Resettlement preferences from landslide prone areas in the Bamboutos caldera: Willingness to move, reasons to stay

Highlights

Resettlement is a DRR strategy, but entails a threat for livelihoods

Resettlements preferences are heterogeneous

Poorer households prefer resettlement with extended family which provides safety net

Wealthy household attach more importance to improved road infrastructure

Individual preferences and group dynamics determine effective resettlement decision

Key words

Discrete choice experiment, mixed method, semi-structured interview, structured household survey, latent class model, mixed logit model, natural disasters

Abstract

Information about resettlement preferences is important for voluntary resettlement programs to be a successful disaster risk reduction strategy. This study combines semi-structured interviews and structured household surveys which includes a discrete choice experiment to elicit ex-ante resettlement preferences of households that live in landslide prone areas. We use a mixed logit model and latent class model to assess resettlement preferences and to investigate differences in preferences between socioeconomic groups. We find that, in general, people are willing to resettle away from a landslide prone area to a safer area and to an area that is accessible by roads. The willingness to resettle increases when additional arable land is provided, when the extended family can come along and when monetary compensation is offered. However, the relative importance of these attributes varies among socioeconomic groups. More wealthy households show a greater willingness to resettle and attach more importance to improved road infrastructure, while poorer respondents are less willing to resettle and attach more importance to whether their family can move along. Although the majority of households are willing to resettle, previous resettlement attempts were not always successful and individual willingness is not translated into actions. This can be attributed to the fact that little unused land is available in highly populated areas which may results in border disputes at the resettlement destination. In addition, resettling is costly and the effective monetary compensation received by resettlers is often low (and not in line with the government's promises). Finally, group dynamics also play a role: households mainly want to resettle along with their (extended) family. Hence, if there is no consensus among a large part of the community to resettle, the status quo remains.

Declaration conflict of interest: none

1. Introduction

Climate change and increasing population pressure in high risk areas are increasing the prevalence of natural disasters around the world (Artur and Hilhorst, 2014; Dai et al., 2002). One example of a natural disaster that is affected by climate change is landslides (Gariano and Guzzetti, 2016; Huggel et al., 2013; Reder et al., 2016). Climate change is predicted to modify raining patterns so that more rain will fall in shorter bursts of time (Cifrodelli et al., 2015; Huggel et al., 2013; Reder et al., 2016) and thereby it increase landslide frequency (Gariano et al., 2017; Komori et al., 2018; Rianna et al., 2014).

Landslides can have devastating effects on local communities. In African agricultural communities they have been found to reduce agricultural productivity, damage infrastructure and cause casualties (Froude and Petley, 2018; Mertens et al., 2016; Mugagga et al., 2012; Van Eynde et al., 2017). Besides the direct costs, associated with the damages and degradation of property and productive sources, there are also expenses required for measures which can mitigate the impact (Glade and Crozier, 2005; Maes et al., 2018).

If one treats risks as the outcome of the risk equation (Risk = hazard x vulnerability x elements at risk), strategies to reduce disaster risk can be subdivided into three categories (Crozier and Glade, 2005): the best way to reduce the risk is to eliminate the hazard, the risk can be diminished by avoiding exposure and measures can be taken to lower the vulnerability, thus mitigating the impact of the hazard (Artur and Hilhorst, 2014). In the case of landslides, although eliminating the hazard is not evident due to the widespread occurrence of unstable slopes, spatial planning and development of early-warning systems can reduce the elements at risk. However, spatial planning requires strict enforcement and monitoring which is often ineffective in areas with high population density, land shortages and/or weak institutions (Claessens et al., 2007; Knapen et al., 2006). Even if early warning systems combined with evacuations can save human lives, they cannot entirely eliminate the risk (Anderson et al., 2011).

Permanent resettlement is also considered as a strategy to reduce exposure (Anderson et al., 2011; Artur and Hilhorst, 2014; Churchill and Hutchinson, 1984; Claudianos, 2014; Correa et al., 2011; Vlaeminck et al., 2016). However, it comes with questions of feasibility and social acceptability. Resettlement might be expensive and require a lot of political will, since benefits in well-being and safety are unlikely to be realized within a political term (Artur and Hilhorst, 2014; Claudianos, 2014). In addition, moving or hosting communities might reject a resettlement program, even with financial compensation, as they might perceive that resettlement entails a greater threat for their livelihoods than landslides. (Kita, 2017). Research has shown that resettlement can lead to increased landlessness, joblessness, homelessness, food insecurity and other adverse effects (Cernea, 1997). Careful planning can reduce the chance that these adverse effects occur, but resettlement will continue to entail risks for the considered population. Consequently, due to the problems and limitations of resettlements, some authors consider resettlement a measure of last resort (Ferris, 2014; Kita, 2017).

In the past, resettlement strategies have failed because of inappropriate house design, insufficient infrastructure, ownership issues, cultural appropriateness and problems of affordability (Sridarran et al., 2018). It is therefore very important to know the preferences of the villagers. A successful resettlement strategy is one that is instigated by the resettlers themselves, yet governments might want to know what additional support is needed for a satisfactory resettlement. Earlier research in developing countries revealed that the willingness to accept a resettlement program rises with the amount of compensation, previous negative experience of the population with natural disasters, the attractiveness of the resettlement destination, the level of participation of the affected population in the design of the resettlement program and the size of land offered to the households (Arnall et al., 2013; Artur and Hilhorst, 2014; Churchill and Hutchinson, 1984; Correa et al., 2011; Vlaeminck et al., 2016; Yong Chen et al., 2017). Willingness to resettle might be higher in poorer households, who are more risk-averse due to higher downside risk (Dercon, 2002). Key determinants of satisfaction after resettlement are the level of consultation and the number of choices offered, rather than the income levels reached after the resettlement (Claudianos, 2014; Fujikura and Nakayama, 2012). Therefore, it is important to know preferences of farmers and take their desires and needs into account when designing and implementing resettlement programs.

This study uses a combination of semi-structured interviews and a structured household-survey with discrete choice experiment to elicit ex-ante resettlement preferences. Choice experiments offer a very practical tool to identify these preferences, yet it suffers from a hypothetical nature. This case is innovative in the sense that it combines semi-structured interviews, with a structured household survey and a choice experiment to identify resettlement preferences in a context where resettlement has already occurred, sometimes with failure and sometimes with success. Preferences for hypothetical resettlements are thus combined with insights regarding effective resettlements experiences. In past resettlement programs in the study region, the government offered financial compensation to resettlers, but the conditions and implementation differed across villages. As such this study can overcome some of the shortcomings of previous studies on hypothetical resettlements in the presence of landslides (Vlaeminck et al., 2016) and can carefully identify those conditions which make resettlement a suitable option, and those that do not.

We focused on the Bamboutos caldera, situated in the Cameroon Volcanic Line (CVL). This study area is pertinent, because (i) the CVL is frequently affected by landslides (Guedjeo et al., 2013) and (ii) several resettlement attempts have been observed in the Bamboutos caldera, presumably because of landslides. Contrary to previous research (Vlaeminck et al., 2016), we make no assumptions on what is causing the preference heterogeneity and allow the data to be divided using a latent class analysis. This way, important differences in preferences between different socio-economic groups of the targeted population are identified. With such information, governments can adapt resettlement programs to the needs of the affected population and a higher willingness to resettle can be achieved, increasing the chances of success of voluntary resettlement programs as a durable coping strategy for landslide risk.

2. Study area

The Bamboutos caldera is situated in the Wabane Sub-Division of Lebialem in the Southwest region of Cameroon (Figure 1). It is the most populated caldera of the CVL (Wouatong et al., 2014; Zangmo et al., 2011). This 13 by 8 km elliptically shaped volcanic crater is characterized by a high elevation gradient and dissected slopes. It reaches up to 2740 meters and is located more than 30 km from main urban centers and approximately 20 km from the nearest paved road (Gountie Dedzo et al., 2011; Ngoufo, 1992). Wabane is inhabited by approximately 62,000 inhabitants who can be divided into three ethnic groups: Mundani, M'mouck and Fulani (Wabane Council, 2012). Most of the population belongs to the Mundani clan who can be found throughout the caldera. The M'mouck people form a smaller group in the caldera who live predominantely in the southern part of the caldera. The Mundani and M'mouck are Christians and participate in farming activities. A third group is the Fulani or Fulbe. This ethnic group is Muslim, has a nomadic lifestyle and constitutes only a very small percentage of the population living in the caldera.

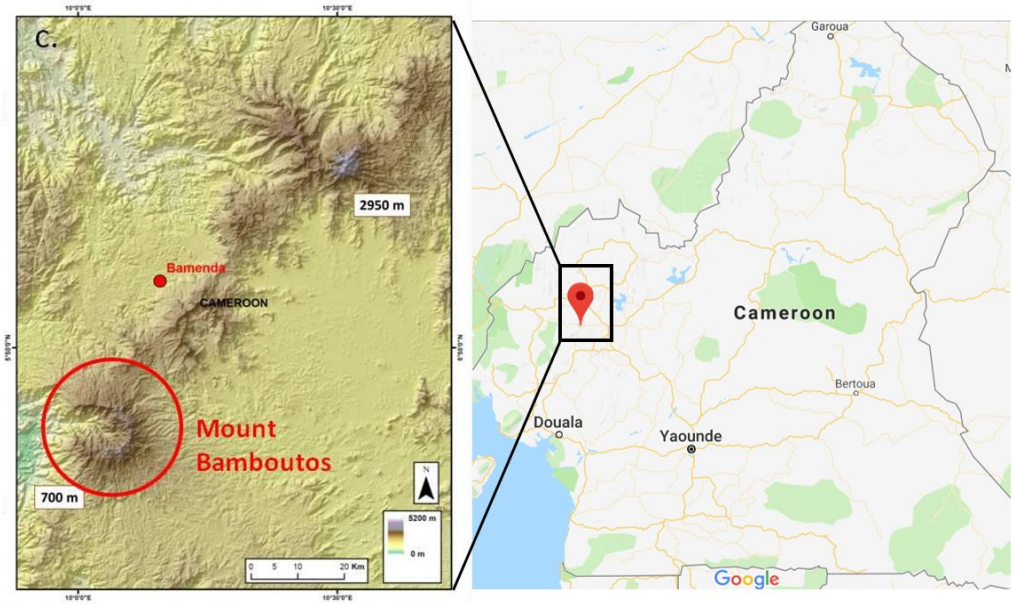

Figure 1: Location of Bamboutos caldera in Cameroon. Maps originate from (Kervyn et al., 2015) and google.com respectively.

The caldera is mainly covered by felsic rocks, which form fertile soils that are cultivated by smallholder farmers who produce high input-high value crops, such as potatoes (*Solanum tuberosum*), cabbages (*Brassica oleracea*), leeks (*Allium ampeloprasum*), carrots (*Daucus carota*) and maize (*Zea mays*) for the nearby cities of Baffousam, Bamenda and Dschang (Zangmo et al., 2011). Increasing population pressure has led people to settle on the steeper slopes (Guedjeo et al., 2013; Lambi and Ndenecho, 2010) which are frequently affected by both small and large landslides in the raining season (Wouatong et al., 2014; Zangmo et al., 2011), leaving the population exposed. Some villages in the Bamboutos caldera have already resettled or have attempted to do so, while others do not consider it a relevant option for now. The differences in resettlement preferences between households and villages are related to historical processes in the region, which makes the Bamboutos caldera an excellent region for the study of resettlement as a coping strategy.

A sample of 6 villages in the caldera was investigated. Atsualah was targeted because it had already undergone a resettlement. The other villages were randomly selected. The village-level characteristics, gathered during semi-structured interviews, are displayed in Table 1, the positioning in Figure 2. The road quality differs across villages, with Nkongle being the most accessible and Fomenji being the most isolated. The dominant agricultural system in the caldera is potato-based cash cropping. The exceptions are Fomenji and the parts of Magha situated at lower altitudes where food cropping based on cocoyam (*Colocasia esculenta*) and banana cultivars (*Musa*) is more prevalent. The population pressure (based on the availability of free parcels) is highest in Nkongle and lowest in Fomenji. The dominant language in the northern villages is Mundani, whereas it is M'mouck in the southern villages (Table 1, Figure 1). The 6 villages investigated have been affected by landslides, but some more severely than others. For example, villagers in Aghong have only seen their crops damaged, whilst inhabitants in Fomenji, Atsualah and Nkongle have experienced damage to houses. Only in Magha people have perished. 3 villages have undergone a resettlement throughout their recent history. Aghong resettled at an earlier stage in 1988, to improve their access to the road. Magha attempted a resettlement after the landslide event in 2003 but this resettlement failed and the population had to return to the original location. Atsualah successfully resettled after the landslides in 2003.

Table 1: Village-level characteristics.

Village	Fomenji	Magha	Atsualah	Aghong & Marita[b]	Nkongle[a]
Connectivity by road	Isolated, limited access by motorcycle	Access by motorcycle year-round, terrain vehicle in summer	Access by terrain vehicle	Access by terrain vehicle	Access by car
Dominant agricultural system	Food crops: cocoyam, banana, carrot, sugar cane	Gradient, potato-based cash cropping at higher altitudes, food cropping at lower altitudes	Potato based cash cropping	Potato based cash cropping	Potato based cash cropping
Population pressure	Low	Medium	Medium	Medium	High
Dominant language	Mundani	Mundani	Mundani	M'mouck	M'mouck
Affected by landslides	Houses damaged at multiple points in time	23 casualties in 2003	Major damage to houses in 2003	Minor damage to crops	Houses damaged at multiple points in time
Resettlement	No resettlement	Unsuccessful resettlement attempt in 2003	Successful resettlement from 2003 onwards	Resettlement in 1988, to gain access to road	No resettlement

a) The marketplace at Nkongle is where multiple communities meet. They are considered as one village, even if strictly speaking, they consist of multiple villages. b) Aghong and Marita are strictly speaking separate villages but were considered together for the purpose of readability.

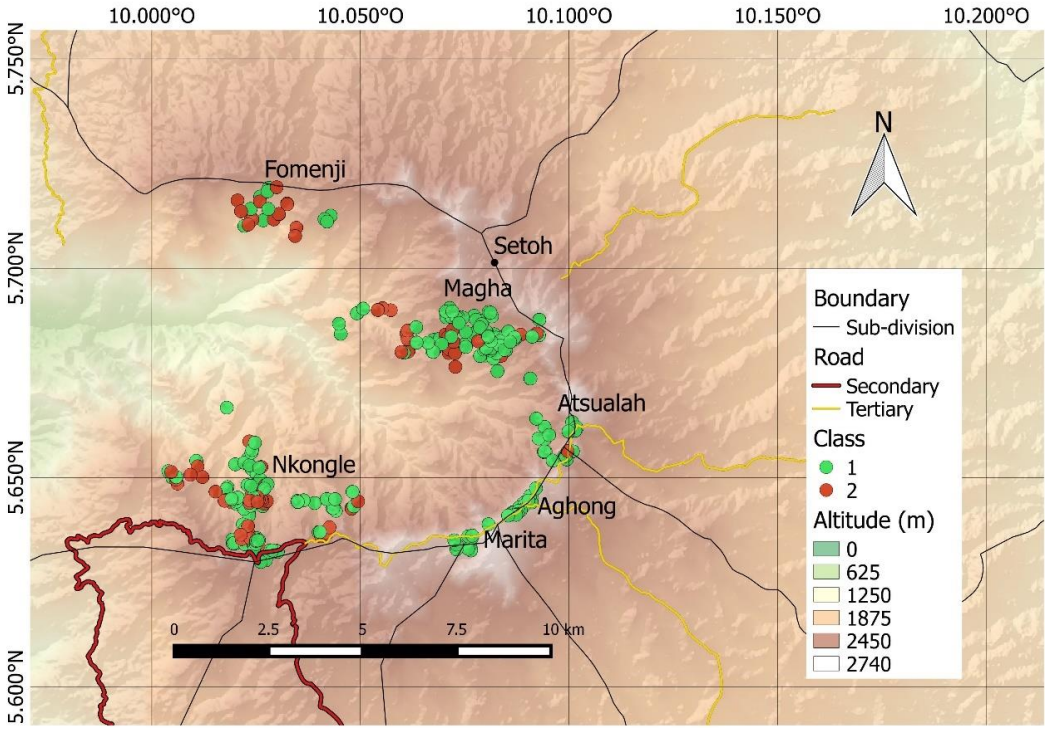

Figure 2: Map of the Bamboutos caldera. Each point corresponds to the location of an interviewed household. The two classes refer to the results of the latent class model presented in section 4.2. The isolated village of Fomenji is visible in the northwest. Setoh is located at the boundary of the sub-division. This map was made using openstreetmap.

3. Methodology

3.1 Semi-structured interview

26 semi-structured interviews were conducted: 7 focus group discussions with villagers and 19 interviews with village chiefs. Additionally, a discussion was held with the government administration and the paramount chief of the region (who is the traditional leader). Written communications between the traditional representatives (chiefs) and the Cameroonian government were investigated to verify the stories brought up during the half-open interviews. The interviews were used to give more information on the background of the region, villagers' perceived landslide risks, their attitudes towards resettlement, their previous experience with resettlement attempts and group dynamics regarding the decision to resettle.

3.2 Structured household survey and choice experiment

The quantitative research consisted of a face–to-face household survey, with a discrete choice experiment (DCE) embedded in it. A DCE is a quantitative technique for eliciting individual stated preferences (Mangham et al., 2009; Nguyen et al., 2015). It allows uncovering of how individuals value selected properties of a product, service or program by asking them to choose between hypothetical alternatives. These alternatives possess several features, called attributes. By eliciting choices, values are inferred for the different attributes and their levels. The method is based on random utility theory, which assumes that (i) every alternative comes with a certain amount of utility for the respondent, (ii) the utility of an alternative depends on its attribute levels and (iii) the probability of an alternative to be chosen depends on the relative utility it provides compared to the other alternatives (rational utility maximization principle) (de Bekker-Grob et al., 2012; Mangham et al., 2009; WHO, 2012). Because of these assumed properties, a DCE can be used to derive the amount of utility that attribute levels bring to the respondent and the extent to which respondents are willing to trade between attributes (Mangham et al., 2009). Based on these choices, preferences are estimated using the maximum likelihood models in logit models.

According to Hoyos (2010), the development of a DCE consists of 4 components: (i) definition of the attributes and the attribute levels, (ii) experimental design, (iii) questionnaire development and (iv) sampling strategy.

3.2.1 Attributes and attribute levels

A list of attributes was established containing the most important controlling factors for the success of a hypothetical resettlement programs and its associated resettlement locations (Table 2). This list was based on the literature (Mberu et al., 2013; Vlaeminck et al., 2016), expert opinion and field visits. The attribute levels were determined based on the feedback received from the enumerators and respondents during a test-run. The attribute *travel distance* is the one-way time required to walk from the old settlement to the new settlement. This is used as a proxy for cultural distance, which has been found to strongly influence willingness to resettle (Vlaeminck et al., 2016). *Family action* portrays the resettlement action taken by the neighboring friends and extended family, reflecting the social dimension of resettlement. Some resettlement programs come with *extra arable land* at the resettlement location. An important presumption is made that farmers can retain their old farming plots on top of the newly received plots, although they might be less accessible due to the increased walking distance. This way, they can still access the fertile soils inside the caldera during the dry season and stay away in periods of heavy rainfall. This assumption is realistic, since there are already some farmers who only come to the caldera in the dry season, when soils are wet relatively to other soils outside the caldera, chance of landslides is low and food prices are high.

The *absense of landslides* expresses whether there are life-threatening landslides at the resettlement location. This attribute was included into the choice experiment because we did not want to presume that a resettlement decision is only driven by fear of landslides. There might be other reasons why people want to resettle, such as improved road access. Consequently, the *road infrastructure* at the resettlement location was used as the fifth attribute. Lastly, a one-time financial *compensation* was included.

Table 2: Attributes and attribute levels. The attribute level perceived as least beneficial, was used as a reference category (RC) (indicated with 0). A higher preference is expected for the attribute levels with improved conditions.

Attribute	Attribute levels	Explanation
Travel distance	0. Four hours 1. Two hours 2. Half an hour	Walking distance between former house and resettlement location.
Family action	0. Does not resettle 1. Resettles to other location (far from where you go) 2. Resettles to the same location	Decision of neighboring, extended family and friends to move.
Extra arable land	0. Plot for house + no extra plots 1. Plot for house + 1 plot for cultivation (50x50m) 2. Plot for house + 2 plot for cultivation (50x50m)	Area of land offered at resettlement location.
Absence of landslides	0. Landslides at resettlement area 1. No landslides at resettlement area	House-threatening landslides at resettlement location.
Road infrastructure	0. Footpath: more than 30 minutes on foot to motorcycle road 1. All-year motorcycle road, but no car 2. All-year Hilux road	Road infrastructure at the resettlement location.
Compensation	0. None 1. 100 000 CFA 2. 500 000 CFA 3. 1 000 000 CFA 4. 2 000 000 CFA 5. 4 000 000 CFA	Monetary compensation offered to the household for resettling. 655 CFA = €1

3.2.2 Experimental design

A D-efficient design of 24 choice cards divided over 3 blocks was made using the Ngene software. Every choice set consisted of 2 alternatives and an opt-out (Figure 3Figure 2). Including an opt-out does not force a choice on the respondent if they would not choose any of the two options in real life, which would lead to inaccurate estimates of consumer welfare (Hanley et al., 2001; Hoyos, 2010). A drawback of including an opt-out option is that it reduces the information that is gathered and allows respondents to avoid making a hard decision, instead of maximizing utility (WHO, 2012).

The respondent received one block of 8 choice sets and had to consider 24 alternatives (8 * (2 alternatives + 1 opt-out)). By limiting the amount of alternatives that the respondent has to consider, it is avoided that boredom sets in (Hanson et al., 2005; Mangham et al., 2009). Attribute overlap and correlation between blocks and enumerators were avoided.

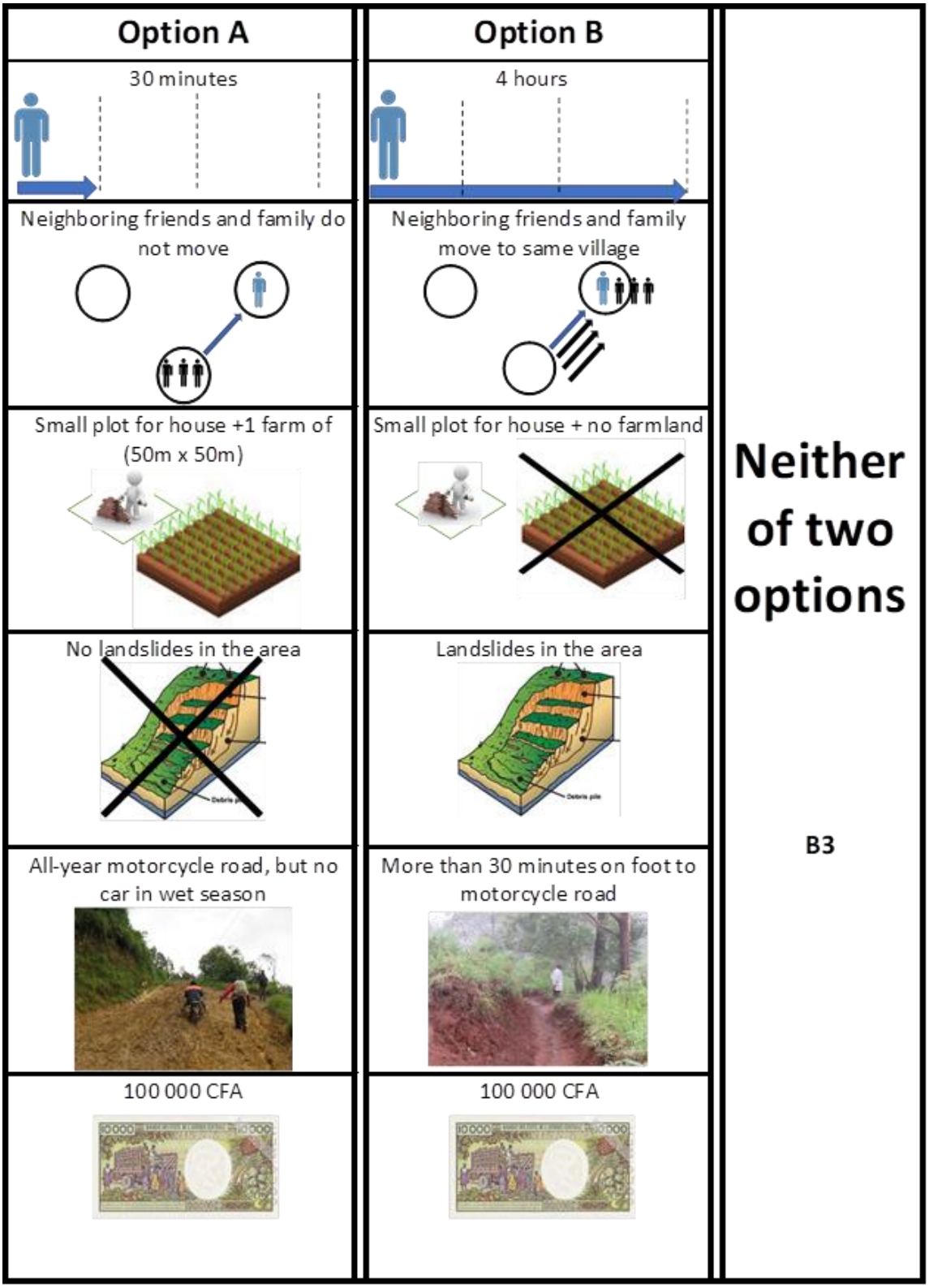

Figure 3: Example of a choice card used in the choice experiment.

3.2.3 Questionnaire development

The questionnaire aimed at identifying the household composition, socioeconomic group, landslide experience and motivations for their choices in the choice experiment. These motivations were used to cross-check the results for attribute non-attendance.

3.2.4 Sampling strategy

During the period of August-October 2017, 350 household heads were interviewed. Two-stage cluster sampling was used. In a first stage, a simple random sample of villages was selected (apart from Atsualah, which was targeted) and then a simple random sample was selected from the units in each sampled cluster. A clustered sample is used because it was not feasible to include all villages into the sample due to logistical limitations. Clustering the observations in 6 villages made the fieldwork more practical. Within these villages, subsamples were randomly selected from lists created by the village heads of the respective villages or from existing microcredit lists. The number of respondents in each subsample was proportional to the number of households in each village.

3.3 Econometric models

For the econometric analysis of the DCE, two logit models were used: the mixed logit model (MXL) and the latent class model (LCM). For the effect of the attribute levels, dummy coding was used, since it facilitates interpretation of preferences. Consequently, it is expected that for dummy coding, all coefficients are positive. The attribute of compensation is numerical and was not coded. For the interpretation of the alternative specific constant (ASC), separate effects-type coded regressions were performed. This is required, because in the dummy coded regression, the utility of the ASC cannot be separated from the utility associated with the attribute levels that are coded as the reference category (Bech and Gyrd-Hansen, 2005), leading to incorrect interpretation.

3.3.1 Mixed logit model

The MXL allows for heterogeneous taste variation, meaning that the model allows for different individuals to have differing preferences. It does this by estimating an average preference for every attribute and a standard deviation of how individuals' preferences vary around this population average (according to a distribution predefined by the researcher). A high standard deviation of a parameter's effect indicates high heterogeneity of the preference for the associated attribute level (Birol et al., 2006; Ryan et al., 2008).

The utility U_{ij} for an individual i associated with scenario j is displayed as $U_{ij} = (\beta + \gamma_i)x_{ij} + \varepsilon_{ij}$, where x_{ij} is the vector containing the observed characteristics of individual i and the observed attribute levels of alternative j, β is the vector containing the coefficients associated with the utility effect for the different characteristics and attribute levels, γ_i is the vector containing the personalized standard deviations of individual i from the mean effect β and ε_{ij} is the stochastic error term (Birol et al., 2006; Cascetta, 2009; Hoyos, 2010).

3.3.2 Latent class model

The LCM presumes that the population can be divided into a finite number of groups so that within groups, preferences of individuals are homogeneous, but between groups preferences of individuals are heterogeneous. However, the variable that defines these groups is unknown (Magidson and Vermunt, 2002; Ryan et al., 2008). The LCM allows estimation of these groups, also called classes or segments. Individuals are assigned to the class with the highest membership probability based on their estimated preferences. Preferences are then estimated per class. After individuals are assigned to classes, the preferences of the classes can be linked to the socioeconomic characteristics that were registered in the household survey. This way, it is possible to get a view on what descriptive characteristics correlate with different classes and what are the differences in preferences between these classes (Ryan et al., 2008).

4. Results

4.1 Background of investigated villages

Experiences with landslides and resettlement vary across the villages in the caldera. The qualitative interviews learnt that internal and external processes impact resettlement preferences. Therefore, the past events in the sample villages are first discussed past events in the sample villages.

4.1.1 Fomenji: no resettlement experience, isolated, low population pressure

In Fomenji, clear signs of recent landslides, at less than 10 meters from property, were observed. When interviewed about this topic, the villagers explained that they were aware of the problem. However, the chief argued that they will only resettle when the situation becomes worse, explaining that since there is still ample space available, individuals can be resettled to a plot nearby when needed. If that would no longer be possible, the chief would consider moving the village to the plains just outside the caldera. Although this attitude seems justified, subsequent villages will prove that this strategy comes with obstacles.

4.1.2 Magha: unsuccessful resettlement attempt, accessible, medium population pressure

According to current responses, no one in Magha was considering resettlement before 2003. Minor landslides had occurred before, but never had a landslide caused significant damage, let alone taken a life. That changed on the 20th of July 2003, when a major landslide occurred close to the center of Magha and 23 people perished beneath the rubble (Morikang, 2003). The disaster sparked action from the community, which decided to move up the caldera ridge to a flat area covered in grasslands called "Setoh". A commission was sent by the government to visit the place of the disaster. During this visit, the resettlement location was inspected and deemed appropriate. Additionally, the commission made the pledge to provide every affected household a sum of 400 000 CFA (€600). Furthermore, the government promised to provide public infrastructure on the location of the new settlement. Following these events, houses were built, and the government constructed a medical center at Setoh.

However, Setoh is situated at the border between two tribes: the Magha people and the Pinyin people. Despite the land being mostly unused, the resettlement attempt of the Magha people was perceived as an encroachment on the land of the Pinyin. Hereafter, conflict ensued, and the Pinyin people chased the Magha settlers off the terrain. These actions were accompanied by violence: reports speak of destruction of property, physical beatings and minor bloodshed (Follah, 2006). No further actions were taken by authorities to further enforce the resettlement plan (Ketu, 2015).

Currently, the Magha people are living on the same location as where the landslide struck them in 2003. They are still waiting for a sign of the government. Nothing remains of the settlement of Setoh, not even the medical center. There is no active conflict between the two tribes, but the relations remain tense. A nobleman from the Pinyin described the situation as follows: *"I eat with them with a long spoon."*

Of the 400 000 CFA promised by the commission in 2003, the affected households only saw 40 000 CFA. Allegedly, the remaining amount was lost due to venation. The department of the organization of territory stated that they are not actively dealing with the land dispute around Magha.

4.1.3 Atsualah: successful resettlement in 2003, accessible, medium population pressure

After being minorly affected by the landslide event of July 2003, the chief of Atsualah advised villagers with damaged houses to resettle out of the caldera, next to the road. However, the land on top of the caldera ridge was already inhabited by neighboring tribes. Therefore, plots had to be bought. Yet the topic of transferring land from one tribe to another is sensitive. Consequently, the price of the land was high. For a plot of one hectare, the price ranged from 0.5 to 1.5 million CFA (770 to 2300 euro). Due to liquidity constraints, most houses in upper (new) Atsualah are built out of wood instead of mud bricks.

According to the group discussion, not everyone that resettled did so because of landslides. Some moved because they wanted to stay close to their communities (which had already resettled), whilst others argued that they liked being closer to the road. Not everyone moved at the same time: some

individuals have moved only eleven years after the landslide event. Specifically, two widows had postponed resettlement due to financial constraints: "*Those women needed more time to amass the means to come up, because they have to pay for it on their own."*

Also, it is important to stress that until today not everyone has moved. Based on the microcredit list, we estimate that approximately one out of four households is still living in the original settlement. This is either because they do not feel that the landslide threat outweighs the hassle of resettlement or because they could not finance it. The chief of the village has not moved, stating he felt safe at his old location. However, the focus groups argued that he does not want to leave his palace, which is linked to his status.

Shortly after the start of the resettlement, the government came to Atsualah and gave a limited amount of financial support (20 000 CFA per household). According to the inhabitants, the government officials had promised that corrugated aluminum sheets for roofs and more financial support was to come. On August 2017, no such aid was provided.

4.1.4 Aghong & Marita: successful resettlement in 1988, accessible, medium population pressure

The village of Aghong moved in 1988, before the major landslides occurred, to have improved access to the road. At the time of their resettlement, the land at the resettlement destination was not claimed by any other chief. Therefore, no tribute had to be paid for acquiring the land. However, in 2004 a problem arose. The lands had originally been bought by a forestry company. When this company left the grounds unused, it returned under the control of the central government, where the ministry of forestry designated the land as a protected ecological zone. Consequently, since the villagers had encroached on a protected ecological zone, they received an eviction notice in March 2009. The chief went to court and in 2011 an agreement between the parties was achieved (KFA, 2011). The villagers were allowed to stay. The management plan for the ecological zone was adapted and it now considers the developmental needs of the local population.

4.1.5 Nkongle: no resettlement experience, accessible, high population pressure

The respondents in Nkongle saw an increasing trend of people building on increasingly unstable land due to increasing population pressure: *"There are no plots left, but the dangerous ones. […] Our only alternative is to move to the city."* Resettlement to a higher location is not possible, because the edge of the caldera is already inhabited. Resettlement deeper in the caldera, to areas with lower population density, is unpopular, because residents in the lower situated quarters speak Mundani, whereas the predominant language on top of this side of the caldera edge is M'mouck. Additionally, the village head stated that resettlement would mean that they would have to leave behind the "holy forest", associated with the culture and tradition of their tribe. This leaves the adolescents in these villages with little perspectives and possibilities. Either they build on an unsafe location, or they sell their assets and move to a major city.

4.2 Econometric analysis

The average age of the household head in the sample was 42 years. 87% of the household heads in our sample were male. About two thirds of the sample were of Mundani ethnicity and one third was M'mouck. The average degree of schooling in the sample was 6.98 years, which aligns with the standard schooling trajectory in Cameroon. 59% of households stated to possess a motorized vehicle. On average, a household had an estimated 4.17 hectares of agricultural land and a total estimated yearly income of 3.11 million CFA (€4600).

4.2.1 Mixed logit

The results of the mixed logit model are shown in Table 3. Aside from the walking distance and "Family moves to other location" all the coefficients are positive and statistically significant. This confirms that the respondents show the same attribute level-preferences as hypothesized. This is important, because the design of the experiment was based on pre-defined assumed preferences for certain attribute levels.

It also supports the idea that the respondents interpret the attribute levels in a similar fashion as we do, which is not self-evident, as local customs could have led to a difference of interpretation of the proposed attribute levels.

Respondents show a preference for resettlement programs where their neighboring family moves along. There is an inclination towards alternatives that provide additional farmland, the more the better, that offer financial compensation, that are free from landslides and have access to improved road infrastructure, especially paved roads. The effects-coded MXL[1] has a statistically significant positive coefficient for "resettlement", indicating that there is a preference for resettling compared to staying in the original location irrespective of the attribute levels.

Aside from "Compensation" and the ASC, all parameters were treated as random parameters. The random parameters are assumed to be normally distributed. Preference heterogeneity was statistically significant on the 1% level for all attributes but arable land. This shows that there is diversity in preferences within the sample. The result that the preference for receiving additional arable land is not heterogeneous indicates that land is of comparable value among different socioeconomic groups.

Table 3: Mixed logit model of the Wabane choice experiment. N = 345 (5 excluded due to incomplete).

Attribute	MXL			
	Coefficient		St. Dev	
Travel distance (walking)				
2 hours [a]	-0.036		0.209	
	(0.101)		(0.244)	
30 minutes [a]	0.148		0.498	***
	(0.098)		(0.145)	
Family action				
Family moves to other location [b]	0.114		1.438	***
	(0.142)		(0.149)	
Family moves along [b]	1.608	***	0.739	***
	(0.120)		(0.134)	
Extra arable land				
1 plot of (50m x 50m) arable land [c]	0.681	***	0.228	*
	(0.102)		(0.131)	
2 plots of (50m x 50m) arable land [c]	1.013	***	0.272	
	(0.103)		(0.258)	
Road infrastructure				
Dirt road [d]	0.317	***	0.656	***
	(0.103)		(0.115)	
Paved road [d]	0.960	***	1.152	***
	(0.117)		(0.147)	
Absence of landslides	1.942	***	1.816	***
	(0.124)		(0.131)	
Compensation (CFA) [e]	0.140	***		
	(0.050)			
Resettlement (ASC) [f]	-1.626	***		
	(0.161)			

Note: ***, **, * ==> Significant at 1%, 5%, 10% level. All categorical variables were dummy coded. a) RC = travel distance 4 hours; b) RC = Family does not move; c) RC = no extra plots of arable land; d) RC = footpath: more than 30 minutes on foot to dirt road; e) coded as * 1 000 000 CFA; f) 1 = Resettlement is chosen, 0 = Opt-out is chosen.

[1] The effects-type coded mixed model resulted in an ASC with a coefficient of 0.530, se (0.083), which was statistically significant at the 1% level.

4.2.2 Latent class Model

The LCM was used to identify the socioeconomic groups that explain this preference heterogeneity. The optimal number of classes was determined by using the NLOGIT software. The variance matrix fails to converge for three classes, meaning that the results for all higher numbers of classes are unreliable (Greene, 2018). Therefore, two latent classes were used for the analysis. Approximately 71,2% of the observations were assigned to class one and 28,8% to class two.

The estimates of the LCM are shown in Table 4. The parameter estimates show differences between the two classes on three aspects. Firstly, the positive coefficient for resettlement for class 1 indicates that the respondents in class 1 show a preference to resettle. Conversely, the negative coefficient for resettlement for class 2 indicates members of class 2 prefer not to resettle. This trend remains in the effects-type coded LCM[2]. Secondly, individuals in class 2 do not value the possibility where their family and friends can relocate to another village, whereas class 1 shows a significant preference for this attribute level over the reference category where the family does not relocate at all. Thirdly, class 1 shows a clearer preference for improved road infrastructure compared to class 2. The attribute levels of travel distance but also of monetary compensation were insignificant.

Travel distance is not significant in any of the produced models. It appears less important in the light of a resettlement decision when compared against the other attributes. At first sight, this might seem to contradict the literature, which finds that the culture at the resettlement location (which is proxied by the attribute “travel distance”) is one of the most important factors that people consider, since people might associate travel distance with cultural distance (Vlaeminck et al., 2016). However, it is also possible that the range of travel distances was insufficiently large to evoke a change in behavior. 4 hours of walking is long but not uncommon in these areas and might not be associated with impracticalities or large cultural differences.

While the offered amount of compensation seem rather high (up to 4 million CFA, equivalent to more than the yearly average household income of the sample), there was no significant effect of compensation found in the LCM (Table 4). This could mean that there is no strong preference towards compensation, yet the MXL did find a significant effect (Table 3). This means that there might exist significant differences in compensation preferences within the latent classes, leading to high standard errors and insignificant estimates. The MXL is more robust and can estimate these homogenous preferences without partitioning the observations in classes.

There might be an underlying cause to this unexpected observation. The compensation levels might be interpreted differently by the respondents. According the qualitative interviews, households in Magha received during previous resettlement attempt only 10% of the promised sum of 400 000 CFA. Because of this bad experience, some villagers might have developed a distrust in promises of financial compensation and consider them vain, or they might consider the potential embezzlement and calculate an adapted, expected compensation. This expected compensation is then a fraction of the proposed compensation. If they take this expected compensation into account when stating preferences, then the choice experiment has measured responses to “promised” levels of compensation rather than actual levels of compensation.

[2] The effects-type coded latent class model resulted in an ASC with a coefficient of 3.139, se (0.271), for class 1 and -0.9461, se (0142), for class 2; both significant at the 1% level.

Table 4: Latent class model of the Wabane choice experiment. N = 344 (5 excluded due to incomplete, 1 dropped by NLOGIT).

Attribute	Latent class 1 Class probability = 71.2%*** Coefficient		Latent class 2 Class probability = 28.8%*** Coefficient	
Travel distance (walking)				
2 hours	-0.033 (0.087)		0.048 (0.179)	
30 minutes	0.093 (0.083)		0.193 (0.171)	
Family action				
Moves to other location	0.308 (0.083)	***	-0.204 (0.214)	
Moves along	0.653 (0.090)	***	2.102 (0.190)	***
Extra arable land				
1 plot	0.330 (0.086)	***	0.776 (0.193)	***
2 plots	0.548 (0.087)	***	1.182 (0.195)	***
Road infrastructure				
Dirt road	0.327 (0.082)	***	0.155 (0.175)	
Paved road	0.886 (0.096)	***	0.343 (0.180)	*
Absence of landslides	1.397 (0.070)	***	1.196 (0.161)	***
Compensation (CFA)	-0.082 (0.088)		0.110 (0.068)	
Resettlement (ASC)	1.403 0.288	***	-3.076 0.293	***

Note: ***, **, * ==> Significant at 1%, 5%, 10% level. All categorical variables were dummy coded.

To compare the differences in preferences between the two classes, attribute importance is calculated (Lizin et al., 2012). It is a measure of the relative importance of each attribute to the overall utility of the respondent (Table 5).

The general model indicates that respondents attach most importance to the absence of landslides and the resettlement actions of their extended family. Additionally, attention is given to the amount of land received and the road infrastructure at the resettlement location. Monetary compensation and travel distance are relatively unimportant. However, when these results are considered for the two separate classes, there is a clear distinction in preferences. Members of class 1 show a greater preference for the absence of landslides and improved road infrastructure at the resettlement location, while members of class 2 have their focus on the actions of their family and the extra arable land provided.

Table 5: Relative attribute importance for the mixed model and for the two separate classes.

	Mixed model n = 344	Latent class 1 n = 245	Latent class 2 n = 99
Travel distance	2%	2%	2%
Family action	20%	12%	26%
Arable land	13%	10%	14%
Road infrastructure	12%	17%	4%
Absence of landslides	25%	26%	14%
Monetary compensation	7%	6%	5%
Resettlement (ASC)	21%	26%	35%

When considering the geographical distribution of the two classes, it is seen that class 1 is overrepresented in the villages of Aghong, Atsualah and Marita (bottom right Figure 2, statistically significant at the 1% level), whilst it is underrepresented in Fomenji (top right in Figure 2, significant at the 1% level).

When comparing the household characteristics of the two classes (Table 6), the results show that members of class 1 generally have more arable land, a higher income (both agricultural income and non-agricultural) and are more likely to possess a motorcycle (Table 6). This could be linked to their higher preference for paved roads: respondents who possess a motorcycle might have more benefits from paved roads or might be more familiar with the benefits that these roads can bring (e.g. market access). This knowledge of the benefits of road access might also be caused by the proximity of the road in the original settlement, which is also higher for class 1 (Figure 2).

Respondents with a larger acreage (class 1) tend to attach less importance to extra land compared to respondents with a smaller acreage (class 2) (Table 5). We argue that the extra land can lead to a greater relative improvement of the wellbeing of the members of class 2, who have less farmland and are more dependent on agricultural income (Table 6) which can explain why they have a higher appreciation for additional farmland.

Half of respondents in class 1 state that they have lost the life of a family member or a part of their house due to landslides. In group 2, this is only 14% of respondents. Similarly, respondents in class 1 are more likely to have known someone who died in a landslide than respondents in class 2 (88% vs 56%) and are more likely to have moved the location of their house in the past due to a landslide. This can explain why they attribute greater importance to resettlement locations that are safe from landslides and why they are more willing to resettle (Table 4Table 5). This observation seems to contradict earlier research, where wealthier individuals were found to be less affected by landslides (Vlaeminck et al., 2016). However, we believe that this is caused by a spatial effect. Members of class 2, who are less wealthy, tend to live in more remote areas, where they are isolated from markets (causing a focus on food crops; cfr. Table 1; and consequently, a lower income), where population density is lower and where people have ample choice for the location of their house, allowing them to pick a safer location. As such their willingness to resettle is lower. An additional explanation is that with more land (class1) and equal exposure, it is statistically more likely that part of their land is affected by landslides.

Alternatively, it is argued that poorer households are more risk averse (Dercon, 2002). Considering that a resettlement attempt is a costly and risky undertaking, it can be hypothesized that the poorer households consider the resettlement risk higher than the landslide risk. Conversely, wealthier households are more likely to take the risk of resettlement, because they have better mechanisms to cope with the downside risks of resettlement (Dercon, 2002).

The LCM illustrates that the respondents of class 1 prefer that their family is moved to safe location, irrespective of whether this is at the same location as themselves or not (Table 4). This was confirmed by the findings of the focus group discussions: *"I can not run away from the landslides and leave my*

family in this place." If this feeling prevails, then resettlement of the family to another location is still an acceptable alternative. Meanwhile, individuals of class 2 have a strong preference for a resettlement when their neighboring family can move along with them to the new location. Since these households are poorer, they probably rely more on their family network as a safety net. The relocation of your family to a separate location can disconnect you from your social network and the associated support (Barcus and Werner, 2017; Morse and Mudgett, 2018; Mulder and Malmberg, 2014).

Respondents were also asked which attribute they considered most important for making the choices in the DCE. Respondents in class 1 indicated absence of landslides and improved roads to be the most important factors, whereas individuals in class 2 stated that the action of their family was most important to them. This is consistent with the preference estimates for the classes in the LCM, showing active engagements of respondents in the choice experiments. (Table 4, Table 5, Table 6).

Table 6: Household characteristics for the full sample and for the separate classes.

Characteristics	Full sample Mean	Latent class 1 Mean	Latent class 2 Mean	Significance difference between two classes
General characteristics				
Age of the HH head	42.04	41.66	43.05	
% male HH head	87%	89%	80%	**
Mundani ethnicity	65%	64%	68%	
M'mouck ethnicity	35%	36%	32%	
Years of education	6.98	7.01	6.9	
Foreign observer present	18%	20%	14%	*
Welfare characteristics				
Possession motorcycle	59%	66%	43%	***
Acreage (ha)	4.17	4.84	2.42	***
Total agric income (per year, 10^6 CFA)	2.75	2.99	2.15	**
Total non-agric income (per year, 10^6 CFA)	0.35	0.48	0.04	***
Total income (per year, 10^6 CFA)	3.11	3.46	2.18	***
Landslide related characteristics				
HH ever lost life or house due to LS	40%	50%	14%	***
HH knew someone who died due to LS	79%	88%	56%	***
Moved because of LS	17%	19%	9%	**
Most important attributes in CE (stated)				
Distance to former plot	1.4%	1.6%	1%	
Family	45%	30%	82%	***
Area of land	28%	28%	28%	
Road quality	27%	30%	18%	***
Absence of landslides	52%	61%	30%	***
Compensation	3.5%	2.4%	6.3%	**
	Note: ***, **, * ==> Significant at 1%, 5%, 10% level.			

5. Discussion

The econometric analysis highlighted that a large part of the population was willing to resettle to a location without landslides. However, such undertakings are quite rare. This section considers these differences between actual behavior and stated preferences by investigating some of the underlying causes of why the individual willingness does not always express itself into actions.

5.1 Group choices vs individual choices

If the risk of landslides does not outweigh the risks of losing your social capital, the decision to resettle goes from a decision at the household level to a decision at the village level. This seems to be at play in the study area because of three observations. First, high preferences were found for resettlement programs that allowed neighboring friends and extended family to move along to the new location, indicating that preserving family ties is considered essential. Second, the resettlement attempts in Atsualah and Magha were the result of group dynamics and a decision of an entire group of households to resettle. Third, when the individuals in the surroundings do not react to a threat, the individual feels pressured not to react himself. This effect, named group inhibition or bystander effect (Latane and Darley, 1968), is observed in Fomenji: individual respondents mention that they realize the gravity of the situation and admit that they are individually willing to resettle. If they were the only ones living in the caldera, they might have already moved. However, as long as there is no consensus within the community to resettle, the status quo remains. Consequently, a substantial proportion of the population might be willing to move, yet the group behavior supports the status quo.

5.2 Obstacles to resettlement

Even when the group choice is to resettle, five types of obstacles were encountered. (i) If population pressure becomes high, finding a suitable location for resettlement becomes difficult, as encountered around Nkongle, where smaller villages are willing to resettle, but there are no good alternative locations. (ii) If it is unclear on where the boundary lies between communities, resettlement can lead to border disputes, as seen in the dramatic events that took place at Setoh. (iii) If resettlement is not officially registered, conflict might ensue with governmental planners, such as in Aghong, where villagers were nearly displaced after they had resettled into a protected ecological area. (iv) It might be difficult to leave behind the old location when there is a strong cultural link, as demonstrated by the chief of Atsualah, who advised others to resettle but did not do so himself. Similarly, the village head in Nkongle reported that he would not resettle because of the presence of a holy forest on the old location. (v) Resettlement is very costly, especially if land and building materials must be bought. Despite their successful resettlement, villagers in Atsualah still live in wooden houses of poor quality (14 years after the start of the resettlement!).

5.3 A mixed method approach to evaluate (future) resettlement programs

A DCE seems to be a valuable method for investigating ex-ante resettlement preferences, because it comes at a low cost and can be executed at short notice. However, it is questionable whether the technique is optimal to estimate willingness to resettle in general because of (i) the problem of hypothetical bias and (ii) the differences between individual willingness and collective actions. A DCE is developed to measure individual preferences while resettlement decisions are often made on the group level. Thus, the question remains whether respondents would follow their statements with actions if given the opportunity. Combining the DCE with qualitative, semi-structured interviews allows to mitigate these problems. It offers additional information about the willingness to resettle, which can be used to cross-check the validity of the individual preferences and it can be used to include the group dynamics that are overlooked by the DCE.

6. Conclusion and recommendations

This study used a discrete choice experiment to identify preferences and estimate willingness for hypothetical resettlement from landslide prone areas in the Mount Bamboutos caldera in Cameroon. Additionally, it examined whether there is heterogeneity in these preferences and which socioeconomic parameters can be linked to differences in preferences.

We find that there is a general willingness to resettle away from landslide prone areas. Willingness to resettlement increases if the new settlement comes with arable land, road infrastructure, monetary compensation and if family and friends can move along. These aspects are important as also resettlement can entail some risks and both landslide risk and resettlement risk may differ across households and regions.

The results confirm that resettlement preferences are heterogeneous between socioeconomic groups. The results show that individuals in poorer, more isolated communities attribute the greatest importance to the preservation of their social network and receiving arable land, whilst households in richer, more connected communities are more sensitive to the presence of improved road infrastructure. We also find differences for the importance of the absence of landslides at the resettlement location for the two groups. This can be explained by the differences in exposure (due to differing levels of population pressure) and differences in risk behavior (due to differences in coping capabilities). These results illustrate that individuals from different communities have different requirements for a resettlement program to be acceptable and this should be considered in voluntary resettlement program.

Our results also stress the importance of keeping up promises of compensation to avoid disappointment, discouragement and distrust in future resettlement programs. We also argue that in order to achieve a durable solution, neighboring tribes should be involved in the resettlement process and compensated for losses in access to land, since when this is not the case, the reactions of discontent neighbors might negatively affect a resettlement attempt.

This research shows that qualitative research brings added value to choice experiments for evaluating future resettlement programs. It sheds light on group dynamics and past events that are hard to capture with a DCE. As such it allows to better understand why individual preferences are not in line with their actions. Additionally, it helps to better understand the local context and take this context into account when selecting the attributes (and their levels), it offers a platform to check the validity and ease the interpretation of the results of the DCE. We therefore recommend other researchers to complement their use of DCEs with qualitative research in the evaluation of disaster risk reduction strategies.

7. Acknowledgements

This study would have been impossible without the support of others. That is why we would like to express our gratitude towards the AfReSlide Project, BR/121/A2/AfReSlide, titled ‘Landslides in Equatorial Africa: Identifying culturally, technically and economically feasible resilience strategies’, funded by the Belgian Science Policy (BELSPO) and the VLIR-UOS for their financial support. Moreover, the authors wish to express their appreciation to Ketung Eric, Mantap Heline Awapad, Cecilia Folah, Tezeme Roland Tegomon for their daily endeavors in the field. We also want to express our gratitude towards Pa Follah and Njoyim Hope Singwe, for their hospitality and patience, and to the local communities for their cooperation.

8. Bibliography

Anderson, M.G., Holcombe, E., Blake, J.R., Ghesquire, F., Holm-Nielsen, N., Fisseha, T., 2011. Reducing landslide risk in communities: Evidence from the Eastern Caribbean. Appl. Geogr. 31, 590–599. https://doi.org/10.1016/j.apgeog.2010.11.001

Arnall, A., Thomas, D.S.G., Twyman, C., Liverman, D., 2013. Flooding, resettlement, and change in livelihoods: evidence from rural Mozambique. Disasters 37, 468–488. https://doi.org/10.1111/disa.12003

Artur, L., Hilhorst, D., 2014. Floods, resettlement and land access and use in the lower Zambezi, Mozambique. Land Use Policy 36, 361–368. https://doi.org/10.1016/j.landusepol.2013.08.017

Barcus, H., Werner, C., 2017. Choosing to Stay: (Im)Mobility Decisions Amongst Mongolia's Ethnic Kazakhs. Globalizations 14, 32–50. https://doi.org/10.1080/14747731.2016.1161038

Bech, M., Gyrd-Hansen, D., 2005. Effects coding in discrete choice experiments. Health Econ. 14, 1079–1083. https://doi.org/10.1002/hec.984

Birol, E., Karousakis, K., Koundouri, P., 2006. Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida wetland in Greece. Ecol. Econ. 60, 145–156. https://doi.org/10.1016/j.ecolecon.2006.06.002

Cascetta, E., 2009. Random Utility Theory, in: Transportation Systems Analysis, Springer Optimization and Its Applications. Springer, Boston, MA, pp. 89–167. https://doi.org/10.1007/978-0-387-75857-2_3

Cernea, M., 1997. The risks and reconstruction model for resettling displaced populations. World Dev. 25, 1569–1587. https://doi.org/10.1016/S0305-750X(97)00054-5

Churchill, R.R., Hutchinson, D.M., 1984. Flood hazard in Ratnapura, Sri Lanka: Individual attitudes vs collective action. Geoforum 15, 517–524. https://doi.org/10.1016/0016-7185(84)90022-8

Cifrodelli, M., Corradini, C., Morbidelli, R., Saltalippi, C., Flammini, A., 2015. The Influence of Climate Change on Heavy Rainfalls in Central Italy. Procedia Earth Planet. Sci., World Multidisciplinary Earth Sciences Symposium, WMESS 2015 15, 694–701. https://doi.org/10.1016/j.proeps.2015.08.097

Claessens, L., Knapen, A., Kitutu, M.G., Poesen, J., Deckers, J.A., 2007. Modelling landslide hazard, soil redistribution and sediment yield of landslides on the Ugandan footslopes of Mount Elgon. Geomorphology 90, 23–35. https://doi.org/10.1016/j.geomorph.2007.01.007

Claudianos, P., 2014. Out of Harm's Way; Preventive Resettlement of at Risk Informal Settlers in Highly Disaster Prone Areas. Procedia Econ. Finance, 4th International Conference on Building Resilience, Incorporating the 3rd Annual Conference of the ANDROID Disaster Resilience Network, 8th – 11th September 2014, Salford Quays, United Kingdom 18, 312–319. https://doi.org/10.1016/S2212-5671(14)00945-9

Correa, E., Ramirez, F., Sanahuja, H., 2011. Populations at risk of disaster : a resettlement guide (No. 65355). The World Bank.

Crozier, M.J., Glade, T., 2005. Landslide Hazard and Risk: Issues, Concepts and Approach, in: Glade, T., Anderson, Icolm, Crozier, M.J. (Eds.), Landslide Hazard and Risk. John Wiley & Sons, Ltd, pp. 1–40. https://doi.org/10.1002/9780470012659.ch1

Dai, F.C., Chin-Fei, L., Ngai, Y.Y., 2002. Landslide risk assessment and management: An overview. Eng. Geol. 64, 65–87.

de Bekker-Grob, E.W., Ryan, M., Gerard, K., 2012. Discrete choice experiments in health economics: a review of the literature. Health Econ. 21, 145–172. https://doi.org/10.1002/hec.1697

Dercon, S., 2002. Income risk, coping strategies, and safety nets. World Bank Res. Obs. 17, 141–166.

Ferris, E., 2014. Planned relocations, disasters and climate change: consolidating good practies and preparing for the future. Background document., in: Disasters Climate Change and Displacement. Presented at the Sanremo consultation, UNHCR. Brookings. Georgetown univeristy., Sanremo, Italy, p. 16.

Follah, P., 2006. Request for government intervention in Magha-Pinyin border dispute.

Froude, M.J., Petley, D.N., 2018. Global fatal landslide occurrence from 2004 to 2016. Nat. Hazards Earth Syst. Sci. 18, 2161–2181. https://doi.org/10.5194/nhess-18-2161-2018

Fujikura, R., Nakayama, M., 2012. The long-term impacts of resettlement programmes resulting from dam construction projects in Indonesia, Japan, Laos, Sri Lanka and Turkey: a comparison of land-for-land and cash compensation schemes. Int. J. Water Resour. Dev. 29, 4–13.

Gariano, S.L., Guzzetti, F., 2016. Landslides in a changing climate. Earth-Sci. Rev. 162, 227–252. https://doi.org/10.1016/j.earscirev.2016.08.011

Gariano, S.L., Rianna, G., Petrucci, O., Guzzetti, F., 2017. Assessing future changes in the occurrence of rainfall-induced landslides at a regional scale. Sci. Total Environ. 596–597, 417–426. https://doi.org/10.1016/j.scitotenv.2017.03.103

Glade, T., Crozier, M.J., 2005. The Nature of Landslide Hazard Impact, in: Glade, T., Anderson, Icolm, Crozier, M.J. (Eds.), Landslide Hazard and Risk. John Wiley & Sons, Ltd, pp. 41–74. https://doi.org/10.1002/9780470012659.ch2

Gountie, D.M., Nono, A., Njonfang, E., Kamgang, P., Zangmo, T.G., Kagou, D.A., Nkouathio, D.G., 2011. Le volcanisme ignimbritique de la Ligne du Cameroun (Mounts Bambouto et Bamenda, Ouest-Cameroun): signification dans la genèse des caldeiras | Request PDF. Bull. L'Institut Sci. Rabat Sect. Sci. Terre 33, 1–15.

Greene, W., 2018. Number of classes when matrix fails to converge.

Guedjeo, C.S., Kagou, D.A., Ngapgue, F., Nkouathio, D.G., Zangmo, T.G., Gountie, D.M., Nono, A., 2013. Natural hazards along the Bamenda escarpment and its environs: The case of landslide, rock fall and flood risks (Cameroon volcanic line, North-West Region). Glob. Adv. Res. J. Geol. Min. Res. 2, 15–26.

Hanley, N., Mourato, S., Wright, R.E., 2001. Choice modelling approaches: A superior alternative for environmental valuation? J. Econ. Surv. 15, 435–462.

Hanson, K., McPake, B., Nakamba, P., Archard, L., 2005. Preferences for hospital quality in Zambia: results from a discrete choice experiment. Health Econ. 14, 687–701. https://doi.org/10.1002/hec.959

Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. Ecol. Econ. 69, 1595–1603. https://doi.org/10.1016/j.ecolecon.2010.04.011

Huggel, C., Gruber, S., Korup, O., 2013. 13.17 Landslide Hazards and Climate Change in High Mountains, in: Shroder, J.F. (Ed.), Treatise on Geomorphology. Academic Press, San Diego, pp. 288–301. https://doi.org/10.1016/B978-0-12-374739-6.00367-5

Kervyn, M., Jacobs, L., Maes, J., Bih Che, V., de Hontheim, A., Dewitte, O., Isabirye, M., Sekajugo, J., Kabaseke, C., Poesen, J., Vranken, L., Mertens, K., 2015. Landslide resilience in Equatorial Africa: Moving beyond problem identification! Belg. Rev. Belge Géographie. https://doi.org/10.4000/belgeo.15944

Ketu, I., 2015. Request for effective use of the feasability studies realized since 2008 on the disenclavement of Magha-Bamumbu disaster zone in Wabane subdivision.

KFA, 2011. White paper for a simple ecological reserve in the Bamboutos Massifs. Combining the imperatives of the survival of the residents and that of their off-springs on one hand, and the imperatives of conservation and preservation of biodiversity on the other hand. Knowledge For All. Support Programme for the Structuration of Civil Society in Cameroon., Mbouda.

Kita, S.M., 2017. Urban vulnerability, disaster risk reduction and resettlement in Mzuzu city, Malawi. Int. J. Disaster Risk Reduct. 22, 158–166. https://doi.org/10.1016/j.ijdrr.2017.03.010

Knapen, A., Kitutu, M.G., Poesen, J., Breugelmans, W., Deckers, J., Muwanga, A., 2006. Landslides in a densely populated county at the footslopes of Mount Elgon (Uganda): Characteristics and causal factors. Geomorphology 73, 149–165. https://doi.org/10.1016/j.geomorph.2005.07.004

Komori, D., Rangsiwanichpong, P., Inoue, N., Ono, K., Watanabe, S., Kazama, S., 2018. Distributed probability of slope failure in Thailand under climate change. Clim. Risk Manag. https://doi.org/10.1016/j.crm.2018.03.002

Lambi, C.M., Ndenecho, E.N., 2010. Ecology and Natural Resource Development in the Western Highlands of Cameroon. Issues in Natural Resource Management: Issues in Natural Resource Management. African Books Collective.

Latane, B., Darley, J.M., 1968. Group inhibition of bystander intervention in emergencies. J. Pers. Soc. Psychol. 10, 215–221. http://dx.doi.org.kuleuven.ezproxy.kuleuven.be/10.1037/h0026570

Lizin, S., Van Passel, S., De Schepper, E., Vranken, L., 2012. The future of organic photovoltaic solar cells as a direct power source for consumer electronics. Sol. Energy Mater. Sol. Cells 103, 1–10. https://doi.org/10.1016/j.solmat.2012.04.001

Maes, J., Mertens, K., Jacobs, L., Bwambale, B., Vranken, L., Dewitte, O., Poesen, J., Kervyn, M., 2018. Social multi-criteria evaluation to identify appropriate disaster risk reduction measures: application to landslides in the Rwenzori Mountains, Uganda. Landslides. https://doi.org/10.1007/s10346-018-1030-0

Magidson, J., Vermunt, J.K., 2002. A Nontechnical Introduction to Latent Class Models.

Mangham, L.J., Hanson, K., McPake, B., 2009. How to do (or not to do) … Designing a discrete choice experiment for application in a low-income country. Health Policy Plan. 24, 151–158. https://doi.org/10.1093/heapol/czn047

Mberu, B.U., Ezeh, A.C., Chepngeno-Langat, G., Kimani, J., Oti, S., Beguy, D., 2013. Family Ties and Urban–Rural Linkages among Older Migrants in Nairobi Informal Settlements. Popul. Space Place 19, 275–293. https://doi.org/10.1002/psp.1711

Mertens, K., Jacobs, L., Kabaseke, C., Maertens, M., Poesen, J., Kervyn, M., Vranken, L., 2016. The direct impact of landslides on household income in tropical regions: A case study from the Rwenzori Mountains in Uganda. Sci. Total Environ. 1032–1043.

Morikang, I., 2003. 21 people perish in landslides in Wabane. Cameroon-Info Net.

Morse, C.E., Mudgett, J., 2018. Happy to Be Home: Place-Based Attachments, Family Ties, and Mobility among Rural Stayers. Prof. Geogr. 70, 261–269. https://doi.org/10.1080/00330124.2017.1365309

Mugagga, F., Kakembo, V., Buyinza, M., 2012. Land use changes on the slopes of Mount Elgon and the implications for the occurrence of landslides. Catena 39–46.

Mulder, C.H., Malmberg, G., 2014. Local Ties and Family Migration. Environ. Plan. Econ. Space 46, 2195–2211. https://doi.org/10.1068/a130160p

Ngoufo, R., 1992. The Bamboutos Mountains: Environment and Rural Land Use in West Cameroon. Mt. Res. Dev. 12, 349–356. https://doi.org/10.2307/3673685

Nguyen, Thanh Cong, Robinson, J., Whitty, J.A., Kaneko, S., Nguyen, The Chinh, 2015. Attribute non-attendance in discrete choice experiments: A case study in a developing country. Econ. Anal. Policy 47, 22–33. https://doi.org/10.1016/j.eap.2015.06.002

Reder, A., Rianna, G., Mercogliano, P., Pagano, L., 2016. Assessing the Potential Effects of Climate Changes on Landslide Phenomena Affecting Pyroclastic Covers in Nocera Area (Southern Italy). Procedia Earth Planet. Sci., The Fourth Italian Workshop on Landslides 16, 166–176. https://doi.org/10.1016/j.proeps.2016.10.018

Rianna, G., Zollo, A., Tommasi, P., Paciucci, M., Comegna, L., Mercogliano, P., 2014. Evaluation of the Effects of Climate Changes on Landslide Activity of Orvieto Clayey Slope. Procedia Earth Planet. Sci., The Third Italian Workshop on Landslides: Hydrological Response of Slopes through Physical Experiments, Field Monitoring and Mathematical Modeling 9, 54–63. https://doi.org/10.1016/j.proeps.2014.06.017

Ryan, M., Gerard, K., Amaya-Amaya, M. (Eds.), 2008. Using Discrete Choice Experiments to Value Health and Health Care, The Economics of Non-Market Goods and Resources. Springer Netherlands.

Sridarran, P., Keraminiyage, K., Amaratunga, D., 2018. Enablers and barriers of adapting post-disaster resettlements. Procedia Eng., 7th International Conference on Building Resilience: Using scientific knowledge to inform policy and practice in disaster risk reduction 212, 125–132. https://doi.org/10.1016/j.proeng.2018.01.017

Van Eynde, E., Dondeyne, S., Isabirye, M., Deckers, J., Poesen, J., 2017. Impact of landslides on soil characteristics: Implications for estimating their age. CATENA 157, 173–179. https://doi.org/10.1016/j.catena.2017.05.003

Vlaeminck, P., Maertens, M., Isabirye, M., Vanderhoydonks, F., Poesen, J., Deckers, S., Vranken, L., 2016. Coping with landslide risk through preventive resettlement. Designing optimal strategies through choice experiments for the Mount Elgon region, Uganda. Land Use Policy 51, 301–311.

Wabane Council, 2012. Wabane Communal Development Plan. Programme National de Developpement Participatif.

WHO, 2012. WHO | How to Conduct a Discrete Choice Experiment for Health Workforce Recruitment and Retention in Remote and Rural Areas: A User Guide with Case Studies. World health organization, Geneva.

Wouatong, A.S.L., Medjo Eko, R., Nankam, M.A., Kamgang Kabeyene Beyala, V., Ekodeck, G.E., 2014. Mineralogy, Geochemistry and Geotechnical Characteristics of Magha Landslides in the Bambouto Caldera, West Cameroon. J. Civ. Eng. Sci. 3, 36–49.

Yong Chen, Yan Tan, Yong Luo, 2017. Post-disaster resettlement and livelihood vulnerability in rural China. Disaster Prev. Manag. Int. J. 26, 65–78. https://doi.org/10.1108/DPM-07-2016-0130

Zangmo, T.G., Nkouathio, D.G., Kagou Dongmo, A., Wandji, P., Gountie Dedzo, M., Tchoua, F.M., 2011. Mount Bambouto Caldera (Cameroon Volcanic Line): Formation, structure and environmental impact. YES Netw. 1.