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ASSESSMENT OF COMMUNITY'S PERCEPTION OF FLOOD DISASTERS IN THE BAMENDA MUNICIPALITY, NORTH-WEST CAMEROON

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ABSTRACT

The primary objective of this work was to characterize and explain the Bamenda community's perception of flood disasters based on causes and management. The reconnaissance survey method was used for this work by means of field questionnaires, geologic and topographic maps and previous literature. The main results revealed that the main causes of floods are heavy rainfall, inadequate drainage systems and water-saturated soils. The best flood prevention techniques according to respondents include straightening the River Mezam bed, building drainage systems, construction of levees along the river and a dam at up station to hold rain water and release it at safer rates after heavy downpour. The common strategies used by the inhabitants to prevent floods are building of embankment walls, raising foundations of houses and straightening of river channels. Respondents agreed that the best flood management strategies that the Government should adopt to prevent floods are channelling of major streams and rivers, building of drainage systems in town, earmark resettlement sites to relocate people from high risk zones, construct embankments along major rivers, construct, a dam to hold water during heavy rains, convert wetlands to touristic sites. However, 50% respondents do not agree that conversion of wetlands into touristic sites and relocating people from high risk zones (50% disagree) are good strategies. Contrary to the literature, most of the respondents denied that deforestation, landfills, refuse disposal in streams and water-saturated nature of the soils contribute to flooding in Bamenda. This could be attributed to low level of education as 42% and 27% of respondents where respectively holders a First School Leaving certificates (FSLC) and

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General Certificate of Education Ordinary Levels (GCE OL) and might not master methods of flood management. The Government, therefore, ought to sensitize the inhabitants of Bamenda on issues of flood and environmental management. Meanwhile, a community-based approach of flood prevention and management will be a relief to the Bamenda inhabitants.

1. Introduction

Flood is one of the most devastating natural disasters as it has serious effects on the population and the environment (Ayonghe et al., 1999; Bronstert, 2003; Balgah et al., 2006; Guedjeo et al., 2012; Wisner et al., 2013; Balgah et al., 2015). Its frequency depends on the type of flood, zone of occurrence, and the season of the year. Many factors are responsible for flooding such as heavy and consistent rainfall, accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, accelerated urbanization, failure of man-made structures such as dams, levees, retention ponds (Chanze, 2017; Vinet, 2017; Rushdi et al., 2018; Nkwunonwo et al., 2019). The negative impacts of floods are numerous like loss of human lives, the spread of faecal and vector-borne diseases, mental disorders, psychosocial traumas, etc (Neira et al., 2008; Abuaku et al., 2009;). Some techniques of flood mitigations include structural and non-structural options as documented by the National Research Council (2013). In developed countries, numerous advanced technological strategies have been developed to prevent and manage slopes often involving satellite monitoring and imagery at regular frequency (Parker, 2011; Vinet, 2017; Webber et al., 2018a; Webber et al., 2018b). Developing countries often possess little potential for flood prevention and management justifying the high frequency and vulnerability of such regions to flood disasters (Acho-Chi, 1998; Nicholls, 2002; Fogwe, 2010; Afungang et al., 2017).

In Cameroon, urban areas have been identified as particularly vulnerable to flooding (Ayonghe et al., 1999). In 2001, severe floods hit the Limbe municipality causing the loss of lives anddestruction of property . In 2008, the Nkolbisson neighbourhood suffered two severe floods (Tchindjang, 2012). Floods regularly affect the coastal towns of Cameroon like Limbe, Kribi, Tiko and Douala (Ayonghe et al., 1999; Ndenecho and Eze, 2004). In recent years, Yaoundé and Douala, major urban centres in Cameroon, have been severely affected by floods at a frequency of 5 to 10 times per annum. In the Maga and Lagdo, rural areas in Northern Cameroon, frequency of occurrence ranges from 1 to 5 times per year (Tchindjang, 2012). In the Ndop plain (North West Cameroon), since the construction of the Bamendjin dam in 1975, floods have been frequent during each rainy season. Bamenda city has seen a progressive deterioration in its environmental quality as a result of rapid and unplanned urbanization that took off since 1980 (Acho-Chi, 1998; Guedjeo et al., 2012; Kometa and Akoh, 2012). Devastating effects of floods for some neighbourhoods of the Bamenda Municipal area from 1995 to 2009, reflected in the loss of lives and property have been compiled by Kometa and Akoh (2012). If this phenomenon is left unchecked, it might lead to more severe disasters in future. There is an immediate need for concrete environmental management plans to control flooding in this municipality. The present paper aims to characterize and explain how the inhabitants of Bamenda Municipality view and understand flood disasters. The specific objectives are:

1. To assess the knowledge of the inhabitants of the Bamenda municipality on flood disasters and its impact on flood management strategies.
2. To study the adoptive and mitigative measure to manage flood disasters by the inhabitants of the Bamenda municipality.

The following questions require answers: what are the causes of floods in Bamenda municipality? What strategies have the inhabitants and City Council and government put in place to prevent flood disasters in Bamenda? This study will raise awareness on the need for flood forecasting and prevention especially in a city like Bamenda that has so many floodplains clustered around the Mezam River and its tributaries.

2. Materials and Methods

2.1. Study Site Description

Bamenda town is located on the northwest flank of the Bamenda Mountain (2621m) which is a strato-volcano situated along the Cameroon Volcanic Line (Guedjeo et al., 2012; Afungang et al., 2017). It is situated from longitude 10^o 08' to 10^o 12' E and latitude 5^o 55' to 6^o 00' N (Figure 1). The town covers a surface area of 71.23 km^2. It is separated into an Upstation and Downtown by an escarpment of about 150 m height whose slope attains 35^o. The climate is the - Cameroonian type equatorial domain characterized by two seasons: a rainy season of 7 months from April to October and a dry season of 5 months from November to March. The mean annual rainfall is 2670 mm and the average annual temperature is 25ºC. The Mezam River draining the town is a second order perennial stream fed by several other small streams, most of which take their rise from the Bamenda escarpments. They form a dense dendritic network. The major winds affecting this zone are harmattan (that bring the dry season) and the monsoon (that brings rain). Rainfall is heavy and destructive. The vegetation is the Guinea Savannah mixed with short stunted trees (Bamenda Grassfields) and short deciduous trees; meanwhile Raffia palms grow in the valleys and depressions. The town occurs along the Cameroon Volcanic Line and exhibits two very distinct relief environments: the high lava plateau (Upstation) with an altitude of about 1400m and the lower plateau (Downtown) with an average altitude of 1100m. Geologically, Bamenda is underlain by a Precambrian granite-gneissic basement, overlain by volcanics (basalts, trachyte, dolerite and ignimbrites) and sedimentary silty clays of the Mezam River floodplains (Guedjeo et al., 2012; Ndenecho and Eze, 2004; Kamgang, 2003). The dominant soil types are the red ferrallitic soils associated with lightly evolved soils rejuvenated by erosion. Detailed soil characteristics by Guedjeo et al. (2012) and Kagou Dongmo et al. (2018) show low bulk density (1.32-1.59 g/cm^3), low particle density (2.20-2.58 g/cm^3), high porosity (47.92-64.28 %) and low cohesion (2.60-7.20 kPa). The natural water content exceeds 35% and the angle of internal friction ranges from 25^o to 28^o. The soils of the wetlands of Bamenda municipality have been highly influenced by human activities. Ninety percent of the soils have a sandy loam texture while 10% are of the sandy clay-loam textural class (Asongwe et al., 2016). Farming is the main activity carried out and it is mostly crop-based farming, pure pastoral normadism, mixed crop livestock, secondary and tertiary activities.

2.2. Research Design

A quantitative reconnaissance survey was carried out between February and April 2017 using structured questionnaires, historical linings, interviews, visual appreciation and literature review. A total of 300 questionnaires were randomly administered in four neighbourhoods (Ntenefor, Below Foncha, Mulang and Ngomgham) of Bamenda Town-based on the high frequency of floods in these zones. Although random sampling was used, factors such as age, gender, level of education and status were considered in order to guarantee the representativeness of the various social groups within the community and to ensure that people with in-depth knowledge on the theme are administered questionnaires. The respondents were mainly composed of the elderly members of the family with possible long experience of flooding in their neighbourhoods. Different land use activities in the study area such as settlements, agriculture and forestry were given particular attention to helping interpret and correlate the respondents' answers. The causes of floods were identified after analysis of the fieldwork data and other potential sources of data (text books, articles, geological and topographic maps). The existing cadastral database of Bamenda was checked at the Bamenda City Council. Already existing flood preventive measures were also checked to see how the population and the City Council at large have been preventing and managing the recurrence of floods.

2.3. Data analysis

Statistical analysis was performed using the SPSS software program (SPSS Inc., Version 12.0). The data were analyzed by one-way analysis of variance (ANOVA). To detect the statistical significance of differences ($P< 0.05$) between means, the Tukey's test was performed.

3. Results

3.1. Identification of respondents

Based on age, more than 80% of the respondents were between 15 and 50 years of age, but the majority (57%) were between 30 and 50 years old (Figure 2). Only 23% of respondents were aged above 50 years and 1.7% did not disclose their ages. There was a significant difference ($P<0.05$) between all the age groups.

Gender wise, there was no significant difference ($P>0.05$) between the number of male and female respondents (Figure 3). However, the male respondents were more numerous than the females.

Education-wise, 42% of the respondents were holders of the FSLC (First School Leaving Certificate), while 27% and 23% were respectively holders of the Cameroon General Certificate of Education Ordinary Levels (GCE OL) and Cameroon General Certificate of Education Advanced Level (GCE AL), respectively (Figure 4). Only 5% of the respondents were holders of at least a Bachelors Degree. All certificate holding scores were significantly different based on respondents.

Amongst the respondents, 59% were victims of previous floods while 41 % were not (Figure 5). There was a significant difference in scores between respondents who were victims and those that were non-victims.

3.2. Causes of floods in Bamenda

According to the respondents, the main causes of floods are poor drainage (80%), the overflow of the Mezam River (86%), heavy and consistent rainfall (93%) (Figure 6). Factors like the construction of houses in flood plains (66%) also play a great role. The dumping of refuse into streams (34%), saturated nature of the soil (7%), deforestation (13%) and the refills on wetlands (23%) contribute to very little to flooding according to the respondents. Among the different causes, there was no significant difference ($P>0.05$) for the % agreed for responses to poor drainage systems, overflow of rivers and heavy rainfall. All the other variables showed a significant difference in terms of % agreement of respondents (Figure 6). For the percentage disagreed among causes, most of the scores were not significantly different ($P>0.05$), except for poor drainage systems and overflow of rivers that were not significantly different among themselves but different from all the other variables. Within the same cause, all the responses were significantly different ($P<0.05$).

3.3. Flood prevention approach

Overall, 83 % of respondents agreed that there had been flooding preventive measures through the building of embankments (Figure 7). Also, 75 % respondents agreed that attempts are been made by some inhabitants by raising stone foundations of the houses as mitigation strategies. Some inhabitants have also resorted to increasing the width of streams as agreed by 50% of respondents. Among different prevention methods, there was no significant difference (P>0.05) in % of those who are in agreement of building of embankments and raising of foundations of houses, meanwhile the rest of the prevention methods were significantly different (P<0.05) within themselves. Within the same prevention methods, there was a significant difference in % score of respondents for all the variables tested, except for responses to increase the width of screams.

3.4. Government/Bamenda City Council flood disasters prevention approach

According to 50% of the respondents, the Bamenda City Council and Government have constructed drainage systems in town (Figure 8). However, there is no dam as confirmed by 0% of correspondents. Meanwhile, 8% and 0% of respondents agreed to the channelling of the Mezam River and the building embankments along the river, respectively. Among prevention approaches, most of the % respondents that agree are 0% or less than 10%.Within prevention approaches, the total scores of respondents that disagreed are significantly different from those that either agreed or had no idea, except for building of drainage channels around town.

3.5. Best flood prevention approaches according to inhabitants of Bamenda

The survey permitted to note that 58% of respondents agreed that floods in Bamenda can be prevented by building embankments, meanwhile 83% and 91% positively suggested a channelling of Major River and tributaries, and the building of drainage systems around town, respectively (Figure 9). The building code implementation plan was agreed by all respondents100% as a solution as a major preventive approach to flood management in Bamenda town. Among the flood prevention methods, there are scores that are not significantly different (P>0.05) from one another, but equally some cases where the difference is significant. Within flood prevention method, the percentage scores of respondents were significantly different (P<0.05) for all cases.

4. Discussion

Numerous natural factors contribute to floods in Bamenda town**.** The town is located within the Cameroon volcanic line precisely on the north western slope of the Bamenda strato-volcano which culminates at 2621m. The Cameroonian type equatorial climate, warm (25ºC mean annual temperature) and humid (2670 mm/year), favours weathering to give mostly thick (>10 m) red ferrallitic soils and erosion. Rocks are Precambrian granite-gneisses overlain by basalts, trachytes, dolerites and ignimbrites, silty sedimentary clays (Guedjeo et al., 2012; Ndenecho and Eze, 2004; Kamgang, 2003). Lithology also plays a vital role in the occurrence of floods in the area. Ignimbrites along the steep slopes easily weather under the warm and humid climate into clays and silts which are eroded and deposited in stream beds and plains. The consequence is a reduction of infiltration rate of water and increase in volume of water in streams and rivers channels leading to floods during heavy downpours. The Mezam River and its tributaries, with a dense and dentritic pattern, help to transport weathered material into the lower landscape positions; subsequent deposition into the wetlands at the foot of the escarpment is favoured by sharp drop in stream velocity due to slope break. The soils are generally fragile and show a silty clayey texture, low bulk density, high porosity and high water holding capacity and low cohesion. Thus, drainage network, landscape configuration, consistently heavy rainfall, geology and the nature of the weathered material are important factors that favour flooding. During heavy downpours in those areas, natural drainage systems cannot carry the run-off generated by the rain and causes temporary inundation in many localities. Such rain-fed floods (FEMA, 1997; Fogwe, 2010) occur in floodplains where natural drainage systems have been disturbed due to human interferences mainly by the construction of unplanned rural roads and illegal occupation of river courses. Such anarchical activities results from deforestation, urbanization, river channel reduction, land recovery, microclimate modification, waste disposal into streams, etc (Neba, 1999; Kometa and Akoh, 2012; Badmos et al., 2017; Aka Tangan et al., 2018).

Based on community's perception of flood hazards in the Bamenda Municipality, there are many contributing causes of flooding in the area but the paramount causes are heavy and consistent rainfall, poor drainage systems, overflow of rivers, and construction of houses in flood plains. These findings corroborate those of Nicholls (2002), Balgah et al. (2009) and Aka Tangan et al. (2018) who affirmed that the major causes of floods are heavy rainfall and poor drainage system. Also, according to Wotchoko et al. (2016), the causes of floods in the Ndop plain are both natural (siltation, peculiar geomorphology, the nature of soils, and rainfall) and anthropogenic (subsistence farming, plantation agriculture, dam-backing effect of the Bamendjing Dam, and dumping of refuse into rivers). Contrary to most findings (Neba, 1999; Kometa and Akoh, 2012; Balgah et al., 2015; Aka Tangan et al., 2018), a majority of the inhabitants of Bamenda disagree that deforestation, landfills, refuse disposal in streams and saturated nature of the soils are responsible for flooding in the Bamenda town. This might simply be because most of the inhabitants don't want to lose their lands. It might also be due to ignorance. In fact, this survey revealed that the higher the certificate, the lower the number of respondents holding it. Most of the respondents (42%) were holders of the FSLC and might not properly master modern techniques of flood management. This is true for most communities in developing countries as school drop-out rate increases with age and certificate (Neba, 1999). Generally, people with higher years of education tend to have access to more sources and type of information. There is likelihood that as the level of education increases, there is higher chance to have better perception of environmental issues. These findings are in line with a baseline survey among vulnerable population in Bangladesh where the level of education shows a strong positive correlation with knowledge on climate change (Kabir et al., 2016). The works of Balgah et al. (2012), Ndambiri et al. (2013) and Badmos et al. (2017) already reported that education affects scientific beliefs and can predict what and how people think. This is called the Social Representation Theory (SRT) (Moscovici, 1988). This theory considers the information circulating in the community (ideas in people's minds) critically very important and useful in understanding and exploring how scientific knowledge diffuses in society (Aniah et al., 2016). Perhaps, Bamenda has changed from a small, isolated population cluster in the past to a large inter-connected economic and urban centre. Urban growth and the concentration of people in this urban area have created societal as well as environmental problems (Kometa and Akoh, 2012). Many of the farmlands, wetlands, and forests that existed in the 1950s have over the past decades been transformed into urban settlements during which Bamenda experienced a rapid evolution in its urban landscape.

The survey revealed that 59% of the respondents are also flood victims but yet continue to stay in the flood-prone areas. This might imply that the inhabitants are unwilling to relocate to safe zones. Similar works by Balgah et al. (2012) and Aka Tangan et al. (2018) have already revealed that an overwhelming majority of the population is always reluctant to self-relocate or do so as part of Government policy. Such reluctance might be due to lack of trust in Government institutions by local inhabitants in the management of natural disasters for the fear of not being compensated (Ngwa, 1992;

Bang, 2013; Forbes et al., 2015). Also, factors like poverty, land scarcity and social attachment to the community or to engagement in the rural community might also cause population be reticent to resettle elsewhere. Moreover, there is no site earmarked for resettlement as agreed by 88% of the respondents. Report by Aka Tangan et al. (2018) mentions cases where dead family members are buried inside or beside the house such that relocating will imply departing from love ones. This agrees with APFM (2017) that the impact of floods on communities is based on traditional backgrounds and features of communities. Bamenda is the Capital of the North West region of Cameroon, so there is intense urban migration by people in search of jobs. So there is high population density. The area is also an industrialised zone attracting many youths in search of jobs. The demand for housing is high and Landlords often look for cheaper pieces of land in swampy areas to fill and build to give out on rent. Respondents believe that the Government could channel the Mezam River, build drainage systems, allocate resettlement sites for the inhabitants in risky zones, construct embankments along Mezam River, build a dam at upstream to hold water during heavy downpours and if possible convert wetlands to touristic sites as best mitigation measures. Half of the respondents (50%) did not agree that conversion of wetlands into touristic sites and relocating people from high risk zones (50% disagree) were good strategies. Perhaps, this opinion might tie with the fact that most of inhabitants own land in the risk zones and would not like to lose it or they might be ignorant of the risks involved.

The common measures to prevent floods by inhabitants are building of embankment walls, raising foundations of houses and straightening of river channels. This agrees with the findings of Kometa et al. (2012). According to 50% of respondents, the Bamenda City Council/Government has constructed drainage systems around town. However, there is no channelling of river, no construction of embankments along the river and tributaries, no dam to hold water during heavy rains, no conversion of wetlands into touristic sites, no building code for those along floodplains and no relocation of people from high risk zones. Based on UN/ISDR/UNDP (2003, 2004) in Mozambique, Motoyoshi (2006) in Japan and Aka Tangan et al. (2018) in Cameroon, the Government is involving the local population in the process of flood prevention and management. However, these strategies differ from those documented by skinner et al. (2017) based on natural methods. The works of Jukrkorn et al. (2014) on the 2011 megafloods in Thailand emphasize the need for an integrated approach to flood risk management, combining local community-based approach and a national strategic policy in the preparation and reduction of vulnerability of the country. Similar findings have also been reported by Shah et al. (2018). Building the capacity of less visible stakeholders (women, elders, remote people, minorities) could help to better manage and prevent flood disasters. Also, the disparity in education, wealth, gender, age, culture or scientific/technical knowledge should be considered for the success of community activities (APFM, 2017).

5. Conclusion

The present work has revealed how the inhabitants of the Bamenda municipality perceive flood disasters. Thus, according to respondents, the main causes of floods are heavy and consistent rainfall, poor drainage systems and the saturated nature of the soils. However, contrary to most findings, a majority of the respondents disagree that deforestation, landfills and refuse disposal in streams are responsible for flooding in Bamenda. This might be attributed to low level of education as 42% and 27% of respondents were respectively holders of a First School Leaving certificates (FSLC) and General Certificate of Education Ordinary Levels (GCE OL) and might not properly master methods of flood management. The best flood prevention techniques are straightening the River Mezam bed, putting in place of drainage systems, building of a levee along the river and building of a dam at Upstation to hold rain water and releasing it at safer rates after every heavy downpour. This is because most of the floods occurring in the area are concentrated along areas where the Mezam River passes. The common strategies used by the inhabitants to prevent floods are building of embankment walls, raising foundations of houses and straightening of river channels. Respondents are unanimous that the best flood management strategies that the Government should adopt to prevent floods are channelling of the Mezam River, building of drainage systems around town, earmarking a resettlement sites to relocate people from high risk zones, construct embankments along major rivers, construct a dam to hold water during heavy rains, convert wetlands to touristic sites. Also, 50% of the respondents do not agree that conversion of wetlands into touristic sites and relocating people from high risk zones (50% disagree) are good strategies of flood management. The Government therefore ought to sensitize the inhabitants of Bamenda on issues of flood and environmental management. Meanwhile, a community-based approach will be a relief to the Bamenda inhabitants for flood management.

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Conflict of Interests

The authors have not declared any conflict of interests.

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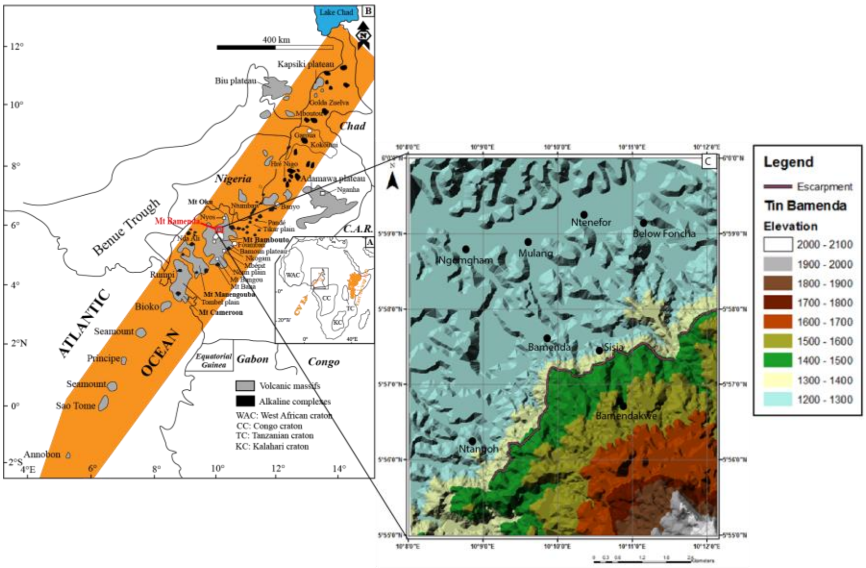

Figure 1. Location of the studied site (C) in Cameroon (B) and in Africa (A)

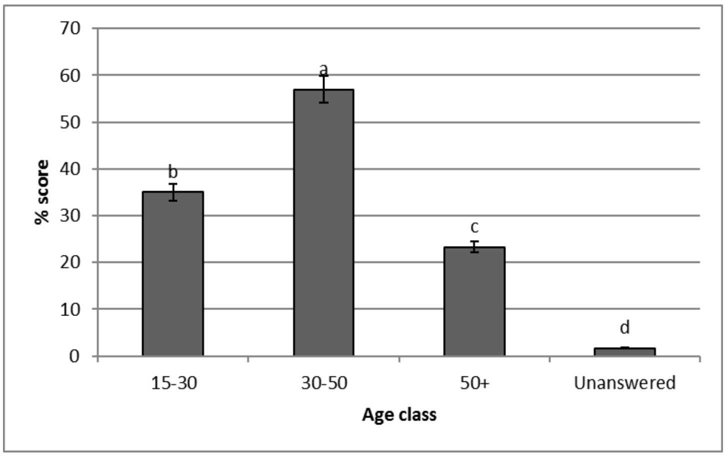

Figure 2. Identification of respondents by age group. Scores (bars) carrying the different letters show significant difference ($P < 0.05$) for all age classes. Bars represent standard deviation.

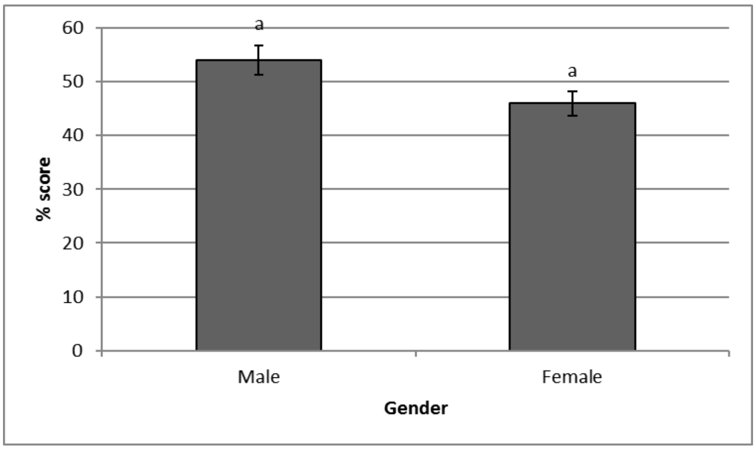

Figure 3. Identification of respondents by gender. The letter (a) shows that both scores are not

significantly different ($P < 0.05$). Bars represent standard deviation.

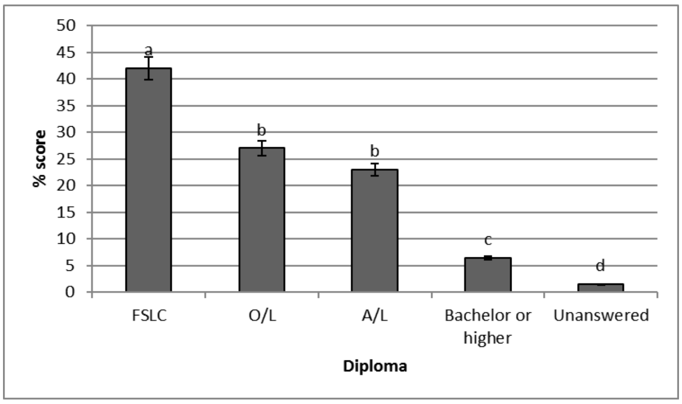

Figure 4. Educational level of respondents. Scores carrying the same letters are not significantly different ($P< 0.05$). Bars represent standard deviation.

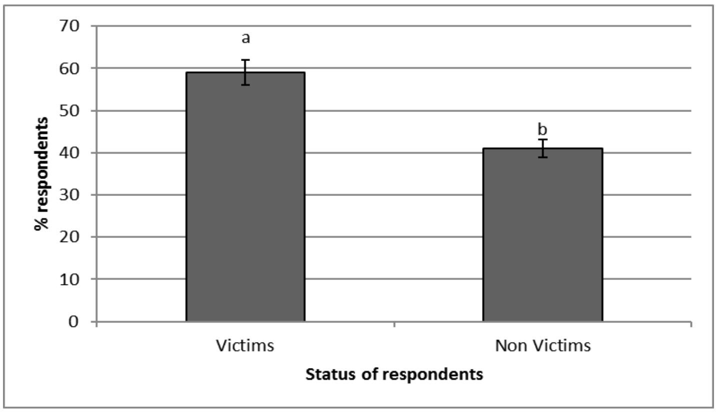

Figure 5. Identification of respondents by status. The different letters (a and b) show that both scores are significantly different ($P< 0.05$). Bars represent standard deviation.

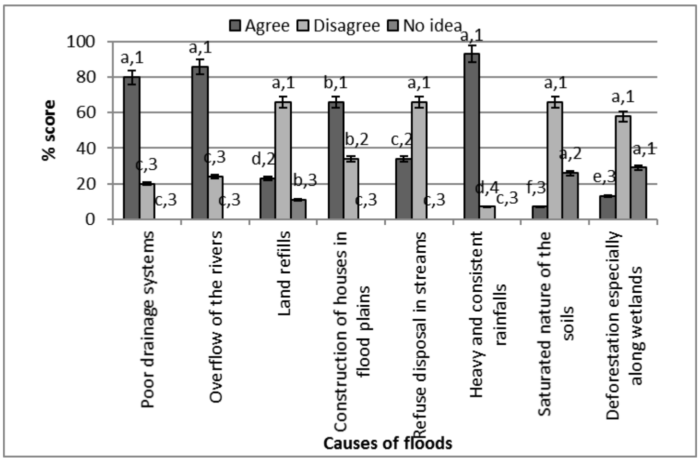

Figure 6. Percentage score of respondents to various causes of floods in Bamenda. *Scores (bars) with different shades carrying the same letters are not significantly different (P<0.05); Scores (bars) with similar shades carrying the same numbers are not significantly different (P< 0.05). Bars represent standard deviation*.

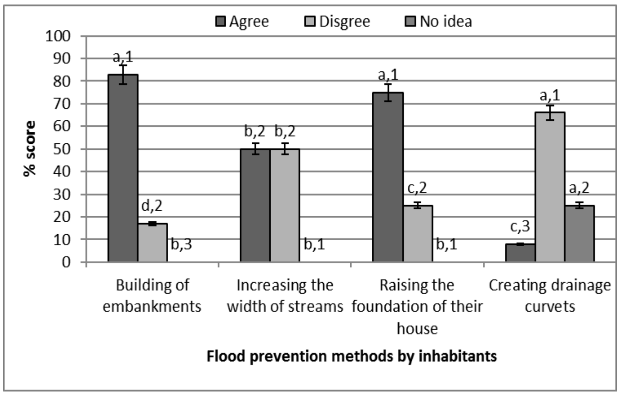

Figure 7. Percentage score of respondents to methods of preventing floods by inhabitants in Bamenda. . *Scores (bars) with different shades carrying the same letters are not significantly different (P<0.05); Scores (bars) with similar shades carrying the same numbers are not significantly different (P< 0.05). Bars represent standard deviation.*

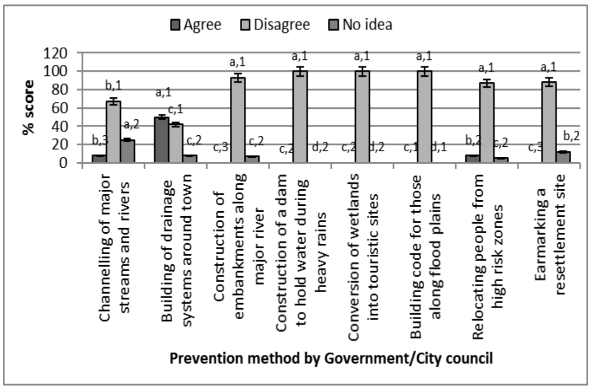

Figure 8. Percentage score of respondents to methods of preventing floods by Government/City Council in Bamenda. . *Scores (bars) with different shades carrying the same letters are not significantly different (P<0.05); Scores (bars) with similar shades carrying the same numbers are not significantly different (P< 0.05). Bars represent standard deviation*.

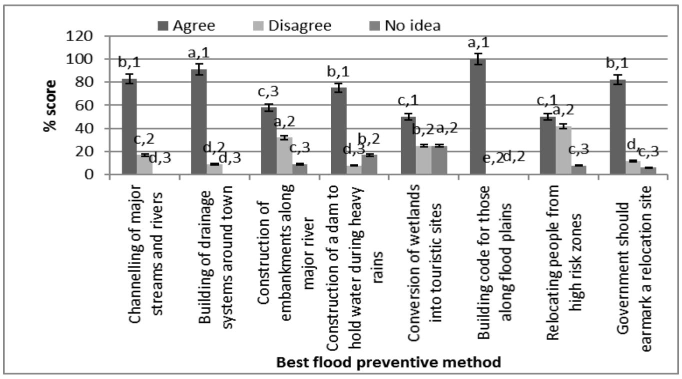

Figure 9. Percentage score of respondents to best prevention methods of floods by inhabitants in Bamenda. *Scores (bars) with different shades carrying the same letters are not significantly different (P<0.05); Scores (bars) with similar shades carrying the same numbers are not significantly different*

($P < 0.05$). Bars represent standard deviation.