Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.6, No.2, 2016

Stakeholder Perception of Global Warming, Rainfall Variability and Sea Level Rise Hazard Perils in Three Coastal Districts of Douala-Cameroon

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Abstract

Present day climate change scientist fully embrace the concept of global warming and have repeatedly pointed out that a solution to global warming problem requires studies on climate change education, awareness and proper understanding of causes and impacts. The present study was designed to assess the level of knowledge and awareness of inhabitants of three sub divisions of Douala on the impacts of SLR hazards.

1200 questionnaires were administered to inhabitants of Douala I, IV and V by stratified purposive sampling technique. The Chi square (X^2) statistical tests were performed to compare responses to survey questions across sub divisions as well as across demographic groups. The Cramer's V test (nonparametric correlation) was performed to detect strength of associations of causes and impacts of global warming, rainfall variability, sea level rise perception and social determinants. Correlates of perception of global warming, rainfall variability, sea level rise and water quality parameters and environmental hazards were also assessed.

Results show that awareness and perception to global warming, yearly variation of rainfall and knowledge of sea level rise were highly significant ($p<0.000$) across districts. The Douala V inhabitants (37.8 %) were more aware of global warming and bothered about its impact than Douala IV and I respondents. Douala V respondents perceived that human beings are linked to the causes of global warming, rainfall variability and sea level rise than Douala I and IV. The Douala IV respondents were more knowledgeable in terms of SLR (37 %) than Douala I and V respondents. Impacts of exaggerated heat wave and increase in floods had significant differences across the district ($p<0.000$). Sources of water during the rainy season (rivers/streams, wells, rainfall) were highly significant while differences in the use of water resources for domestic purposes across the three districts were also significant. Flooding and tidal effects were perceived to be the most devastating hazards in Douala I, IV and V as they were highly significant ($p<0.000$).

Highly significant association ($P<0.01$) between the perceived human causes of sea level rise and knowledge of it for Douala I and IV were observed. Rising water tables, inundation, changed colour of water and odour of water as impacts of sea level rise were associated with the taste of water sources. The most devastating hazards were tidal effects and flooding (39 % each) for Douala IV and wave action (44 %) for Douala I.

Awareness and knowledge on causes and impacts of climate change were low. A majority of the respondents perceived the will of God as being responsible to climate change causes and impacts on water resources quality in the study area. There is an urgent need for education of inhabitants on causes and impacts of climate change variables that are implicated on water source quality.

Keywords: *Perception and awareness, global warming, rainfall variability, sea level rise hazards, Douala-Cameroon*

1. Introduction

Global warming and water resources are connected and constitutes an important topical issue of increasing attention in recent years for the environment. The hydrosphere which is one of the components of the environment is vital for its proper functioning. Unfortunately, human activities have undermined these resources in several ways and this is been compounded by associated hazards of sea level rise due to global warming.

In Cameroon, average temperatures are expected to increase and a drop in the number of rainfall days is anticipated (Ayonghe, 2001). This could add on the stresses to water availability and quality especially as rainfall serve as recharge sources of ground water sources. The increase in temperature, consequent sea level rise and rainfall variability might have negative impacts on water resources in coastal areas directly and this may be significant due to likely reductions in precipitation. Should the decrease in water quality be exacerbated as a result of climate change, livelihood activities could be undermined with devastating consequences.

Global warming has gained official recognition and constitutes an issue of concern for the public, although the degree of such concern varies among groups who conceptualize global warming in different ways. It is still unclear how the public relate to global warming in terms of knowledge, awareness and perceptions. Only when background knowledge and information about the environment is adequate, could it enable the public to take part in decision making concerning their environment.

Unfortunately, the knowledge of global warming and associated risks and its relation with other related environmental concerns is not well appreciated by those in the non-climate world (Rukevwe, 2008, Ekpoh and Ekpoh, 2010, Pam, 2007). Madzwamuse (2010) stipulated that the problems of global warming are worldwide as well as local, the intervention of which requires the engagement of stakeholders at global, national and local levels.

Present day climate change scientists fully understand the concept of global warming. They highlight the fact that anthropogenic warming and sea level rise (SLR) will continue for centuries due to the time scales associated with climate processes and feedbacks even if greenhouses gases concentrations were to be stabilized (McGrath, 2013, IPCC, 2014, IPCC, 2013). Furthermore, climate scientists have repeatedly pointed out that a solution to global warming problem requires studies on climate change education, awareness and proper understanding of causes and impacts. This is because such studies provide useful insights about changing trends and patterns of the seasons and weather. Such studies require the use of survey studies with the help of questionnaires which can provide valuable information to disaster management institutions for developing risk management procedures (Bird, 2009).

Much work on global warming education and awareness has been done (Elrick-Barr *et al*., 2015, Yu *et al*., 2013, Brulle *et al*., 2012, Odjugo, 2013, Ejembi and Alfa, 2012, Codjoe *et al*., 2013, March *et al*., 2014, Jamelske *et al*., 2013, Lieske *et al*., 2013, Varkuti *et al*., 2008, Addo *et al*., 2011, NIEA, 2012). However, such studies are lacking in Cameroon, and this could fill the gap of information especially with paucity of scientific data on weather and environmental change observation. Thus, the human response is critical to understanding and estimating the effects of SLR impacts on fresh water quality for ease of developing adaptation strategies.

Furthermore, the development of appropriate adaptation and mitigation measures to global warming will not depend on physical sciences alone but rather an understanding of public knowledge and perceptions of these hazards and risks. Therefore, an assessment of questionnaire based hazard knowledge and risk perception of global warming consequences will inform global warming policy in part. This is so because the impacts of global warming variability are uncertain, temporally variable and providing a complex mix of attributes that challenge views on what constitutes a public concern. The present study was designed to assess the level of knowledge and awareness of inhabitants of three sub divisions of Douala on the impacts of SLR hazards.

*2*2. Materials and methods

2.1 Study sites

The study was conducted from November 2014 to June 2015.Three sub divisions of Douala (Douala 1, IV and V) potentially exposed to coastal hazards were selected based on proximity to the sea and rivers as case study (Figure 1). These sites are physically vulnerable to climate risks (global warming, rainfall variability and sea level rise hazards impact) as they are low lying with the highest area not more than 10 m. above mean sea level. It is made up of built up areas, mangroves, estuaries and a dense network of rivers.

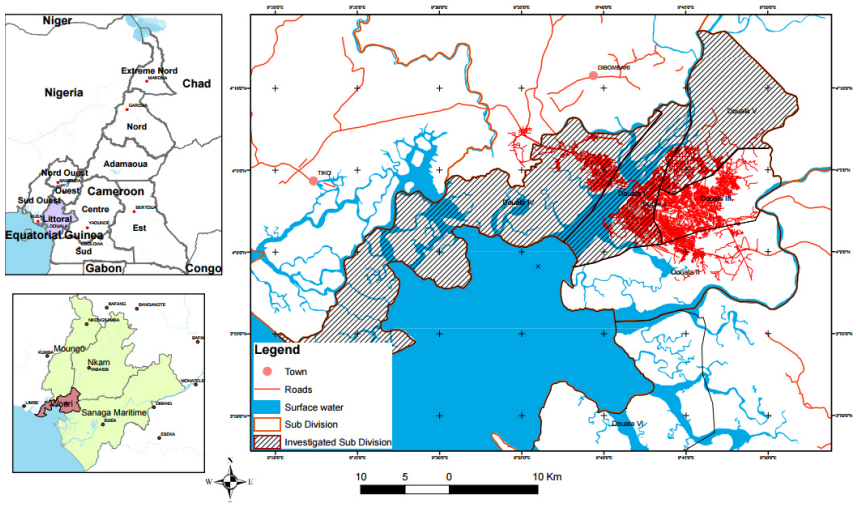


Figure 1: Douala showing the three sub divisions (Douala 1, IV and V)

2.2 Sample size and design

From published tables, formulas and online sample size procedures calculation, a population of one million and above requires 384 samples (Naing *et al*., 2006b, Morgan and Krejei, 1990). The combined population size of the three districts is about slightly more than two million. According to Naing *et al*. (2006a), it is wise to oversample by 10 % to 20 % of the computed number required depending on how much the investigators would anticipate these discrepancies. This study takes the confidence of 95 % to ensure the accuracy and the corresponding Z value is 1.96; δ is the overall standard deviation, and takes 0.5; and d is the sampling error range.

A total of 1200 questions were distributed with 400 for each sub division. 937 (78 %) completed survey responses were received. This number is greater than the minimum valid sample size of 384 and satisfies the basic requirements for sample size. The returned rate was 309 (33.0 %), 318 (33.9 %) and 310 (33.1%) for Douala I, IV and V respectively. Stratified purposive sampling technique as recommended by Monroe and Monroe (1993) was used to administer the questionnaires, though the samples chosen did not reflect the true population of Douala but this technique enables the inclusion of respondents from different stakeholder groups that might otherwise be underrepresented if random sampling was used.

2.3 Data analysis

Descriptive statistics was used to analyse the data and presented in simple percentages. This data concerned socio-demographic characteristics (age, gender, occupation, highest level of education attainment). Analytical statistical tools were used to analyse data the perception of the causes and impacts of SLR hazards on water resources according to the methods described by Lieske *et al*. (2013) using the SPSS version 20.0 software.They highlighted the fact that these variables have previously been identified to influence risk perception.

Chi square statistical tests were used to compare responses to survey questions across sub divisions as well as across demographic groups. The Cramer's V test for association, which is a derivative of the Chi square test, was performed to detect associations of causes and impacts of global warming, rainfall variability, sea level rise perception and social determinants. Correlates of perception of global warming, rainfall variability, sea level rise and water quality parameters and environmental hazards were also assessed using the Cramer's V test according to the methods described by Ennos (2007).

3 Results

3.1 Characteristics of study population

Table 1 presents the demographic characteristics of the study population for the three sub divisions investigated (Douala I, Douala IV and Douala V). The distribution of gender, household size and duration of stay in the three study populations were quite similar implying that there were no significant differences from the expected value and hence no evidence of associations. However, statistically significant differences were

observed in the distribution of age group, education and occupation between sub divisions (X^2 = 96.23, 57.53, and 127.75 respectively with p < 0.000).

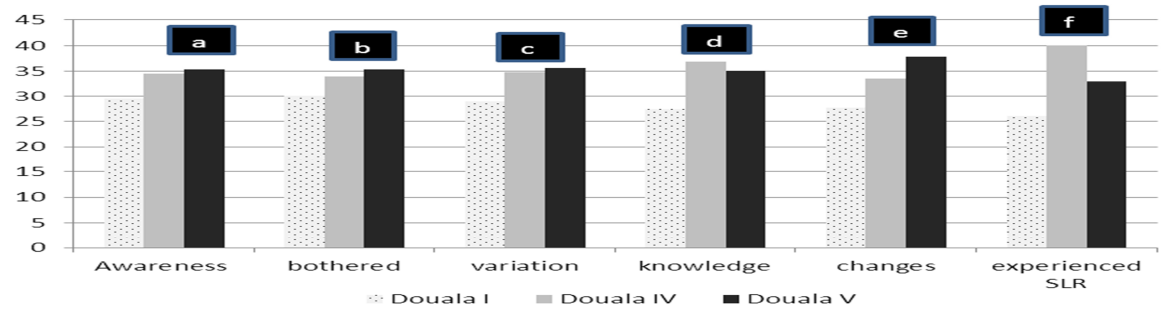
Table 1: Demographic characteristics of respondents for the three study areas (Douala I, Douala IV and Douala V)

	Douala I	Douala IV	Douala V	X^2	*p*
Gender					
Female	164 (34.7)	172 (36.4)	130 (27.5)	19.83	0.07
Male	143 (30.8)	144 (31.0)	176 (37.9)		
Age					
< 20	77 (48.1)	42 (26.2)	38 (23.8)		
21 – 30	65 (37.6)	38 (22.0)	69 (39.9)		
31 – 40	82 (34.5)	80 (33.6)	75 (31.5)	96.246	0.000
41 – 50	59 (29.9)	89 (45.2)	48 (24.4)		
51 – 60	19 (16.1)	54 (45.8)	44 (37.3)		
>61	6 (11.8)	13 (25.5)	32 (62.7)		
Education					
No formal education	6 (37.5)	6 (37.5)	4 (25)		
Primary school	41 (36.9)	35(31.5)	32 (28.8)		
First cycle secondary school	79 (47.3)	37 (22.2)	50 (29.9)	57.532	0.000
Second cycle secondary school	92 (33.5)	105 (38.2)	77 (28.0)		
Higher education	90 (24.5)	133 (36.1)	143(38.9)		
Household size				87.584	0.969
Occupation					
Civil servant	31(21.5)	51 (35.4)	61 (42.4)		
Farmer	5 (29.4)	6 (35.3)	5 (29.4)		
Business	75 (33.9)	92 (41.6)	54 (24.4)		
Student	78 (41.1)	54 (28.4)	54 (28.4)		
Housewife	22 (33.3)	25 (37.9)	19 (28.8)		
Applicant	25 (40.3)	9 (14.5)	28 (45.2)	127.755	0.000
Fisher man	9 (56.2)	1 (6.2)	6 (37.5)		
Mangrove logger	0 (0)	4 (66.7)	2 (33.3)		
Canoe operator	0 (0)	3 (30)	7(70)		
Call box retailer	2 (28.6)	2 (28.6)	3 (42.9)		
others	61 (31)	68 (34.5)	67 (34.0)		
Duration of stay				221.189	1.00

About 48 % of the respondents below 20 years were obtained in Douala 1 area. The middle age group was concentrated in Douala IV (41-50 and 51- 60). More than half of the respondents above 61 years of age were in Douala V (63 %). Respondents in Douala V (39 %) seem to have higher education levels than in Douala I and Douala IV respectively. The majority of respondents of Douala V were civil servants (42 %) when compared with Douala I and IV. Douala V had higher number of canoe operators and applicants (70 % and 45 %) as compared with Douala I (0 and 40 %) and Douala IV (30 and 15 %). The highest number of mangrove loggers (67 %) was obtained in Douala IV. For Douala I the value for fisher men and students were higher (56 and 41 %).

3.2 Perception and awareness of causes, impacts and adaptation of climatic change indicators.

Results of the awareness and knowledge of temperature changes, rainfall variability and SLR are shown on Figure 2. Apart from the question if the region is affected by SLR in the investigated zones that shows similarities across the sub divisions (X^2 = 34.58/p>0.05). The rest of the variables were statistically different from the expected distribution across the sub divisions. From Figure 2 the majority of the respondents who had heard and bothered about global warming were in Douala V (35 %).



Where a= (X^2=56.88, p<0.000); b=(X^2=37.78, p<0.000), c= (X^2=57.15, p<0.000), d=(X^2=32.32, p<0.001), e=(X^2=50.39, p<0.000), f=(X^2=39.72, p<0.002)

Figure 2: Perception and awareness level of selected climate variables in the study area

About 52 % of respondents who did not know about changes in temperature associated to global warming of the region were in Douala I (Table 2). Similarly, 49 % and 42 % of respondents in Douala I indicated that there are no noticeable changes due to global warming and that global warming was associated to decrease in temperature respectively. However, 39 % of respondents in Douala V were aware of increases in temperature due to global warming ($p < 0.005$).

Over 36 % of respondents in Douala IV perceive rainfall pattern to be heavy, 41 % (Douala V) think it is light while 38 % of Douala I respondents perceive rainfall pattern as normal. Overall the respondents of Douala V (38 %) indicated that there had been changes in rainfall pattern lately with yearly variations in this pattern (36 %). A majority of the Douala V respondents (39 %) indicated an increase in these changes as opposed to 53 % of Douala I respondents who were not aware if there had been changes to rainfall pattern.

The Douala IV respondents (37 %) were knowledgeable to the concept of SLR (Figure 2). They further indicated that Douala IV experiences SLR (40 %). However, the importance of SLR (39 %) was appreciated most by the Douala V respondents as compared to the Douala I and IV study populations (Table 2). 38 % of Douala IV respondents as compared to Douala I and V obtain information more as concerns variables of SLR. Audio-visual sources of information were important in Douala IV (36.5 and 36.4 %) for television and Radio respectively. Print media and interactive sources of information were equally more important in Douala IV.

Table 2: Changes in temperature, rainfall and sources of information on climate variables

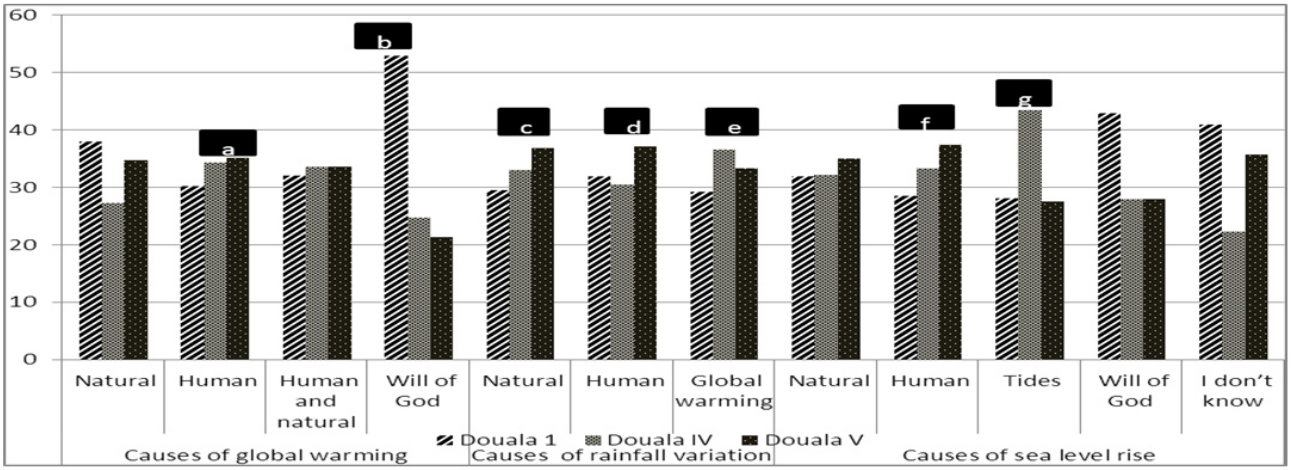
	Douala I	**Douala IV**	**Douala V**	X^2	*p*
Noticeable changes with temperature of this region.					
Increase in temperature	177 (26.5)	227 (34.0)	260 (38.9)		
Decrease in temperature	37 (42)	30 (34.1)	21 (23.9)	86.663	0.000
No changes	31 (49.2)	22 (34.9)	9 (14.3)		
I don't know	58 (51.8)	36 (32.1)	16 (14.3)		
How is the rainfall pattern?					
Heavy	142 (28.3)	184 (36.7)	171 (34.1)		
Light	57 (34.5)	40 (24.2)	68 (41.2)		
Normal	74 (38.1)	68 (35.1)	50 (25.8)	39.941	0.002
Others	32 (44.4)	24 (33.3)	15 (20.8)		
What are these changes?					
Increase	146 (28.5)	164 (32.0)	200 (39.0)		
Decrease	70 (34.8)	66 (32.8)	62 (30.8)	55.908	0.000
I don't know	55 (52.9)	32 (30.8)	17 (16.3)		
others	33 (31.7)	47 (45.2)	23 (22.1)		
Importance of sea level rise	112 (34.4)	85 (26.1)	127 (39)	34.268	0.012
Area affected by sea level rise	109 (25.6)	172 (40.5)	140 (32.9)	34.58	0.075
Information source of these variables	199 (29.8)	253 (37.9)	212 (31.7)	30.199	0.003
Sources of information					
Television	172 (29.0)	217 (36.5)	201 (33.8)	31.182	0.008
Radio	135 (28.7)	171 (36.4)	160 (34.0)	24.024	0.008
Printed material	47 (19.3)	108 (44.4)	86 (34.0)	62.415	0.000
Lecturers/teachers	90 (26.6)	141 (41.7)	104 (30.8)	48.503	0.000
Colleagues/friends	96 (27.1)	150 (42.4)	106 (29.9)	56.022	0.000
Personal observation	121 (29.0)	170 (40.8)	122 (29.3)	45.236	0.000

As shown on Figure 3, over 35 % of respondents of Douala V perceive human causes as responsible for global warming. Similarly, the majority of respondents in Douala V (both 37 %) perceived human causes as responsible for the current pattern of rainfall variations and SLR. However, 53 % and 43 % of respondents in Douala I perceived the will of God as the major cause of global warming and SLR respectively. Contrarily, about 44 % of respondents of Douala IV perceive tides as responsible for SLR.

Figure 4 also presents the results of impacts of SLR variables on the environment. The results show similarities between the three sub divisions for thermal expansion of surface water, floods, loss of habitat, malarial prevalence, air pollution and species extinction. However, there were significant differences in distribution across sub divisions in terms of exaggerated heat waves, changes in weather pattern and drying of streams and rivers based on the probable impacts of global warming.

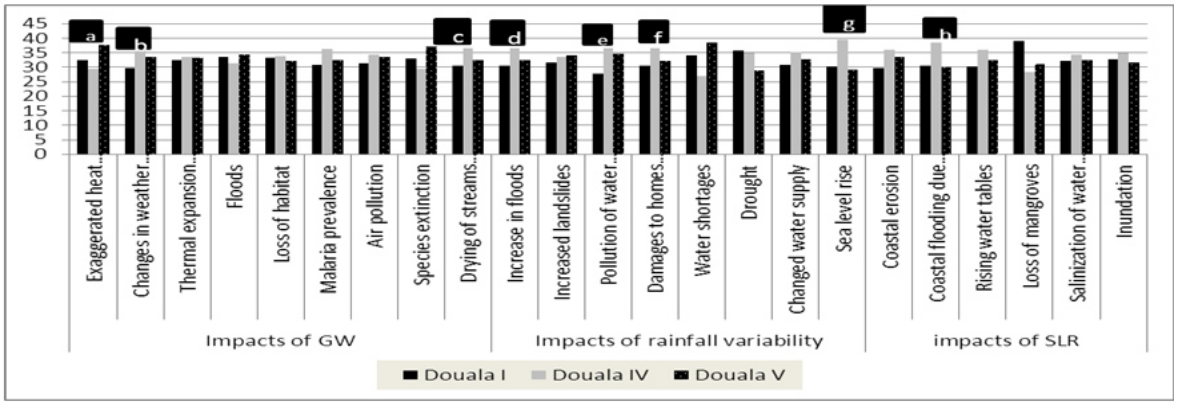
38 % of respondents in Douala V indicated that exaggerated heat waves was a major impact of global warming while about 36 % of respondents of Douala IV indicated changes in weather pattern as the major impact of global warming. Similarly, the majority of Douala IV respondents noted that drying of streams and rivers (37 %) as impacts of global warming. Overall the respondents of Douala IV (35 %) strongly agree that temperature changes have impacted on them in one way or the other.

The results of impacts of rainfall variability (Figure 4) on increased landslides, water shortages, drought and changed water supply across the three sub divisions showed similarities. There were however, statistically significant differences in terms of increased floods, pollution of water sources, damage to homes and buildings and SLR across the sub divisions. Over 36 % of respondents of Douala IV believed in increase in floods as the major impacts of rainfall variability. Similarly, a majority of respondents of Douala IV perceive pollution of water sources, damages to homes and buildings and SLR (36.4 %, 36.6% and 40 %) as major impacts of rainfall variability compared to Douala I and V.



Where a= (X^2=19.738, p<0.001), b= (X^2=36.82, p<0.000), c= (X^2=19.72, p<0.011),d=(X^2=15.34, p<0.009), e=(X^2=40.42, p<0.000), f=(X^2=25.02, p<0.000), g=(X^2=55.27, p<0.000)

Figure 3: Perceived causes of climate change variables in the study area



Where a= (X^2=30.99, p<0.000), b= (X^2=20.1, p<0.003), c= (X^2=21.2, p<0.002), d= (X^2=21.2, p<0.002), e=(X^2=33.13, p<0.000), f= (X^2=30.21, p<0.003), g= (X^2=44.34, p<0.001

Figure 4: perceived impacts of climate variables in the study area

Apart from coastal flooding due to storm surge that presented significant differences in its distribution in the sub divisions, X^2 = 43.85/p<0.000, the rest of the variables were quite similar across the sub divisions (coastal erosion, rising water tables, loss of mangroves, salinisation of water sources and inundations). A majority of the inhabitants of Douala IV (38 %) believe coastal flooding due to storm surge is more important as opposed to 31 % and 30 % of Douala I and V respondents respectively.

From Table 3, about 36 % of respondents of Douala V think that public enlightenment and the use of old cars to be discouraged could curb the impacts of global warming while a majority of the respondents of Douala IV (37 %) believe that, if air pollution is arrested, it could curb the impacts of global warming.

Table 3: Adaptation strategies of global warming and sea level rise.

	Douala I	**Douala IV**	**Douala V**	X^2	*p*
Adaptations to global warming					
Public enlightenment	172 (29.8)	197 (34.1)	205 (35.5)	22.826	0.001
Reduce deforestation	200 (32.4)	196(31.8)	214(34.7)	9.177	0.956
Encourage tree planting	237 (30.8)	259 (33.7)	266 (34.6)	13.184	0.356
Make use of public cars	127 (37.6)	103 (30.5)	103 (30.5)	9.817	0.133
Use of old cars should be discouraged	151 (29.9)	171(33.9)	179 (35.4)	850.758	0.000
Stop air pollution	205 (30.4)	247 (36.6)	217 (32.1)	27.891	0.000
Discourage urbanisation	96 (31.1)	119 (38.5)	92 (29.8)	17.264	0.505
Adaptations to sea level rise					
Early warning	176 (32.1)	192 (35.0)	176 (32.1)	14.855	0.021
Development of educational programs	175 (29.5)	191 (32.2)	221 (37.3)	19.053	0.004
Awareness campaign	193 (30.3)	220 (34.5)	221 (34.7)	20.066	0.001
Legislation and policies	117 (29.9)	136 (34.8)	133 (34.0)	15.963	0.014
Land use planning	155 (29.1)	192 (36.1)	179 (33.6)	20.447	0.308
Dredging and shore protection	163 (29.4)	202 (36.4)	184 (33.2)	29.399	0.000
Drainage construction	192 (30.0)	239 (37.3)	205 (32.0)	29.070	0.004
No action	40 (51.9)	17 (22.1)	20 (26.01)	13.234	0.021
Changes on temperature have impacted me					
Strongly agree	78 (30.2)	91 (35.3)	88 (34.1)		
Agree	124 (29.7)	135 (32.3)	155 (37.1)		
Neither agree or disagree	68 (38.4)	59 (33.3)	48 (27.1)	28.969	0.519
Disagree	25 (47.2)	18 (34.0)	10 (18.9)		
Strongly disagree	10 (45.5)	9 (40.9)	3 (13.6)		

35 %, over 34 %, 36 % and 37 % of respondents in Douala IV perceive, early warning, legislation and policies, dredging and shore protection and drainage construction respectively as adaptation measures of SLR when compared to Douala I and IV. Paradoxically, more than half of the respondents of Douala I believe no action should be taken to adapt to SLR.

3.3 Fresh Water resource quality

Table 4 presents results of fresh water sources, perceived quality of water sources and probable causes and impact of water on mankind. Sources of water in the dry season from Rivers/streams and wells were similar. Equally, tap water sources during the rainy season showed similarities across the three sub divisions. However, tap sources water during the dry season were significantly different in their distribution (X^2 = 19.45/p<0.003). The majority of respondents (about 34 %) from Douala V compared with Douala I and IV indicating tap water as a more important source of water during the rainy season. Most of the respondents from Douala I (> 46 %) indicated rivers/streams as their most reliable source of water during the rainy season, while about 42 % of the respondents from Douala IV think rain water is the most probable source of water in the rainy season followed by over 37 % of Douala IV respondents who stated that well water is another reliable water resources.

From Table 4, the majority of respondents use water for agriculture and domestic purposes (42 and 35 %) in Douala IV when compared with the other sub divisions. Respondents in Douala V (34 %) believe that no matter the source of water, it should be treated before use. Regarding the taste of fresh water sources from the investigated area, respondents of Douala I perceived water as being salty as well as other qualities (> 37 %) as shown on Table 4. Paradoxically, about 36 % of the Douala IV area perceives water as tasteless.

In terms of the impacts of poor quality water to mankind, respondents of Douala I believed that gastro-

intestinal diseases cholera (47 %) and dysentery (48 %) are the more important water borne diseases while the respondents of Douala IV (37 % and 38 %) think fevers (typhoid and malaria) were more important water borne diseases (Table 4).

Table 4: Fresh water resource sources, perceived quality and impact on water quality

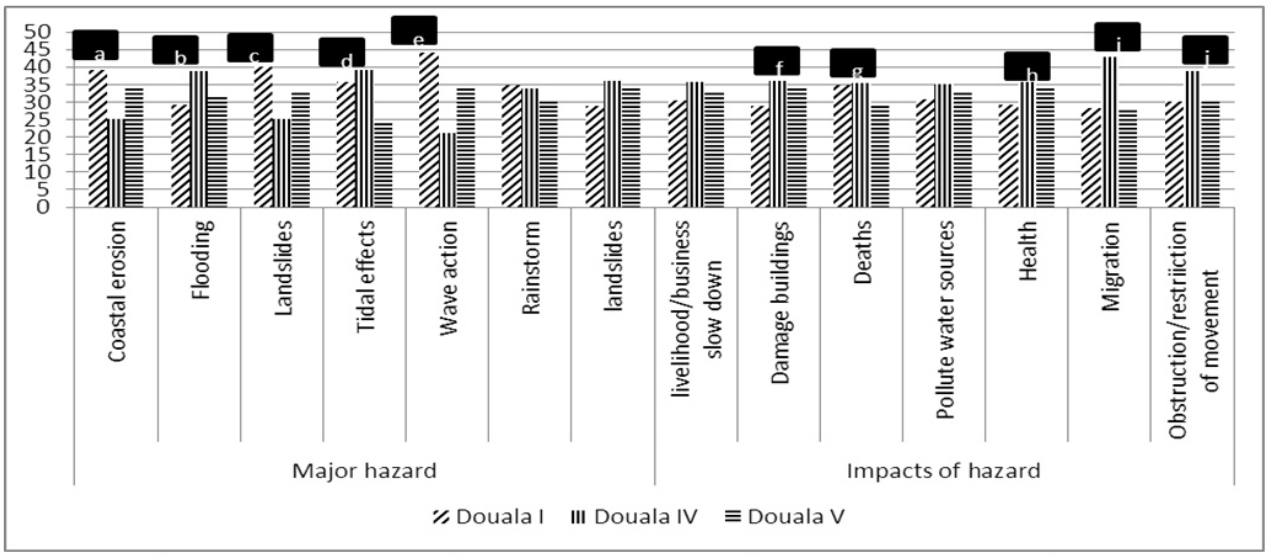
	Douala I	Douala IV	Douala V	X^2	*p*
Sources of water in the dry season					
Rivers/streams	96 (45.7)	61 (29.0)	53(25.2)	20.317	0.061
Wells	155 (34.1)	143(31.4)	153 (33.6)	3.220	0.781
Tap water	253 (31.6)	270 (33.8)	271 (33.9)	19.454	0.003
Sources of water in the rainy season					
Rivers/streams	101 (46.1)	62 (28.3)	54 (24.7)	26.617	0.000
Wells	174 (35.5)	182 (37.1)	131(26.7)	31.496	0.000
Tap water	252 (31.0)	274 (33.7)	280 (34.4)	20.028	0.051
Rain water	169 (31.2)	227 (41.9)	141 (26.0)	55.501	0.000
Uses of water					
Agriculture	129 (34.5)	156 (41.7)	86 (23.0)	41.520	0.000
Domestic purposes	274 (31.0)	307 (34.7)	296 (33.5)	30.317	0.034
Industry	91 (38.7)	64 (27.2)	77 (32.8)	8.740	0.120
Treatment of water	229 (32.5)	232 (32.9)	237 (33.6)	24.033	0.020
Interest in the water quality	255 (32.2)	254 (32.1)	276 (34.8)	20.161	0.064
Pollution of water sources					
Unpolluted	86 (29.5)	101 (34.6)	103 (35.3)		
Polluted	156 (32.3)	165(34.2)	159 (32.9)	7.639	0.664
Very polluted	58 (38.7)	49 (32.7)	42 (28.0)		
Taste of water source					
Tasteless	145 (28.3)	184 (35.9)	181 (35.4)		
Salty	84 (37.8)	70 (31.5)	63 (28.4)	29.887	0.039
others	73 (37.8)	59 (30.6)	61 (31.6)		
Cases of water borne diseases	195 (31.0)	228 (36.2)	200 (31.8)	12.450	0.410
Types of water borne diseases					
Typhoid	130 (31.2)	156 (37.4)	128 (30.7)	31.219	0.000
Cholera	87 (47.0)	54 (29.2)	43 (23.2)	13.703	0.003
Dysentery	99 (47.8)	61 (29.5)	46 (22.2)	22.518	0.000
Diarrhoea	111 (41.7)	71 (26.7)	81 (30.5)	7.943	0.439
Proliferation of malaria	139 (26.1)	202 (38.0)	186 (35.0)	49.361	0.000
Causes of these diseases					
Standing water	175 (28.3)	233 (37.7)	205 (33.2)	36.714	0.000
Unsafe water sources	193 (31.6)	231(37.9)	180 (29.5)	37.349	0.000
Point source pollution	140 (34.1)	160 (38.9)	108 (26.3)	35.984	0.000
Non point source pollution	67 (38.1)	56 (31.8)	52 (29.5)	4.635	0.591
Impact of sea level rise on water sources of this area					
Increase salt concentration	187 (33.5)	177 (31.7)	189 (33.9)	7.939	0.790
Changes colour of water	166 (27.1)	234 (38.2)	205 (33.5)	45.111	0.000
Increase particles in the water	184 (29.3)	222 (35.3)	218 (34.7)	23.516	0.001
Water has odour	155 (27.3)	224 (39.4)	182 (32.0)	39.932	0.000

The results further indicate that the majority of Douala IV respondents (37.7 %, 37.9 % and 39 %) consider the main causes of water borne diseases as resulting from standing water, unsafe water sources and point source pollution respectively. Furthermore, the majority of respondents of Douala IV perceive; changes in colour of water (38 %), increase particles in the water (35 %) and water has odour (39 %) as consequences of SLR on water sources of this area as compared with the Douala I and IV respondents.

3.4 Hazards related concerns

Results of chi-square obtained for hazard related concerns in the study area show statistically significant differences in distribution between the sub divisions (Figure 5). Over 39 %, 40 %, 44 % and 35 % of respondents from Douala I are concerned about coastal erosion, landslides, wave action and rainstorms respectively as the

most devastating hazards when compared with Douala IV and V. However, respondents of Douala IV consider flooding (38.9 %) and tidal effects (39 %) as hazards of concern compared with Douala I and IV.



Where a= (X^2=12.96, p<0.024), b= (X^2=48.58, p<0.000), c= (X^2=15.42, p<0.004), d= (X^2=33.79, p<0.000), e= (X^2=23.54, p<0.003), f= (X^2=40.88, p<0.000), g= (X^2= 17.85 , p<0.007), h= (X^2= 24, p<0.002), i= (X^2= 66.69, p<0.000), j= (X^2= 30.62 , p<0.000)

Figure 5: Hazards related concern and its impact in the study area

This corroborates with more than half of the respondents of Douala IV (52 %) who consider the frequency of coastal flooding as "very often" as opposed to Douala V respondents (44 %) who think that the frequency of flooding "rarely occurs" (Table 5).

The major causes of hazards related concerns (Table 5) show significant differences in distribution except for deforestation as a cause of hazard that is similar across the sub divisions. Douala I respondents attribute "cemented urban surface" (47 %) and "the will of God" (50 %) as being the major causes of hazards in the area while 38 % of respondents of Douala V attributed the causes of hazards in the area to "building along drainage paths". The majority of respondents of Douala IV believe the causes of these hazards are as a result of little or no drainage networks (37.3 %), excessive rain (36.1%), soil type (37.2%), blocked drains (34.6%), type of topography (42.6 %), development of vulnerable lands (41.9 %) and SLR (37.5 %) as opposed to Douala I and V whose responses had lower percentages.

The consequences of "livelihood/business slow down" and "the pollution of water sources" are quite similar across the three sub divisions. The rest (damage to buildings, deaths, health, migration and obstruction/restriction of movement) show statistically significant differences in associations of distribution (Table 6). Of these differences, the majority of respondents of Douala IV indicated that damage to buildings (36 %), deaths (35 %), health problems (35.8 %), migration (43%) and obstruction/restriction of movement (39%) were more important than in Douala I and V.

Regarding, what people perceived to be government's measures to check such hazards; early warning, legislation and policies and "no action" were observed to be similar in all the regions. However, the majority of Douala IV respondents perceived awareness campaign (35%), land use planning (41 %), drainage clearance/construction (37.4 %) and dredging/shore protection (38.4%) as more important when compared with Douala I and V in their adaption to SLR hazard impacts. On the other hand, respondents of Douala V think the development of educational programs (34.4 %) should be one of the major approaches of adaptation to such hazards.

Table 5: Major cause of hazards, frequency of hazards and government's adaptation measures

	Douala I	Douala IV	Douala V	X^2	*p*
Frequency of hazard in a season					
Daily	20 (30.8)	31 (47.7)	14 (21.5)		
Once in a week	25 (26.6)	50 (53.2)	19 (20.2)		
Once in a month	75 (51.4)	36 (24.7)	33 (22.6)	77.008	0.000
Once in a year	56 (32.0)	43 (24.6)	74 (42.3)		
Not always	129 (28.6)	154 (34.1)	165 (36.6)		
Frequency of coastal flooding					
Very often	68 (29.2)	122 (52.4)	41 (17.6)		
Often	123 (35.0)	113 (32.2)	113 (32.2)	73.901	0.000
rarely	111 (32.3)	80 (23.3)	150 (43.6)		
Major cause of hazards					
Cemented urban surface	98 (46.7)	52(24.8)	59 (28.1)	30.272	0.011
Building along drainage path	161 (30.3)	164 (30.8)	202 (38.0)	16.793	0.010
Little or no drainage network	156 (26.6)	218 (37.2)	208 (35.5)	41.346	0.000
Excessive rainfall	208 (29.3)	257(36.1)	243 (34.2)	32.691	0.000
Soil type	123 (33.2)	138 (37.2)	109 (29.4)	18.938	0.015
Blocked drains	167(30.6)	189 (34.6)	186 (34.1)	16.922	0.005
Topography	102 (25.1)	173 (42.6)	126 (31.0)	59.151	0.000
Development of vulnerable lands	117 (26.8)	183 (41.9)	133 (30.4)	47.536	0.000
Sea level rise	147 (29.3)	188 (37.5)	162 (22.3)	26.282	0.003
Deforestation	121(32.6)	106 (28.6)	140 (37.7)	8.717	0.559
Will of God	105 (49.5)	58 (27.4	47 (22.2)	36.909	0.001
Government's adaptation measures					
Awareness campaigns	223 (30.5)	252 (34.5)	250 (34.2)	26.225	0.010
Early warning	189 (30.0)	224 (35.6)	211 (33.5)	27.826	0.065
Development of educational programs	207 (30.7)	230 (34.1)	232 (34.4)	16.448	0.012
Legislations and policies	139 (30.2)	171 (37.2)	145 (31.5)	27.793	0.065
Land use planning	149 (25.7)	236 (40.8)	190 (32.8)	64.095	0.000
Drainage clearance and construction	195 (28.8)	253 (37.4)	224(33.1)	32.269	0.000
Dredging and shore protection	156 (28.0)	214 (38.4)	183 (32.9)	40.157	0.000
Nothing	27 (55.1)	7 (14.3)	15 (30.6)	16.050	0.098

3.5 Strength of association between districts on awareness and knowledge of sea level rise impacts

The strength of association existing between the three districts based on awareness and knowledge of sea level rise impacts on fresh water resource quality were computed using Cramer's V coefficient. This value is best for nominal data and can be used when the rows and columns are not equal. It shows how much of the dependent variable is determined by the independent variable**.**

3.5.1 Analysis of the association between awareness and knowledge of causes of variability of climate change factors and some socio-economic parameters

Table 6 presents the results of the analysis of association between awareness and knowledge of causes of variability of climate change variables and age, level of education and occupation. The results indicate that the age of the respondent has a significant association with awareness and knowledge of global warming in Douala I. The level of education of Douala I and V are strongly associated with awareness of global warming with Cramer's V value of 0.361 and 0.25 respectively. Occupation was strongly associated with awareness of global warming for Douala V respondents. Cramer's V coefficient indicates that the association between the level of education and occupation with rainfall variability for Douala IV was 0.17 and 0.27 respectively. This association was observed to be significant at $P<0.05$. With regards to the knowledge on sea level rise in Douala IV, a significant association was observed when compared with the age and occupation of respondents while the other associations in Douala I and V were not significant ($P>0.05$).

Table 6: Analysis of the association between awareness and knowledge of climatic factors and some socio-economic parameters

	Heard of global warming					
	Douala 1		Douala IV		Douala V	
Social variable	**V**	**p**	**V**	**p**	**V**	**p**
Age	0.202	0.027	0.127	0.418	0.123	0.501
Level of Education	0.361	0.000	0.153	0.060	0.245	0.000
Occupation	0.152	0.519	0.218	0.114	0.314	0.000
	Variation of rainfall pattern from year to year					
Age	0.127	0.467	0.118	0.549	0.151	0.111
Level of Education	0.096	0.749	0.165	0.028	0.093	0.836
Occupation	0.155	0.579	0.267	0.002	0.169	0.678
	Knowledge of sea level rise					
Age	0.150	0.231	0.189	0.012	0.130	0.403
Level of Education	0.156	0.114	0.074	0.901	0.097	0.663
occupation	0.149	0.556	0.235	0.039	0.167	0.630

A Cramer's V coefficient of 0.14 (Table 7) indicates a significant association existing between the combined effect of human and natural causes of global warming and awareness to it for Douala I. Human causes alone (Cramer's value 0.13) also had a significant association with global warming for the same area. The respondents in all the three districts attributed the will of God as a cause of climate change to have a significant association with global warming.

Table 7: Analysis of the association between causes of climate change and awareness and knowledge of climatic factors

	Heard of global warming					
	Douala I		Douala IV		Douala V	
Causes of global warming	**V**	**P**	**V**	**P**	**V**	**p**
Natural	0.120	0.847	0.049	0.786	0.121	0.156
Human	0.127	0.034	0.125	0.162	0.142	0.069
Natural and human	0.138	0.019	0.151	0.054	0.140	0.060
Will of God	0.222	0.000	0.317	0.000	0.142	0.037
Causes of Rainfall variation	**Rainfall variation from year to year**					
Natural	0.153	0.043	0.059	0.671	0.092	0.532
Human	0.122	0.243	0.094	0.370	0.133	0.319
Global warming	0.318	0.000	0.208	0.003	0.087	0.702
Causes of sea level rise	**Knowledge on sea level rise**					
Natural	0.214	0.002	0.159	0.027	0.233	0.000
Human	0.228	0.000	0.197	0.033	0.284	0.000
Tides	0.235	0.000	0.224	0.002	0.168	0.034
Will of God	0.107	0.075	0.126	0.143	0.107	0.273
I don't know	0.294	0.000	0.312	0.000	0.234	0.000

Yearly variation of rainfall was perceived to have a significant association with natural causes for Douala I. Results from Table 7 (V value of 0.32 and 0.21) also indicated an association between global warming and yearly variation of rainfall for Douala I and IV. Apart from the will of God that was not associated with perceptions of knowledge on SLR, results obtained show that across the districts, variables of causes of SLR (Table 7) (natural, human, tides and unspecified) were associated with the knowledge of SLR in the study area. The main finding here is that there is a highly significant association ($P<0.01$) between the perceived human causes of sea level rise and knowledge of it for Douala I and IV.

3.5.2 Impact of rainfall variability, sea level rise and taste of ground water resources

The results of analysis for the association of impact of rainfall variability and perception of taste of water resources are shown on Table 8. Douala V respondents indicated an association between impact of rainfall variability (increase in floods, pollution of water sources, changed water supply and sea level rise) and perceived taste of water with Cramer's V value of 0.146, 0.172, 0.165 and 0.171 respectively.

Douala I and IV results indicated no association and this therefore supports the null hypothesis that impacts of rainfall variability are not associated with the taste of the water resources in the area. Furthermore, the results of Cramer's V value of Douala V show significant association of impacts of sea level rise (rising water tables, inundation, changes colour of water and water has odour) and taste of water to be 0.19, 0.17, 0.15 and 0.15 respectively.

Table 8: Analysis of the association of impact of rainfall variability, sea level rise and perception of organoleptic property of ground water resource

	Taste of water					
	Douala I		Douala IV		Douala V	
Impact of rainfall variability	**V**	**P**	**V**	**P**	**V**	**p**
Increase in floods	0.043	0.756	0.034	0.950	0.146	0.042
Landslides	0.035	0.840	0.054	0.857	0.096	0.265
Pollution of water sources	0.138	0.068	0.078	0.660	0.172	0.013
Damage to homes and buildings	0.067	0.606	0.154	0.076	0.065	0.545
Water shortages	0.114	0.160	0.131	0.224	0.102	0.233
Drought	0.100	0.245	0.191	0.025	0.078	0.504
Changed water supply	0.046	0.744	0.097	0.488	0.165	0.005
Sea level rise	0.072	0.567	0.240	0.001	0.171	0.011
Impact of sea level rise						
Coastal erosion	0.068	0.624	0.106	0.407	0.102	0.211
Coastal flooding due to storm surge	0.113	0.160	0.136	0.168	0.121	0.204
Rising water tables	0.089	0.328	0.085	0.581	0.191	0.002
Salinization of water resources	0.055	0.652	0.019	0.557	0.119	0.107
Inundation	0.079	0.399	0.056	0.830	0.169	0.011
Changes colour of water	0.103	0.223	0.072	0.688	0.154	0.007
Increase particles in water	0.025	0.915	0.064	0.773	0.110	0.166
Water has odour	0.047	0.728	0.060	0.795	0.154	0.007

3.5.3 Public perception of causes of climatic variables and climate hazards

Table 9 presents the results of analysis of the relationship between some climatic change variables and climate hazards in Douala I. Natural causes of global warming were perceived to have a highly significant relationship with coastal erosion, landslides and tidal effects. These observations differ from the observations obtained for Douala V (Table 11) where an additional significant relationship was observed for the same parameters with wave action and rainstorm. In the same district, public perceptions of human causes of global warming were observed to have a significant association with coastal erosion ($p<0.01$). The perception that the will of God is a cause of global warming was observed to be highly significantly associated with coastal erosion, tidal effects and wave action. These results are at variance with the respondents of Douala V who observed the will of God to be significantly influencing flooding and rainstorm.

Table 9: Analysis of public perception of the relationship between some climatic change variables and climate hazards in Douala I

	CE		Flooding		Landslides		Tidal effects		Wave action		Rainstorm	
Causes of GW	V	P	V	P	V	P	V	P	V	P	V	p
Natural	0.215	0.000	0.011	0.857	0.243	0.000	0.211	0.001	0.098	0.111	0.084	0.383
Human	0.162	0.008	0.097	0.108	0.077	0.209	0.100	0.098	0.107	0.077	0.140	0.066
Human and natural	0.087	0.147	0.163	0.006	0.123	0.040	0.095	0.118	0.031	0.611	0.050	0.702
Will of God	0.226	0.000	0.046	0.452	0.084	0.172	0.252	0.000	0.213	0.000	0.145	0.054
Causes of RV												
Natural	0.084	0.333	0.184	0.000	0.044	0.767	0.137	0.73	0.147	0.048	0.089	0.338
Human	0.067	0.268	0.102	0.086	0.098	0.107	0.181	0.003	0.044	0.460	0.167	0.020
Global warming	0.056	0.352	0.010	0.862	0.087	0.149	0.164	0.007	0.072	0.233	0.113	0.168
Causes of SLR												
Natural	0.146	0.057	0.041	0.800	0.149	0.055	0.162	0.030	0.178	0.014	0.095	0.303
Human	0.077	0.206	0.095	0.116	0.152	0.013	0.149	0.015	0.165	0.007	0.138	0.078
Tides	0.100	0.103	0.104	0.088	0.144	0.020	0.233	0.000	0.257	0.000	0.070	0.512
Will of God	0.184	0.003	0.020	0.747	0.130	0.035	0.327	0.000	0.301	0.000	0.088	0.344
I don't know	0.064	0.299	0.009	0.886	0.045	0.472	0.082	0.180	0.130	0.034	0.095	0.305

Causes of rainfall variability for Douala I was perceived to be significantly associated with natural causes for flooding and wave action. Anthropogenic activities were implicated significantly as a cause of tidal effects and rainstorm. In the case of global warming it was only significant in the perception for its association with tidal effects.

Natural, human, tides, will of God and unspecified as causes of SLR were all perceived to have a significant ($p<0.05$) association with wave action. The same trend was observed for the association between these parameters and the tidal effects except for the unspecified causes of SLR which did not have a significant association. For landslides, natural and unspecified causes of SLR were perceived to have a non-significant association. There were also no significant relationships between the causes of SLR parameters and flooding as well as coastal erosion except for the will of God with coastal erosion which was significant ($p<0.01$).

In Douala IV there were seven significant associations between parameters for causes of GW and climate hazards (Table 10). These associations were observed between will of God and CE (V= 0.2), human and natural and landslides (V=0.15), natural or human and tidal effects (V=0.176 and 0.18), will of God and wave action (V=0.145). Human causes of SLR were perceived to be highly significantly associated ($p<0.01$) with rainstorms.

Highly significant associations were also obtained for perceptions between all the causes of rainfall variability and rainstorms. The same trend was observed for wave action and tidal effects except for natural causes of rainfall variability for wave action and human causes of rainfall variability for tidal effects which were both not significant ($p>0.05$). Human causes of SLR were however perceived to have a significant relationship with coastal erosion and landslides.

The unspecified causes of SLR were only significant when associated with tidal effects (Table 10). Meanwhile, significant associations were obtained between perceptions of causes of SLR and coastal erosion. In the case of rainstorms, public perceptions of the association with natural, tides and will of God as causes of SLR were highly significant. The same highly significant relationship was observed in the perception of the association between tides and will of God as causes of SLR and wave action. For tidal effects, tides (V=0.42) and natural causes of SLR (V= 0.25) were perceived to have a highly significant association.

Table 10: Analysis of public perception of the relationship between some climatic change variables and climate hazards in Douala IV.

	CE		Flooding		Landslides		Tidal effects		Wave action		Rainstorm	
Causes of GW	V	P	V	P	V	P	V	P	V	P	V	p
Natural	0.129	0.079	0.022	0.763	0.049	0.508	0.176	0.017	0.078	0.295	0.110	0.128
Human	0.041	0.557	0.060	0.372	0.051	0.468	0.180	0.010	0.105	0.186	0.261	0.000
Human and natural	0.053	0.437	0.063	0.328	0.146	0.033	0.069	0.602	0.020	0.771	0.238	0.000
Will of God	0.194	0.007	0.048	0.486	0.102	0.156	0.056	0.737	0.145	0.045	0.061	0.378
Causes of RV												
Natural	0.102	0.146	0.067	0.314	0.066	0.350	0.301	0.000	0.073	0.302	0.304	0.000
Human	0.167	0.019	0.007	0.921	0.233	0.001	0.055	0.448	0.144	0.047	0.154	0.001
Global warming	0.111	0.092	0.017	0.785	0.102	0.125	0.268	0.000	0.162	0.015	0.211	0.001
Causes of SLR												
Natural	0.180	0.011	0.130	0.106	0.109	0.124	0.250	0.000	0.070	0.327	0.250	0.001
Human	0.217	0.002	0.043	0.535	0.176	0.013	0.066	0.651	0.135	0.057	0.004	0.959
Tides	0.135	0.047	0.146	0.025	0.124	0.070	0.416	0.000	0.224	0.001	0.385	0.000
Will of God	0.200	0.018	0.074	0.566	0.223	0.007	0.081	0.521	0.311	0.000	0.219	0.007
I don't know	0.118	0.110	0.087	0.225	0.031	0.680	0.221	0.003	0.022	0.774	0.028	0.695

Table 11 presents the results of analysis of the relationship between some climatic change variables and climate hazards in Douala V. Natural causes of global warming were perceived to have the most consistent significant association with coastal erosion, landslides, tidal effects, wave action and rainstorm ($p<0.05$). The only exception was the association between the cause of global warming and flooding which was not observed to be significantly associated.

Table 11: Analysis of public perception of the relationship between some climatic change variables

	CE		Flooding		Landslides		Tidal effects		Wave action		Rainstorm	
Causes of GW	V	P	V	P	V	P	V	P	V	P	V	p
Natural	0.199	0.002	0.091	0.149	0.270	0.000	0.317	0.000	0.212	0.004	0.168	0.008
Human	0.078	0.213	0.037	0.544	0.144	0.022	0.133	0.034	0.101	0.274	0.092	0.134
Human and natural	0.208	0.001	0.191	0.001	0.194	0.002	0.188	0.002	0.089	0.359	0.064	0.286
Will of God	0.067	0.576	0.197	0.008	0.154	0.056	0.116	0.189	0.039	0.945	0.232	0.001
Causes of RV												
Natural	0.155	0.015	0.098	0.115	0.088	0.170	0.305	0.000	0.262	0.000	0.118	0.059
Human	0.103	0.104	0.276	0.000	0.157	0.017	0.220	0.001	0.265	0.000	0.174	0.005
Global warming	0.138	0.027	0.257	0.000	0.220	0.001	0.186	0.003	0.113	0.198	0.147	0.014
Causes of SLR												
Natural	0.127	0.165	0.258	0.000	0.088	0.430	0.142	0.102	0.200	0.001	0.93	0.360
Human	0.155	0.019	0.331	0.000	0.158	0.019	0.231	0.001	0.292	0.000	0.144	0.026
Tides	0.232	0.001	0.247	0.000	0.274	0.000	0.272	0.000	0.299	0.000	0.068	0.299
Will of God	0.090	0.185	0.036	0.583	0.341	0.000	0.181	0.007	0.106	0.299	0.158	0.018
I don't know	0.161	0.040	0.152	0.054	0.058	0.660	0.093	0.341	0.119	0.138	0.120	0.160

CE: coastal erosion, GW: global warming, RV: Rainfall variability, SLR: Sea level rise, V: Cramer's V value

The association of the perception between anthropogenic causes of global warming and climate variables were observed to be significant with landslides (p= 0.022) and tidal effects (p= 0.034). Meanwhile, the will of God as a cause of global warming was perceived to have a significant association with flooding and rainstorm ($p<0.01$).

When the perception of the association between the causes of rainfall variability and climatic hazards were analysed (Table 11), results showed that natural causes of rainfall variability were associated significantly ($p<0.05$) with coastal erosion (V=0.155), tidal effects (V=0.305) and wave action (V=0.262). For the perception of human causes of rainfall variability, landslides were found to have a significant association ($p<0.05$) while the association with flooding, tidal effects, wave action and rainstorm were highly significant. The relationship between global warming as a cause of rainfall variability and coastal erosion had a significant association ($p<0.05$) while flooding, landslides, tidal effects and rainstorm was highly significant.

Further analysis of the relationship between natural causes of SLR and climate hazards highlighted a highly significant association ($p\leq0.01$) for flooding and wave action. A similar trend for human causes of SLR and its relationship to hazards of flooding, tidal effects and wave action was observed with V test value of 0.331, 0.231 and 0.292 respectively. Apart from rainstorm hazard that was not associated with tides as a cause of SLR, the analysis indicated highly significant association between tides being a cause of SLR and climatic hazards (coastal erosion, flooding, landslides, tidal effects and wave action) with $p\leq0.01$. Results on perceptions of the associations of causes of SLR and associated hazards for Douala IV and V have a similar trend.

4. Discussion

This study is a succinct comparison of results from a survey of selected climate change variables (GW, rainfall variability and SLR) on public opinion of residents from three districts of the littoral region (Douala I, IV and V) of Cameroon. The selection of regions was based on its' proximity to the ocean and river Wouri. This is because different population groups may have different opinions about climate variables as have been highlighted by several authors (Toan et al., 2014, Lieske *et al*., 2013, Elrick-Barr *et al*., 2015).

Major findings of this study indicated highly significant associations of awareness and knowledge of global warming and level of education (Douala I and V) and occupation (Douala V).This indicates that those with higher level of education (38.9 % in Douala V) and who are skilled workers (42.4 % civil servant and 70 % canoe operators) in Douala V had heard of global warming than the Douala IV inhabitants. Similarly, Carew-Reid (2008) found out that resource limited people seem to have less knowledge about the side effects of climate change. The area in question (Douala IV) has 66.7 % of mangrove loggers who are taught to be resource limited probably explaining their lack of knowledge on global warming.

The level of education and occupation of respondents from Douala IV were found to be linked to the yearly variation of rainfall pattern. This could probably be explained by the fact that they are closer to the ocean and are more exposed to SLR risks. More so, DEM results of the area are not more than 2 m above mean sea level (unpublished data). The relationship existing between age and occupation with respect to knowledge on SLR for Douala IV was significant in this study, indicating their close and constant proximity to these coastal

processes. These observations are in accordance with the results of (Lieske et al., 2013, Toan et al., 2014, Brody et al., 2007).

Given the overwhelming scientific consensus on human induced climate change (Jamelske *et al*., 2013, IPCC, 2014, McGrath, 2013, IPCC, 2013, IPCC, 2007, Pendleton *et al*., 2010), the pattern from this study is consistent only with respondents from Douala I, who perceive that human beings are linked to the causes of global warming. The differences found in opinions across districts could be attributed to the level of education. This study is at variance with the findings of Chelsea and Patrick (2012) who reported that climate change awareness most strongly depended on the respondents' level of education. Public perception for all the districts (Douala I and IV and Douala V) linked significantly ($p<0.01$) global warming to the will of God. A highly significant relationship between global warming as a cause of yearly rainfall variation could be attributed to Education.

For the knowledge on causes of SLR, major findings from this study observed a highly significant correlation of human causes for Douala I and V and tides as a major cause for SLR for Douala I and IV. The location of Douala IV (Figure 1) is not far from the ocean and one of the names of the quarters is "Marin Haut" which in English means "high tides". This can well explain the reason why the inhabitants perceive SLR to be caused by high tides. According to Brody et al. (2007) drawing from the psychological distance theory, geographic location is argued to influence causes of perception-as illustrated in Douala IV, where public perception on SLR was linked to tides as responsible for this climate change variability.

Studies on the impact of rainfall variability and SLR on fresh water resource quality have been extensively investigated worldwide (Nicholls and Tol, 2006, Nicholls, 2011, de la Vega-Leinert and Nicholls, 2008, Awosika *et al.,* 1992, Brooks *et al*., 2006, Zghibi *et al*., 2013). This study found out that respondents of Douala IV and V perceive taste of fresh water quality to be highly significantly linked to SLR ($p<0.01$). This could be attributed to poverty as respondents depend on well water resources for their livelihoods. Significant association ($p<0.05$) observed for increase in floods, changes in water source use and pollution of water resources and taste of water resources for Douala V indicates that water sources are not of good quality. Therefore, the respondents need to fetch water from alternative sources when its quality is perceived to be doubtful. The recent July 2015 flooding that seriously affected quarters in Douala V could explain the tangible reasons why the respondents are aware of these as affecting their water quality (Tetchiada, 2015).

Awareness on the links between SLR causes and impacts on water resource quality may help to increase success on the National Prevention Program on climate change. Additionally, an understanding of the worries of the people may help, planners, policy makers to develop and implement effective and sustainable adaptation measures. The lack of knowledge on salt water intrusion as been responsible for salinisation of fresh water resources in the area further exacerbates the very poor global ignorance that respondents perceive as to the effects of sea level rise.

A high level of awareness on the link between impact of SLR (rising water table, inundation, water colour changes and water odour) and taste of water for Douala V was observed. However, there was no link for these same parameters for Douala I and IV ($p>0.05$). This difference could be attributed to the high level of education and the type of occupation for respondents in Douala V. Furthermore, Douala I is an administrative area, where people only go to work and there are few residents in the area.

The perceptions for causes of SLR on coastal erosion indicated that respondents understood very well the underlying factors influencing SLR for Douala IV as the associations with the unspecified variable was not significant. The location of the Douala IV inhabitants which is quite close to the coastline and therefore susceptible to tidal effects could explain their level of awareness as observed in this study. This region experiences more events of tidal changes and it is illustrated by the highest Cramer's V test value (0.416) for the association between tides as a cause of SLR and tidal hazards in this study for the area.

5 Conclusions

The research presented here provides insights into respondent's perception of causes and impacts of climate change variables on fresh water resource quality across three districts of Douala-Cameroon. A high proportion of surveyed respondents across all districts perceive that exaggerated heat waves are as a result of global warming. The most influential factor on such awareness was the level of education for Douala I and V. Apart from level of education; occupation was an influential factor for awareness of global warming for Douala V. Higher level of education was associated with better knowledge on global warming.

The will of god as a cause of global warming was highly significantly associated across all districts. This illustrates the ignorance of the respondents of the major cause of global warming as indicated by climate change scientists. Similar studies by Odjugo (2013) on the analysis of climate change awareness in Nigeria

highlights respondents perception of the causes of climate change to the act of God.

Apart from the will of God, Douala I respondent identified human causes as being responsible for global warming. Global warming was also perceived to be linked with yearly rainfall variations. The knowledge on SLR and its causes did not vary spatially as all respondents across the three districts associated it to tides and human causes.

Global knowledge on the impact of salt water intrusion as a result of rising sea levels into fresh water aquifers, estuaries and rivers was pinpointed by the respondents of Douala IV only. Douala V respondents however, associated rising water tables, inundation, changes in water colour and odour of water to the impact of sea level rise.

Knowledge on the most devastating hazard causes across the three districts were unevenly distributed, additionally perceived causes were poor. Tides relation to tidal hazards, followed by rainstorms stood out clearly as the most devastating hazards for Douala IV that was caused by sea level rise. Respondents of Douala I perceived tidal hazards followed by wave action to be the most devastating hazards in the district and think it is as a result of the will of God. Douala V respondents however associated incidences of flooding to be anthropogenic. Tidal hazards resulting from tides and wave action were associated with tides and anthropogenic activities for the same district.

This study does have some limitations. Firstly, the study was conducted in three urban districts in Douala out of the six, so it may not represent the perceptions elsewhere in Douala- Cameroon. Secondly, the public in Cameroon is usually very reluctant to respond to such studies and require a gift before answers to questionnaires can be provided. Thirdly, the issue under study is complicated and difficult to measure. Therefore it is recommended that people's perceptions on the causes and impacts of sea level rise hazards on fresh water resource quality in the areas under study be investigated. This might provide a more precise reflection of public awareness and knowledge of sea level rise hazards on ground water resource quality.

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