based Disaster Management Personnel (CBDMP), in all potentially hazardous areas/ communities.
2. Furthermore, the Government in partnership with other stakeholders should provide project guidelines and didactic materials for educational and technical assistance of CBDMP.
3. Emphasis should be placed on frequent workshops/ seminars with hazard prone communities and relevant stakeholders.
4. Finally, the CBDMA should be adopted. A proposed model, modified after the one developed for Shan-An Village, Thailand (Chen et al. 2006) is presented on Figure 3.

Conclusion

This paper summarises findings on community engagement in landslide risk assessment and inventory mapping in Limbe, Southwest Cameroon. Emphasis was placed on training and skills development in identifying and characterising landslides and landslide contributory factors. Despite a number of challenges ranging from lack of incentives, proper communication channels and workshops/seminars, the project was successful. Community participation contributed significantly towards updating the landslide inventory map. As project partners, community members developed awareness and basic understanding of the landslide phenomenon plaguing their community. On the basis of the challenges and successes with the project, a CBDMA is considered a plausible solution towards effective mitigation and

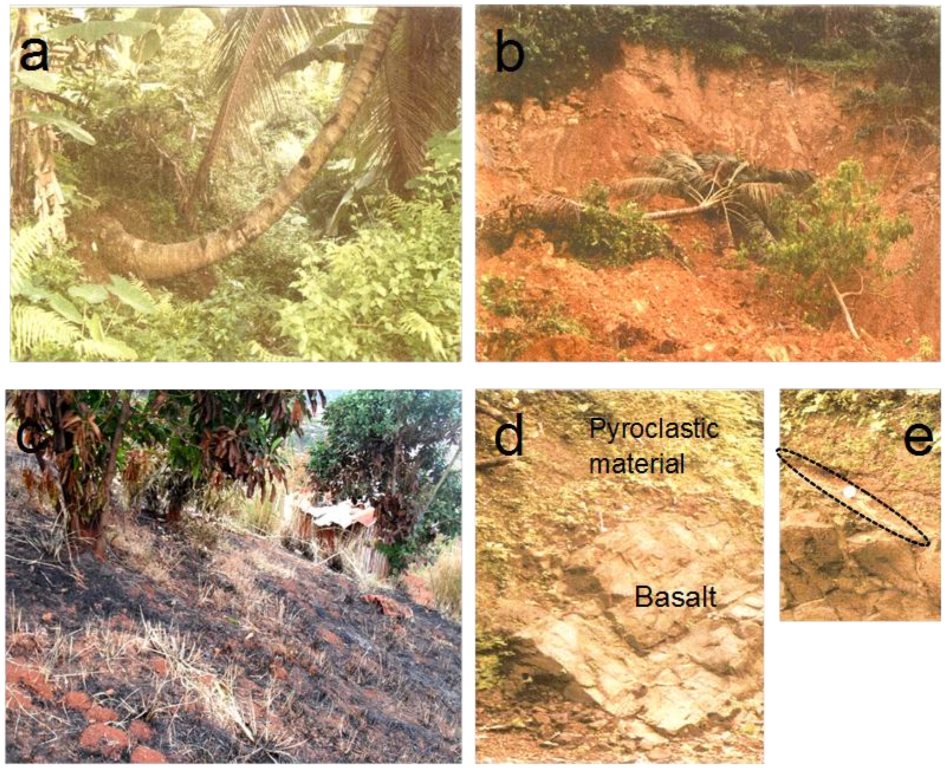

Figure 2. Pictorial representation of selected landslide contributory factors and scars. **a** Soil creep evidenced through outward and upward growth of coconut tree. **b** 2005 Mbonjo landslide scar. **c** Anthropogenic activity. **d** Stratigraphic contact on slope face. **e** A close-up of **d**, showing thin clayey layer developing at pyroclast-basalt interface.

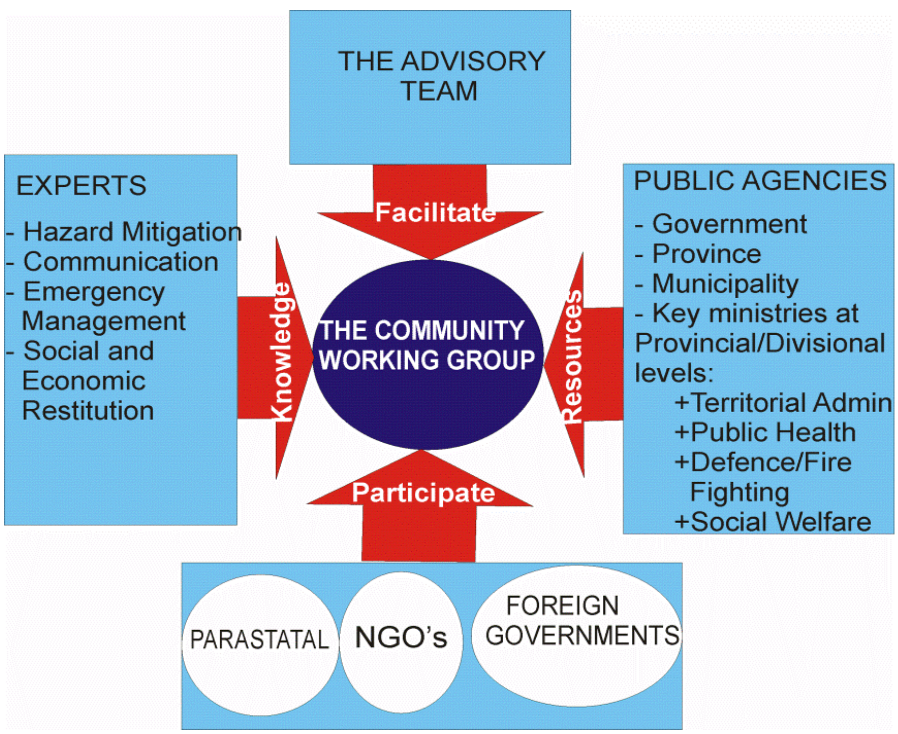

Figure 3. Schematic representation of Community-Based Disaster Management Approach.

management of geohazards especially in developing countries.

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