Chapter

Determinants of Coping Strategies to Floods and Droughts in Multiple Geo-Ecological Zones

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Abstract

Floods and droughts—the most frequent water-related hazards are negatively impacting livelihoods across the world, particularly in Sub-Saharan African countries, where poverty remains endemic. Naturally, victims adopt different coping strategies against burgeoning hydro-meteorological hazards. Contemporary research on determinants for coping decisions in SSA has been largely driven by isolated case studies, of little relevance for broad-based policy making. We analyze the determinants for coping with floods and droughts across multiple geo-ecological zones in Cameroon. Quantitative data primarily obtained from 2024 flood and drought household victims in the Western Highlands and Sudano-Sahelian Upland geo-ecological zones are analyzed alongside qualitative data obtained through 31 FGDs and 99 IDIs using descriptive statistics and regression analysis in MS Excel 2013 and SPSS 20 for the questionnaires and content analysis in Nvivo 11 for the unstructured interviews. Results reveal government policy, socio-cultural, economic and educational factors, and hazard experience as major shapers of coping decisions, irrespective of hazard type, timing and geo-ecology ($P = 0.05$). In contrast to the state-of-the-art, we observed livelihoods improvement after some hazardous events. The policy implications for long-term coping and resilience building are then discussed.

Keywords: determinants, coping strategies, hazards, floods and droughts, multiple geo-ecological zones, broad-based policy making

1. Introduction

Drought and flood-related disasters have been more devastating than other natural hazards (volcanoes, earthquakes, landslides, etc.), as far as deaths, sufferings and economical and cultural destructions are concerned. Apart from destructive direct effects, flood and drought events have been followed by secondary, indirect tragedies, such as famine, epidemics, fire, destruction of social networks, etc. [1]. Despite the progress in science and technology, man has remained very susceptible to extreme drought and flood events. Their escalation is facilitated by the continuous development of costly but inappropriate infrastructures, increase in population density, and a rather decrease in the buffering capacities (deforestation, urbanization, drainage wetlands, etc.). Understanding the way people in such areas, especially in SSA perceive these hazards, their experiences and interpretations

of patterns of occurrence, coping mechanisms, characteristic factors that drive household and community modus operandi when such anomalies strike are of great imperativeness for the design and implementation of household and community based strategies to curb the effects of floods and droughts; and build more resilient communities.

Bhavnani and colleagues for instance opine that droughts and floods alone account for up to 80% of the loss of life and 70% of the economic losses in SSA [2]. Frequent floods and droughts conditions have reduced the GDP growth of many African countries [1, 3, 4]; and have as well endangered their development advances [5]. Both water-related phenomena have direct and indirect impacts. Over the last 5 decades, floods and droughts have evolved to become major problems in SSA; causing depletion of assets, environmental degradation, impoverishment, unemployment and forced migrations [2, 5, 6]. Flood has been variously defined but for the purpose of this study we have operationally defined flood as a body of water which rises to overflow land which is normally not submerged [7, 8]. There are mainly five types of floods: river flood, flash flood, inland flood, storm surge, coastal flood [8, 9]. Floods are considered as one of the most frequent global hazards [10]. Floods account for approximately 40% of natural disasters and will possibly become more recurrent and severe due to global warming [11].

Unlike floods, droughts are characterized by a slow development, long duration, affects vast areas, and high severity [12]. Furthermore, droughts are expected to become more severe and frequent. This is expected to lead to more water demand, global climate change, and a limited water supply [13]. Based on the nature of water shortages, droughts can be classified into the following four types: meteorological, hydrological, agricultural, and socioeconomic [14]. Among these types, meteorological droughts occur more frequently and regularly than the other three drought types and normally trigger other types of droughts [13].

Floods and droughts are now the most frequent types of major disasters. The impacts of climate change are likely to increase their occurrence as they happen to be the most frequent types of major disasters nowadays especially in SSA. In the era of climate change, the reliability on predictability in rainfall patterns has been reduced significantly [15]. The frequency and severity of weather-related events such as floods and droughts have increased unpredictably and shall continue over time.

Cameroon is one of the SSA countries most hit by these climatic extreme anomalies. It is a country in Equatorial Africa, located on the Gulf of Guinea in Central Africa. It lies between latitude 1°40′ and 13°05′ north and between longitude 8°30′ and 16°10′ east; its area is 475, 412 km^2. Cameroon's beauty and relevance in SSA stems from her extremely diversified landscapes, rich natural resources (petroleum, bauxite, timber and many tropical crops), cultural and ethnic diversity and a multiplicity of climatic and geomorphologic zones. It is not surprising therefore that Cameroon has been nicknamed *Africa in Miniature*.

Cameroon's geo-physical location, tectonic history and climate makes her one of the most susceptible countries affected by natural hazards in Africa. The regularity and devastation caused by such hazards along the active Cameroon Volcanic Line (CVL) are becoming more frequent and even more disastrous, affecting livelihood assets including human, social, financial, natural, physical capital [10, 16]. The country is becoming more prone to and persistently hit by floods and droughts but also by mud flows, rock fall, lahars, volcanic eruptions, toxic gas emissions, earth tremors and landslides which occur on a regular annual pattern.

Despite her diversity and abundant natural resources, Cameroon is also a victim of several hazards and disasters which have accompanied global climate change. Average temperatures have risen since 1930 [17] and average rainfall has reduced by

more than 2% per decade since 1960 [17]. Projected changes in rainfall range from −12 to +20 mm per month (−8 to +17%) by the 2090s [18]. Furthermore, average annual temperatures are predicted to increase between 1.5° and 4.5° by 2100, with a 1.6° to 3.3° rise in coastal zones; and a 2.1° to 4.5° rise in the Sudano-Sahelian region [17]. Average rainfall is predicted to continue to decrease, leading to a prolonged dry season in the Sudano-Sahelian ecological zone. Desert conditions are expected to dominate this area by 2100. It is predicted that Lake Chad will be nearly completely dried up by 2060 [19].

IPCC has established that a 2° rise globally will result in a sea-level rise of between 69 cm and 1 m across the world [20]. Cameroon, given its location along the coast is also expected to experience the impacts of sea level rise over the next century. The above-mentioned statistics indicate that Cameroon is highly vulnerable to floods and droughts. Tiefenbacher et al. [21] have argued that such vulnerability presents a serious threat to the development of the leisure sector and in this case would pose serious problems in attaining sustainable development and generates new challenges for achieving the SDGs; and jeopardizes progress already made. The analysis of climate variability impacts in Cameroon indicates consequences in almost all sectors of development, with huge negative impacts on livelihoods especially at household level [19, 22].

Burgeoning floods and droughts are expected to inflict adverse effects on many Cameroonian households, given their heavy reliance on agriculture for livelihoods dependence of most households on agriculture [23]. Current agricultural contribution to the country's GDP could drop by 14% points from 20% now to an estimated 6% in 2025 [16, 22, 24]. This drop will resolve mainly from increased desertification (drought) in the north and higher incidence of flooding in the south and in the north of the country.

A fundamental step towards reducing the effects of floods and droughts in Cameroon lies in identifying risk management strategies whose validity supersedes specific geo-ecological zones [16, 24]. In this paper we therefore undertake the agency to understand the array of household determinants of coping with the threats of floods and droughts, the shapers of the peoples' perceptions, interpretations and experiences to these risks within their daily lives and how all of these tend to shape the way they respond to the threats presented by floods and droughts in their households across the western highlands and the Sudano-Sahelian geo-ecological and socio-cultural areas of Cameroon with the intention to identify drivers that are robust over space and time.

2. Study area and population, data collection and analysis

2.1 Study area

Cameroon is characterized by five geo-ecological zones with varied landscapes and climates. These are described as Zone I (Sudano-Sahelian); Zone II (High Guinea Savannah); Zone III (Western Highlands); Zone IV (Humid Forest with monomodal rainfall pattern); and Zone V (Humid Forest with bimodal rainfall pattern) [25] (**Table 1**).

The current study was carried out in two of the 5 geo-ecological zones; the Sudano-Sahelian upland and the Western highlands. The Sudano-Sahelian zone is located between latitude 7 and 13° north thus covering more than 21% of the national territory. It has a rippling relief with plateaus that have varying altitudes between 500 and 1000 m and plains with altitudes ranging from 200 to 300 m. The area is also characterized by mountains and flood valleys. In addition to the

SN	Geo-ecological zones	Regions	Surface areas (km^2)
I	Sudano-Sahelian Upland	North and Far North	100,353
II	High Guinean savannah	Adamawa Region, Mbam Division and Lom and Djerem Division	123,077
III	Western Highlands	West and North West	31,192
IV	Humid Rainforest with monomodal rainfall pattern (maritime coast)	Littoral and South West Regions	45,658
V	Humid Forest with bimodal rainfall pattern (Tropical forest)	Centre, South and East Regions	165,770
Total			466,050

Table 1.
Cameroon geo-ecological zones and surface areas.

geographical position of the zone, it has a distinctively dry climate as compared to the rest of the country with a single and short rainy season of about 4 months reaching its peak in August and a very severe and lengthy dry season of up to 7 months or more as one progresses up north from the Mandara Mountains. The annual mean rainfall ranges from 400 mm in the northern part to 1100 mm in the southern part of the zone with an average temperature of up to 28° [25].

On the other hand, the Western Highlands is located between latitudes 5°40′ and 7° north and between longitudes 9°45′ and 11°10′ east. The zone is characterized by relief of massifs and mountains. It features several dormant volcanoes, including Mt. Oku and Mt. Bamboutos. A cool temperate-like climate, influenced mainly by mountainous terrain and rugged topography also characterizes the region. Average rainfall is about 2400 mm, temperatures averaging between 23 and 32° [19]. There are two main seasons; the rainy season which starts from mid-March and ends in mid-November and dry season from Mid-November to mid-March. The dry season is characterized by the harmattan with dry air. Forests once largely covered the Western Highlands but because of the influence of anthropomorphic activities the forests were progressively cleared for farmland and grazing, and today, only patches remain. Although small, these patches are recognized as globally important sites for conservation.

2.2 Study population

Study participants were limited to the study areas; were of both sexes (male and female), aged 20 years and above and had been in the area for at least 10 years; and must have witnessed at least one flood and/or drought event. Data were collected from flood victims in 14 communities of the Western Highlands; and 17 drought-only communities, and 10 floods and droughts affected communities in the Sudano-Sahelian geo-ecological zone.

2.3 Data collection

Three Social Science instruments were used for data collection to ensure accurate and reliable data in order to attain the study objective. The combined approach was used in collecting the data. Three instruments (individual questionnaires, Focus Group Discussion (FGDs) guides and In-depth interview guides) were employed in collecting both quantitative and qualitative data to investigate the research question.

2.4 Individual questionnaire

This was a structured questionnaire used to collect quantitative data from 2024 different floods and droughts household heads or their representatives. It was developed to understand victims' perceptions and to identify the factors that influence their adoption of specific coping strategies in situations of floods and/or droughts. Socio-demographic information was collected as well. Questionnaires were administered to respondents on a face to face basis after obtaining their consent. We had two sets of questionnaires designed for the purpose of this study: one for floods victims and the other for drought victims.

2.5 Focus Group Discussions (FGDs) and In-depth Interviews (IDIs)

To generate qualitative data, 31 FGDs and 99 IDIs were conducted in different floods and droughts communities with household members to capture the general opinion and perception of household members on the hazards and disasters, the consequences of such phenomena in their households and the determinants of their preferred coping strategies. We also sort to understand how experience, cultural factors and location within a certain geo-ecological zone could influence the adoption of formal or informal coping strategies. The data collection instruments in this case were also designed separately to distinctively collect data for droughts and floods.

2.6 Data analysis

All quantitative data generated from the questionnaires were entered into a template designed in the Statistical Package for Social Sciences (SPSS version 20.0) (IBM Corp., Armonk, NY, USA). The data were cleaned and later on analyzed using both SPSS and Microsoft Excel 2013.

For qualitative data (FGDs and IDIs), they were recorded in the field using dictaphones (voice recorder) and later on transcribed and typed into a word processing program (Microsoft Word 2013). The transcribed data were analyzed using Nvivo version 11, and themes were established in relation to research objectives. This was to ensure a standardized analysis and interpretation of the qualitative data generated across tools.

3. Results and discussions

3.1 Socio-economic description of sampled population

This section presents and discusses the socio-economic characteristics of the sample. The discussions are done by comparing results from the Sudano-Sahelian region with those from the Western Highlands. It is worth mentioning that the distribution of respondents across geo-ecological zones indicates that 60% of the from the Sudano-Sahelian zone while 40% was from the Western Highlands. In addition, the sample comprises of victims of both droughts and flood events (45.2% drought victims, 40.7% flood victims and 14.1% both drought and flood victims). More so, while all the respondents in the Western Highlands were flood victims, in the Sudano-Sahelian region, only 0.7% of the respondents witnessed floods alone. 75.7% of the respondents were drought victims, 23.6% had witnessed both droughts and floods.

3.2 Education

In general, most of the respondents had attained only primary level of education (65%), seconded by those with secondary level education (21.9%), third by those with no formal education (7.2%) and lastly by those with High school level of education (5.9%). The results are presented in **Table 2**.

Most respondents had attained only primary school education, irrespective of geo ecological zone. This amounted to 69.8% of droughts victims, 55.6% of flood victims and 81% of both flood and drought victims in the Sudano-Sahelian region ($P < 0.001$); and 54% of the flood victims in the Western highlands.

3.3 Sex

Over 60% of the entire sample are male, while <40% are female. The distribution in the different geo-ecological zones is presented in **Figure 1**. In the Sudano-Sahelian region, the males also had the higher proportion as compared to the females among those who witnessed droughts (69.1 and 30.9% respectively, $P = 0.085$) and those who witness both floods and droughts (63.9 and 36.1% respectively, $P = 0.085$). The Sudano-Sahelian region is in the northern part of Cameroon and most of the people here a Muslims living in a closed society. Access to women is generally more challenging than is the case for men. Interestingly, the majority of those who witnessed floods in the Sudano-Sahelian region were females (55.2 and 44.8% respectively, $P > 0.05$). This stems from the fact that women are the ones mostly involved in farming activities and fetching of water thereby exposing them to the daily realities of the environment. In the Western Highlands, majority of the respondents were males (55.2%) as compared to 44.8% who were females.

3.4 Marital status

The distribution in the entire sample according to the marital status of the respondents showed that majority of them were married (76.1%) while 17.7% were still single. In addition, while 4.8% of the respondents were widow(ers), a very small proportion of the respondents (1.3%) had divorced their spouses. Results from the geo-ecological zones are presented in **Table 3**. These are traditional societies where both boys and girls marry very young and divorce is almost viewed as a taboo. Since it is considered that a woman is married to a family, she is generally considered stilled married to the successor of her husband even after the dead of her real husband. Moreover, men generally remarry upon the dead of their wives because the wives facilitate their household chores which men are essentially not familiar with.

Geo-ecological zone	Disaster type	Primary (%)	Secondary (%)	High school (%)	No formal education (%)	X^2 (*P*-value)
Sudano-Sahelian	Drought	69.8	18.8	3.4	8	32.423 ($P < 0.001$)
	Floods	55.6	22.2	0	22.2	
	Both	81	6	2.1	10.9	
Western Highlands	Floods	54	31.1	10.1	4.8	11.547 ($P < 0.001$)

Table 2.
Educational attainment of respondents.

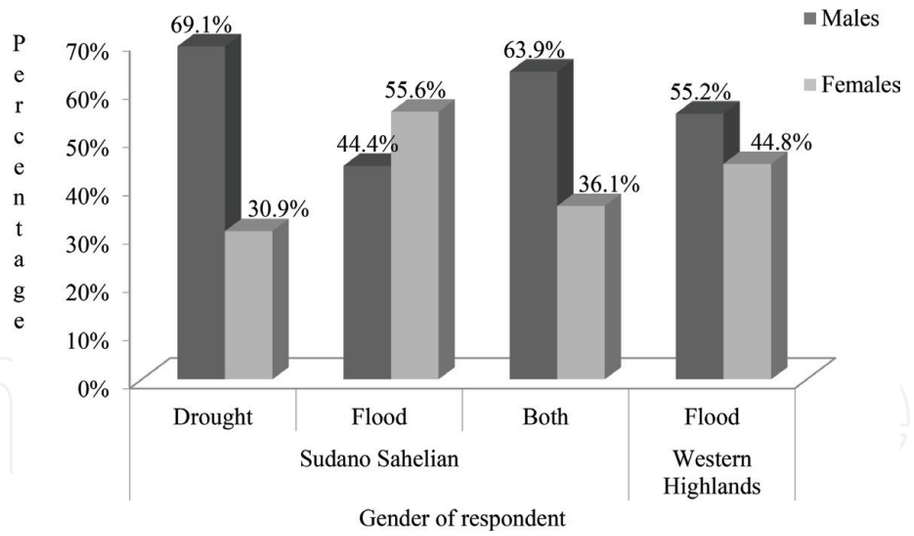

Figure 1.
Sex distribution of respondents.

Geo-ecological zone	Disaster type	Divorced (%)	Married (%)	Single (%)	Widow(er) (%)	Chi-square
Sudano-Sahelian	Drought	0.8	81.9	15.3	2.2	4.6841, $P = 0.585$
	Floods	0.7	77.8	22.2	0.0	
	Both	0.4	86.7	11.2	1.8	
Western Highlands	Floods	1.8	66.4	0.2	22.7	10.308, $P > 0.05$

Table 3.
Distribution according to marital status.

The results indicate that majority of the respondents in both geo-ecological zones as well as for the different disasters were married (66.4% in the Western Highlands and 81.7% for drought, 77.8% for flood and 86.7% for both flood and drought victims in the Sudano-Sahelian region, $P > 0.05$).

3.5 Main occupation

As a livelihood source, most of the respondents were involved in farming activities to sustain their families (60%). However, while 32.1% were business persons, 8.8% of the respondents had salaried jobs. The comparative analysis as presented in **Figure 2** also show that most of the respondents rely on farming for their household livelihoods (56.7% in the Western Highlands and 67.9% for drought and 77.8% for flood victims in the Sudano-Sahelian region, $P = 0.001$).

For those who witness both floods and droughts, the majority of them were found to rely on their respective businesses for their livelihoods (52.4%) as compared to 43.7% who rely on farming.

3.6 Religious affiliations

In our sample, only a slight difference was observed between Christians and Muslims (48.1 and 48.4% respectively). However, a small proportion of the respondents (3.5%) were African Traditionalists. **Figure 3** presents the distribution in the two geo-ecological zones.

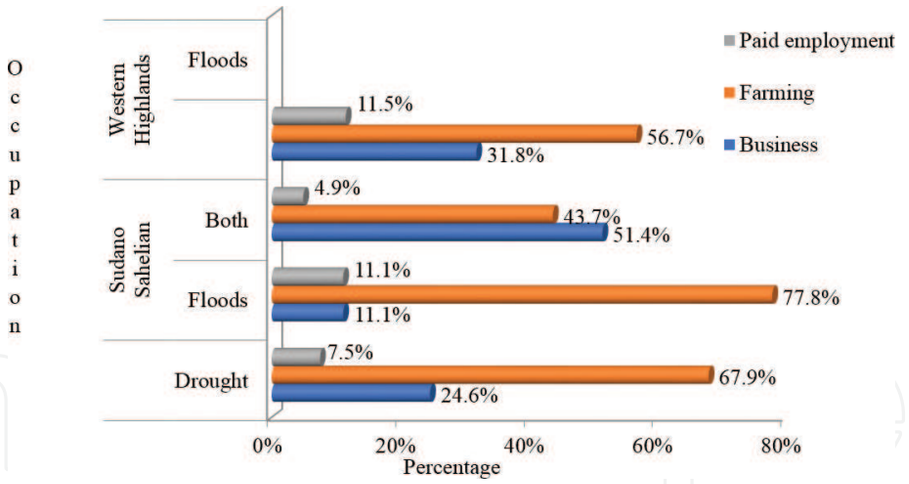

Figure 2.
Main occupation of respondents.

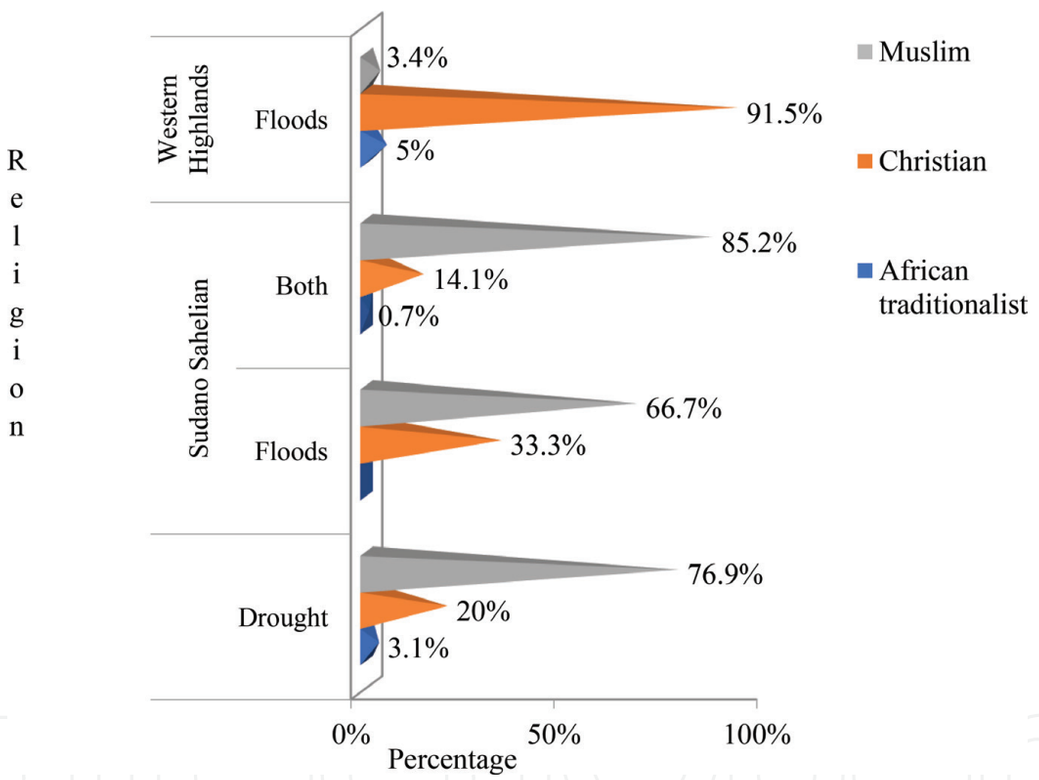

Figure 3.
Religious affiliation of respondents.

From **Figure 3**, we can infer that most of the victims in the Western Highland region are Christians (91.5%). On the contrary, majority of the respondents in the Sudano-Sahelian region for all disaster types were Muslims (85.2% for both drought and flood victims, 66.7% for flood victims and 76.9% for drought victims, $P = 0.02$). This is logical as the Western highlands and the Sudano-Sahelian Zones are both Christian and Muslim communities respectively. More description of the sample population has been presented in **Table 4**.

It can be inferred from **Table 3** that the age of the respondents was significantly higher among respondents in the Sudano-Sahelian zone than those in the Western Highlands (45.41 ± 16.617 years and 43.4 ± 13.739 years respectively, $P = 0.004$). Similar result was also observed with respect to the number of years the respondents have been living in their communities, as it was significantly higher among

Geo-ecological zone	Variable	Sample mean	Disaster type	Mean	Std. dev	Std. error
I	Age/years	45.41**	Floods	43.22*	22.532	7.511
			Droughts	44.13*	16.757	0.554
			Both	49.59*	15.284	0.905
	Number of years living in the village	26.35***	Floods	28	8.139	2.713
			Droughts	25.16	11.99	0.396
			Both	30.14	8.922	0.529
	Total household size	7.41	Floods	8.33	3.122	1.041
			Droughts	7.6	2.933	0.097
			Both	6.77	2.444	0.145
	Income before disaster/FCFA	64,990***	Floods	87,780	125,300	41,770
			Droughts	66,950	72,440	2390
			Both	57,975	46,650	2760
	Income after disaster/FCFA	34,050***	Floods	46,330	75,290	25,090
			Droughts	32,290	48,220	1590
			Both	26,480	23,930	1420
II	Age/years	43.40**	Floods	43.40*	13.739	0.481
	Number of years living in the village	24.5***	Floods	24.5	11.575	0.405
	Household size	7.62	Floods	7.62	3.024	0.106
	Income before disaster/FCFA	113,390***	Floods	113,390	173,040	6060
	Income after disaster/FCFA	63,670***	Floods	63,670	95,555	3350

**Significant at 10% level.*
***Significant at 5% level.*
****Significant at 1% level.*
I = Sudano-Sahelian; II = Western Highlands.

Table 4.
Age, household size, years in the community and income of respondents.

respondents in the Sudano-Sahelian zone than those in the Western Highlands (26.35 ± 11.507 years and 24.5 ± 11.575 years respectively, $P = 0.001$). On the other hand, the estimated household income before and after the disasters were significantly higher among the respondents in the Western Highlands over those from the Sudano-Sahelian zone (FCFA113, 390 and FCFA64, 990 respectively before, $P = 0.001$ and FCFA63, 670 and FCFA34, 050 respectively after, $P = 0.001$). Only the total household size was found not to differ significantly between the two geo-ecological zones (7 ± 3 persons for the Sudano-Sahelian and 8 ± 3 persons for the Western Highlands, $P = 0.105$). Details across the different disaster types have also been provided in **Table 3**.

3.7 Characteristics of floods and droughts in the study areas

This sections first of all looks at the number of times the respondents have witness disaster events in the last decade, before exploring their perceptions with respect to

damage of the disasters as well as the severity of the damage. From **Table 5**, we can infer that more floods have been witnessed in the last decade in the Sudano-Sahelian Zone than in the Western Highlands (5 and 3 respectively, $P < 0.001$).

These disasters are known to bring about damages to the asset portfolio of their victims. Presented in **Table 6** are some of the negative impacts of the disasters faced by the victims both at household and community levels. The results show mix impacts. For instance while damage to natural environment and livestock at the household level was higher in the Sudano-Sahel region than in the Western Highlands (reported by 91 and 43.8% respectively) loss of property was higher in the Western Highlands than in the Sadano-Sahel region (reported 72.6 and 59.9% respectively).

For the Sudano-Sahel region, the highest three damages are incurred through increase in sickness and diseases (reported by 96.9%), destruction of crops (reported by 93.4%) and damage to natural environment and livestock (reported by 91%). For the Western Highlands, the highest three damages are incurred through the destruction of crops (reported by 97.3%) increase in sickness and diseases (reported by 93.7%) and damage to ancestral links (reported by 89.1%). Details of these as well as the perceptions with respect to damages at the community level can be obtained from **Table 5**.

3.8 Severity of disaster damage

Base on the level of damage experienced by each household, the respondents provided information on the severity of the damages caused by the disasters both at household and community levels. The results have been summarized in **Figures 4** and **5**.

At the household level, a significantly higher proportion of the victims from the Sudano-Sahel region acknowledged the severity of the damage from the disasters to be very high than those from the Western Highlands (74.2 and 30.2% respectively, $P < 0.001$). On the other hand those who said the severity of the damage was high was significantly higher in the Western Highlands than in the Sudano-Sahelian region (36.4 and 13.4% respectively, $P < 0.001$).

The results at the community level with respect to the severity of the damages caused by the disasters are similar with those at the household level. For instance just as was the case at the household level, at the community level a significantly higher proportion of the victims from the Sudano-Sahelian region acknowledged the severity of the damage from the disasters to be very high than those from the Western Highlands (71.8 and 28.6% respectively, $P < 0.001$). Similarly, a significantly higher proportion of those who said the severity of the damage was high was from the Western Highlands than in the Sudano-Sahelian region (39.8 and 13.5% respectively, $P < 0.001$).

Disaster	Geo-ecological zone	Mean	Std. deviation	Std. error mean	F-test
Both	Sudano-Sahelian	6.68	1.300	.077	Not applicable
Drought	Sudano-Sahelian	5.99	2.917	.096	Not applicable
Flood	Sudano-Sahelian	4.89	3.060	1.020	0.000
	Western Highlands	3.43	1.615	.057	

Table 5.
Number disasters faced in the last 10 years.

Asset	Geo-ecological zone	Household level		Community level	
		No (%)	Yes (%)	No (%)	Yes (%)
Damage to natural environment and livestock	Sudano-Sahelian	9	91***	8.1	91.9***
	Western Highlands	56.2	43.8***	19.4	80.6***
Loss of human life	Sudano-Sahelian	98.2**	1.8	90.9	9.1
	Western Highlands	97.5*	2.5	92.3	7.7
Loss of property	Sudano-Sahelian	40.1	59.9***	17.7	82.3**
	Western Highlands	27.4	72.6***	21.1	78.9**
Destruction of crops	Sudano-Sahelian	6.6	93.4***	0	100
	Western Highlands	2.7	97.3***	0	100
Destruction of public infrastructure	Sudano-Sahelian	31	69*	0	100
	Western Highlands	33.5	66.5*	0	100
Destruction of worship grounds	Sudano-Sahelian	50.8	49.2	39.5	60.5***
	Western Highlands	36.6	63.4***	7.9	92.1***
Damage to ancestral links	Sudano-Sahelian	39.7	60.3***	71.1***	28.8
	Western Highlands	10.9	89.1***	36.8	63.2
Physical injury	Sudano-Sahelian	61.2	38.8***	19.9	80.1
	Western Highlands	79***	21	17.8	82.2
Increase in sickness and diseases	Sudano-Sahelian	3.1	96.9**	8	92***
	Western Highlands	6.3	93.7**	14.4	85.6***

*Significant at 10% level.
**Significant at 5% level.
***Significant at 1% level.

Table 6.
Analysis of perceptions of damages caused by disasters.

3.9 Disaster management strategies adopted by respondents

This section presents the different strategies explained to be used by the respondents following disasters and especially the last event. As presented in **Table 6**, there were some similarities as well as differences in the disaster management strategies employed by the respondents in the Sudano-Sahelian and Western Highlands regions both at household and community levels. For instance it can be inferred that the respondents in both geo-ecological zones did not rely very much on insurance (0% all round) and borrowing from the Bank (1.6% for Sudan-Sahel and 1.3% for Western Highlands at household level and 0% for Sudan-Sahel and 1% for Western Highlands at community level). On the other hand, they reduced their household savings (94.5% for Sudano-Sahelian and 99.1% for Western Highlands at household

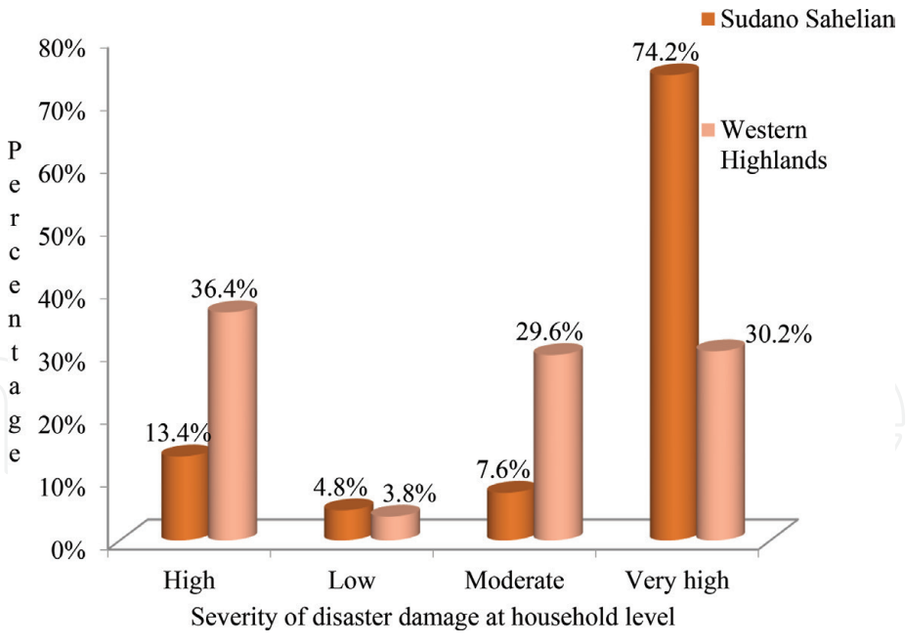

Figure 4.
Severity of damage at household level.

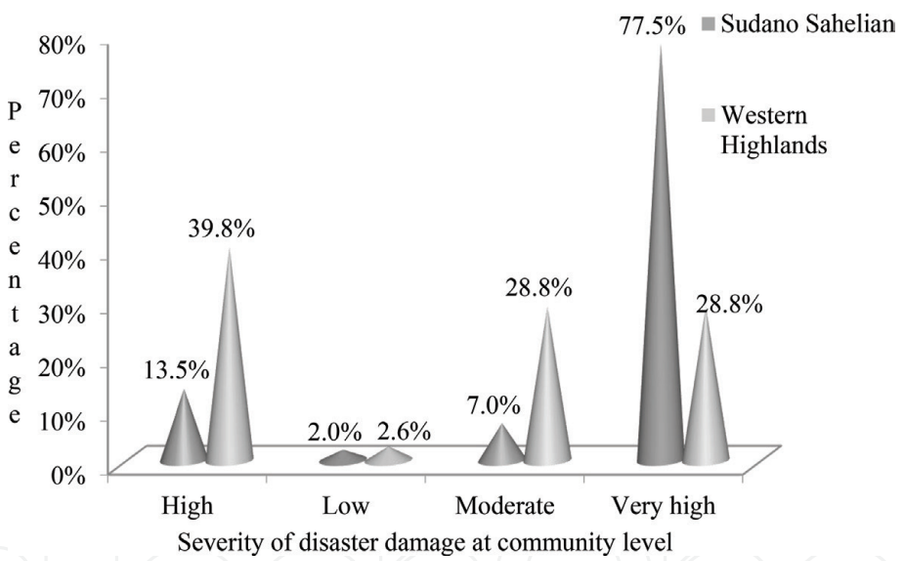

Figure 5.
Severity of damage at community level.

level and 98.1% for Sudano-Sahelian and 98.5% for Western Highlands at community level), rely on stored food (80.3% for Sudano-Sahelian and 87.2% for Western Highlands at household level), and also rely heavily from help from friends and relatives (77.6% for Sudano-Sahelian and 83.6% for Western Highlands at household level and 62.3% for Sudano-Sahelian and 61.6% for Western Highlands at community level). Details of these and more are presented in **Table 7**. It is worth mentioning that of all the strategies captured, only insurance premiums was not used by any of the respondents in the study area.

Presented in **Figure 6** is a summary of the above captured strategies. It can be observed from **Figure 6** that the respondents in both the Sudano-Sahelian Region and the Western Highlands adopted and implemented mainly informal disaster management strategies in order to cope with the negative effects of the disasters (95.6 and 98.9% respectively, $P < 0.001$).

Strategy	Geo-ecological zone	At household level (%)	At community level (%)
Borrow money from Bank***	Sudano-Sahelian	1.6	0
	Western Highlands	1.3	1
Borrow from neighbors***	Sudano-Sahelian	48.2	0.1
	Western Highlands	68.7	19.4
Relocation***	Sudano-Sahelian	40.3	41.9
	Western Highlands	56.6	52
Assembled at central location***	Sudano-Sahelian	30.8	33.2
	Western Highlands	3.6	0
Evacuated by the government***	Sudano-Sahelian	11.8	24.9
	Western Highlands	11.4	3.6
Got help from NGOs***	Sudano-Sahelian	44.2	63.9
	Western Highlands	31.2	44.9
Reduce household savings***	Sudano-Sahelian	94.5	98.1
	Western Highlands	99.1	98.5
Receive help from social groups***	Sudano-Sahelian	39	19.4
	Western Highlands	80.9	49.9
Receive help from Church*	Sudano-Sahelian	8	53.2
	Western Highlands	10.1	49.9
Receive help from friends and relatives**	Sudano-Sahelian	77.6	62.3
	Western Highlands	83.3	61.6
Receive help from Central government***	Sudano-Sahelian	66.5	0
	Western Highlands	17.5	0.2
Receive help from individuals***	Sudano-Sahelian	12	0.2
	Western Highlands	64.7	21.1
Insurance support	Sudano-Sahelian	0	0
	Western Highlands	0	0
Received free medication***	Sudano-Sahelian	67	51.8
	Western Highlands	12.1	25.3
Sold family labor***	Sudano-Sahelian	10.1	69.4
	Western Highlands	27.3	92.4

Strategy	Geo-ecological zone	At household level (%)	At community level (%)
Sold household assets***	Sudano-Sahelian	66	0.1
	Western Highlands	74.2	18.7
Sold household livestock***	Sudano-Sahelian	82.2	0.1
	Western Highlands	36	21.5
Rely on stored food***	Sudano-Sahelian	80.3	0.1
	Western Highlands	87.2	17.1
Building of embankment***	Sudano-Sahelian	62.4	0.4
	Western Highlands	6.1	48.7

*Significant at 10% level.
**Significant at 5% level.
***Significant at 1% level.

Table 7.
Disaster coping strategies.

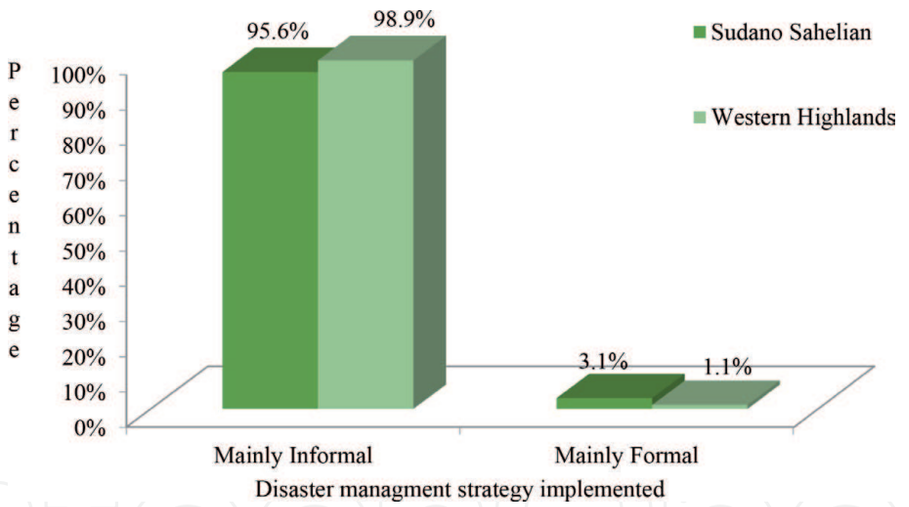

Figure 6.
Main disaster management strategy used by respondents.

We also analysed to identify trends in similarities and differences in the disaster management strategies employed by the respondents from the different disasters faced. The results have been presented in **Table 7**. Mixed results were also observed here at the household and community levels. For instance the distribution according to insurance (0% all round) show that the respondents did not rely very much on it irrespective of the disaster faced. On the other hand, the distribution in terms of reduced household savings indicate strong reliance among the victims of the different disasters (98.9% for flood victims, and 97.5% for drought victims and 100% for both floods and drought victims at the household level, 99.2% for flood victims, and 93.9% for drought victims and 96.5% for both floods and drought victims at community level). Another important strategy used by the disaster victims is to rely heavily on help from friends and relatives (83.3% for flood victims, and 71.8% for drought victims and 96.1% for both floods and drought victims at the household level, 61.4% for

Strategy	Disaster type	At household level (%)	At community level (%)
Borrow money from Bank**	Floods	1.3	1
	Droughts	2.1	0
	Both	0	0
Borrow from neighbors***	Floods	68.8	19.2
	Droughts	62.6	0
	Both	1.1	0.4
Relocation***	Floods	51.6	47.9
	Droughts	25	43.4
	Both	96.8	0
Evacuated by the government***	Floods	11.5	4
	Droughts	15.2	32.5
	Both	0.7	0
Got help from NGOs***	Floods	31.3	45.3
	Droughts	38.3	57.7
	Both	63.2	83.9
Reduce household savings**	Floods	98.9	99.2
	Droughts	97.5	93.9
	Both	100	96.5
Receive help from social groups***	Floods	80.6	49.8
	Droughts	44.8	24.5
	Both	20	2.8
Receive help from Church	Floods	10.1	50
	Droughts	10.2	52.9
	Both	1.1	54.7
Receive help from friends and relatives***	Floods	83.3	61.4
	Droughts	71.8	62.4
	Both	96.1	62.5
Receive help from Central government***	Floods	17.8	0.2
	Droughts	57.6	0
	Both	95.8	0
Receive help from individuals***	Floods	64.2	21.1
	Droughts	14.9	0.2
	Both	2.5	0
Insurance support	Floods	0	0
	Droughts	0	0
	Both	0	0
Received free medication***	Floods	12.6	25.7
	Droughts	58.1	47.4
	Both	95.8	65.3

Strategy	Disaster type	At household level (%)	At community level (%)
Sold family labor***	Floods	26.9	92
	Droughts	13.1	75
	Both	0.7	51.9
Sold household assets***	Floods	74	18.4
	Droughts	56.4	0
	Both	97.2	0.4
Sold household livestock***	Floods	36.3	21.2
	Droughts	77.5	0
	Both	97.9	0.4
Rely on stored food***	Floods	80.3	17.1
	Droughts		0
	Both	87.2	0.4
Building of embankment***	Floods	6.7	48.2
	Droughts	53.6	0.5
	Both	91.2	0

*** Significant at 5% level.*
**** Significant at 1% level*

Table 8.
Disaster management strategies adopted by disaster type.

flood victims, and 62.4% for drought victims and 62.5% for both floods and drought victims at community level). Details of these and more are presented in **Table 8**.

The Binary Logistic Regression was adopted for this analysis. In this analysis, the dependent variable (Disaster coping strategies) took 1 for Mainly Informal Strategies and 0 for Mainly Formal strategies. 16 explanatory variables were used in the analysis. The attributes of our models as presented in **Table 9** and show strong relationships between the dependent and independent variables in the analysis ($X2 = 109.423$, $P < 0.001$).

In addition, the attributes of **Table 10** show that our model explains 23.3% of the factors that affect coping strategies among the drought and flood victims in the two geo-ecological zones.

The factors that affect the coping strategies among the drought and flood victims in the two geo-ecological zones are presented in **Table 11**. The results show that the type of disasters faced, belonging to a social group or network, number of disaster faced, the main occupation of the household head and the number of years living in the community (residence time) positively affected the decisions of the disaster victims to adopt mainly informal disaster coping strategies. On the other

		Chi-square	df	Sig.
Step 1	Step	110.948	15	.000
	Block	110.948	15	.000
	Model	110.948	15	.000

Table 9.
Omnibus tests of model coefficients.

Step	−2 Log likelihood	Cox & Snell R square	Nagelkerke R square
1	416.685a	0.053	0.233

Table 10.
Model summary.

	B	S.E.	Wald	df	Sig.	Exp(B)
Age*	−.058	.012	22.708	15	.000	0.943
Type of disaster	0.190	0.325	0.341	15	0.559	1.209
Educational level*	−1.523	0.602	6.401	15	0.011	0.218
Geo-ecological Zone	−2.114	1.147	3.394	15	0.065	0.121
Household size	−0.040	0.055	0.539	15	0.463	0.961
Marital status	−0.046	0.333	0.019	15	0.890	0.955
Belong to a group or network	18.098	7067.871	0.000	15	0.998	23.64
Number of disasters faced*	0.210	0.064	10.835	15	0.001	1.234
Main occupation of household head	0.116	0.274	0.181	15	0.671	1.123
Religious affiliations	0.675	0.406	2.767	15	0.096	1.965
Residence time*	0.044	0.014	9.708	15	0.002	1.045
Sex	−0.536	0.319	2.831	15	0.092	0.585
Household income before disaster	.000	.000	0.894	15	0.344	1.000
Household income after disaster	.000	.000	1.701	15	0.192	1.000
Per capita income before disaster	.000	.000	2.851	15	0.091	1.000
Per capita income before disaster	.000	.000	1.544	15	0.214	1.000
Constant	−18.243	7067.872	.000	15	0.998	.000

** Significant at 10% level*

Table 11.
Regression determinants.

hand, the age, educational level, household size, marital status and the sex of the respondents showed negative relationships with adopting mainly informal disaster coping strategies. In addition, both incomes before and after the disasters as well as the per capita income before and after the disasters seem not to be important variables that could be used to differentiate households in terms of disaster coping strategies (B = 0.000 for all four variables). These therefore indicate that the financial/economic status had no influence on the decisions of the disaster victims to adopt one form of disaster coping mechanisms over the other [16, 20, 26, 27].

Of significance to this study is the number of disasters faced (B = 0.210, $P < 0.001$), religious affiliations (B = 0.675, $P = 0.096$) and the residence time (B = 0.044, $P = 0.002$).

The number of disasters experienced by households (B = 0.210, $P < 0.001$) is therefore seen to be an important variable influencing household decisions to adopt mainly informal disaster management strategies. This is normal, considering that experiencing too many disasters often affect the ability of households to bounce back. Consequently, these households tend to lean on community based informal response mechanisms to deal with aftermaths of disasters [28, 29]. This is probably why [30] explained that if people are made aware of any potential disasters they might face and their collective responsibility in preventing or minimizing the

effects of the disasters, it will help them to make preparedness part of their lives according to the disaster management options available to them. Over time, experience in managing (especially long term) shocks becomes an asset, as victims plough back these experiences into strategies aimed at preventing, mitigating, coping or resisting similar (and even dissimilar) shocks in the future. Similar contentions have been raised in the topical literature by [31, 32]. One can therefore conclude that experience with disasters can be quite robust in determining the management practices that victims (especially in developing countries) adopt to deal with natural hazards.

In an area where people roughly share the same way of life, occupation and are subjected to similar shocks, they are likely to employ similar coping strategies when hazards strike as response opportunities and available coping mechanisms are relatively homogeneous [27]. This probably explains why in the research area, the main occupation of the household head affected their household coping strategies. Improving agricultural techniques can therefore enhance the coping capacities of our sampled households to future floods. Improving education to enhance access to off-farm income activities should also be contemplated.

Though not significant, belonging to a social group or network showed the strongest contribution to the use of mainly informal disaster coping strategies in this study (B = 18.098, $P > 0.05$). Therefore, the more networks a household head belongs to, the more the household is going to rely mainly on disaster coping strategies to handle disaster effects. This therefore suggests that households who belong to groups or networks are likely to dissipate risks through livelihood diversification. This aligns with the findings of [31] who explained appropriate forms of social capital especially belonging to networks usually appear to have the potential to aid rural income generation as well as reduce vulnerability to livelihood shocks of poor households. Thus for any additional group that the household head joins, the probability that the household will employ mainly informal disaster coping strategies increases by 23.64 times.

The probability of the Wald statistics for the variables age and educational level for instance (22.708 and 6.401 respectively) suggests that the disaster victims who are older and more educated are likely to move away from using mainly informal risk management mechanisms to both informal and formal mechanisms. The negative coefficient on education leads us to hypothesize that the more educated a household head is, the more he/she is likely to use formal than informal instruments in managing disasters. These results however contradict the findings in the topical case studies [26, 27, 32]. About 34 for instance in his work in India found education to be a very cost-effective strategy for influencing and implementing schooling decisions in poor households in India. A probable explanation for this is the generally low levels of education observed in the Cameroon case study.

4. Conclusion

Our research demonstrates that Cameroon has diverse geo-ecological zones with climate-related hazards and disasters that are specific to some while others cut across. Through a comparative analysis, we differentiate that the Sudano-Sahelian zone is characterized by severe droughts and very deadly floods in both the urban and rural settings while the Western highlands are typified by floods in both the urban and rural settings as well. Further, we gained insights into the different drivers of household determinants of coping with droughts and floods in both geo-ecological zones. Respondents identified Informal coping mechanisms as their major fallback positions and include amongst others; reducing their household

savings, relying on stored food and heavy reliance on assistance from friends and relatives. Formal coping strategies were not identified as major drivers at both household and community levels in any of the zones. This explains that building social networks is a very important component in building policies that aim at making households more resilient in these zones.

We also observed that socio-cultural factors and experience with previous disasters influenced the type of strategies people would adopt in subsequent events. The nomadic nature of the Muslim households in the Sudano-Sahelian area elucidates why temporal or permanent migrations will easily be an option in coping with droughts and/or floods. This was not the case with most of the sedentary population of the Western Highlands where most people reported the wish to maintain their residence even after experiencing the floods except in the neighborhoods that have been completely and permanently inundated.

In addition, this was the first of a kind to have witnessed a positive change in income levels of some household members, especially in the Western Highlands where the huge floods have given the opportunity for change in socio-economic activities. Most have now engaged in lumbering and illicit sale of fuel which are considered more economically rewarding than the farming activities they formerly practiced. The presence of water routes now facilitates the transportation of timber from the hinterland to the coast as well as the transportation of fuel from neighboring Nigeria to Cameroon. The energetic male about the ages of 35 and 45 are gainfully employed in this new found economic sector.

Above all, this study is a first step in developing a robust methodology for comparing household determinants for coping with climate-related vagaries within and across multiple geo-ecological zones and within and across hazards/disasters. It serves as a platform for broad-based policy making and implementation not only within Cameroon but across SSA where similar realities abound.

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References

[1] Jury MR. Economic impacts of climate variability in South Africa and development of resource prediction models. Journal of Applied Meteorology. 2000;**41**:46-55

[2] Bhavnani R, Vordzorgbe S, Owor M, Bousquet F. Report on the Status of Disaster Risk Reduction in the Sub-Saharan Africa Region. Commission of the African Union, United Nations and the World Bank. 2008. Available from: http://www.unisdr.org/files/2229DRRinSubSaharanAfricaRegion.pdf [Accessed November 28, 2018]

[3] World Bank. Managing Water Resources to Maximize Sustainable Growth: A Country Water Resources Assistance Strategy for Ethiopia. Washington DC: The World Bank; 2005. pp. 8-10

[4] Brown C, Meeks R, Hunu K, Yu W. Hydroclimate risk to economic growth in sub-Saharan Africa. Climate Change. 2011;**106**:621-647

[5] Hellmuth ME, Moorhead A, Thomson MC, Williams J, editors. Climate Risk Management in Africa: Learning from Practice. New York, USA: International Research Institute for Climate and Society (IRI), Columbia University; 2007. pp. 15-29

[6] Scheffran J, Marmer E, Sow P. Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. Applied Geography. 2012;**33**:119-127

[7] Yevjevich V. Floods and society. In: Proceedings of the NATOASI Conference on "Coping with Foods", Erice; 3-15 November 1992. 1992. pp. 11-17

[8] Zbigniew WK, Saisunee B, Axel B, Holger H, Lettenmaier D, Menzel L, et al. Natural Resources Forum. 2002;**26**:263-274

[9] Marfai MA. Potential vulnerability implications of coastal inundation due to sea level rise for the coastal zone of Semarang City, Indonesia. Environmental Geology. 2008;**54**:1235-1245

[10] Bang H, Miles L, Gordon R. The irony of flood risks in African dryland environments: Human security in North Cameroon. World Journal of Engineering and Technology. 2017;**5**:109-121

[11] Reacher M, McKenzie K, Lane C, Nichols T, Iversen A, Hepple P, et al. Health impacts of flooding in Lewes: A comparison of reported gastrointestinal and other illness and mental health in flooded and non-flooded households. Communicable Disease and Public Health. 2004;**7**(1):1-8

[12] Hao L, Zhang XY, Liu SD. Risk assessment to China's agricultural drought disaster in county unit. Natural Hazards. 2012;**61**:785-801

[13] Fontaine MM, Steinemann AC. Assessing vulnerability to natural hazards: Impact-based method and application to drought in Washington state. Natural Hazards Review. 2009;**10**:11-18

[14] Wilhitea DA, Sivakumarb MVK, Pulwartyc R. Managing drought risk in a changing climate: The role of National Drought Policy. Weather and Climate Extremes. 2014;**3**:4-13

[15] Doris F, Edward W, Caroline T, Mary A. Assessment of the coping strategies of flood victims in the Builsa District. Environment and Sustainability. 2018;**2**(1):17-25

[16] Azibo BR, Ateh FS, Nji TM, Azibo NK. Determinants for strategies to cope with climate related flood hazards in Cameroon. Climate Change. 2017;**3**(12):2-10

[17] Molua EL, Lambi C. The economic impact of climate change on agriculture in Cameroon. Policy Research Working Papers. 2007;**1**:4364

[18] McSweeney C, New M, Lizcano G. UNDP Climate Change Country Profiles: Cameroon. Oxford: United Nations Development Programme and University of Oxford; 2008. pp. 8, 30-32

[19] IPCC. Climate Change 2007: Impacts, Adaptation and Vulnerability. Cambridge, Cambridge University Press: Intergovernmental Panel on Climate Change; 2007

[20] Helgeson JF, Dietz S, Hochrainer-Stigler S. Vulnerability to weather disasters: The choice of coping strategies in rural Uganda. Ecology and Society. 2013;**18**(2):2

[21] Tiefenbacher JP, Day FA, Walton JA. Attributes of repeat visitors to small tourist-oriented communities. The Social Science Journal. 2000;**37**(2):299-308

[22] Innocent NM, Bitondo D, Balgah RA. Climate variability and change in the Bamenda highlands of North Western Cameroon: Perceptions, impacts and coping mechanisms. British Journal of Applied Science & Technology. 2016;**12**(5):1-18

[23] Nguh BS, Kimengs JN. Land use dynamics and wetland Management in Bamenda: Urban development policy implications. Journal of Sustainable Development. 2016;**9**(5):1-11

[24] Yenshu VE. Knowledge systems, agricultural practices/farming systems and the challenges of climate change. Revue de L'Academie des Sciences du Cameroun. 2013;**11**(1):85-91

[25] Ndi HN. Environmental change and malaria in Maroua, Far North Cameroon. In: Paper Presented at the 2nd International UGEC Conference on "Urban Transitions and Transformations: Science, Synthesis and Policy"; 6-8 November; Taipei. 2014. 27 pp

[26] Berman R, Quinn C, Paavola J. Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: Implications for adapting to future climatic change. Climate and Development. 2014;**1**:1-26

[27] Jensen R. Do labor market opportunities affect young Women's work and family decisions? Experimental evidence from India. The Quarterly Journal of Economics. 2012;**127**:753-792

[28] IPCC. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Geneva: Intergovernmental Panel on Climate Change; 2014

[29] Holzmann R, Hinz RP, Dorfman M. Pension Systems and Reforms Framework: Social Protection and Labour. Discussion Paper No. 0824. 2012. Retrieved from: Sitersources. worldbank.org/Socialprotection/resources/2805581225731593400/spl_at_WB_2000-08.pdf [Accessed: 20/11/2017]

[30] Balgah RA. Managing Natural Risks and Shocks. Informal Response Dynamics and the Role of Non-profit Organization. Stuttgart, Germany: Grauerverlag; 2011

[31] Pathirage C, Seneviratne K, Amaratunga D, Haigh R. Knowledge Factors and Associated Challenges for Successful Disaster Knowledge Sharing. United Nations Office for Disaster Risk Reduction and Global Assessment Report on Disaster Risk Reduction. 2014. Available from: www.preventionweb.net/hyogo//inputs/Pathirage [Accessed February 15, 2018]

[32] Njome M, Chuyong G, de Wit M. Volcanic risk perception in rural communities along the slopes of Mt. Cameroon, west Central Africa. Journal of African Earth Sciences. 2010;**58**:608-622