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Climate Change, Soil Fertility Management and the Nexus: A Knowledge and Opinions Study in Western Cameroon

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Authors' contributions

This work was carried out in collaboration between all authors. Author GKK designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors RKE and FKB managed literature searches and the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Climate change/variability and soil degradation are environmental concerns that are currently, and will certainly hamper the development of most developing countries. These menaces will be exacerbated if there is limited knowledge about them, especially with young adults, who constitute one of the most vulnerable categories of the human population. Motivated by the aforesaid, a survey was carried out to assess knowledge and opinions about these threats.
Methodology: Paper questionnaires were administered randomly to 327 young adults in the West Region of Cameroon over a period of three months. Data collected was subjected to descriptive and inferential statistics using Microsoft Excel 2007 and SPSS (version 19).
Results: Our findings revealed that more than 93% of respondents affirm that climate change is presently occurring, while a majority of respondents (about 75%) have correct ideas on climate

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change and soil fertility notions. With regards to climate change, most of the respondents had good ideas on causes and impacts of climate change, and possible mitigation strategies to be used. As on soil fertility management, most young people had good knowledge on practices that reduce soil fertility, and practical methods of soil conservation. Additionally, about 87% of respondents expressed willingness to become environmental activists.

Conclusion: Given that knowledge gaps were observed on some key environmental concepts, we recommend to environmentalists, educationists, teachers and policy makers in developing countries and sub-Saharan African countries in particular, that environmental science curricula be implemented or reinforced at all levels of formal education, and should be competency-based, so as to enhance skills and competences that will favour climate change preparedness and environmental conservation.

Keywords: Climate variability; soil conservation; young adults; awareness; developing countries; Cameroon.

1. INTRODUCTION

A critical question with most of the people of this era, especially young adults, is how they understand and engage with climate change/variability, soil degradation and food security, especially those from sub-Saharan Africa. Corner et al. [1] noted that, “Being the generation that will face the reality of a changing climate in their own lifetimes, young people are the most vulnerable, yet potentially also the best placed (and most motivated) to generate an ambitious societal response that will avoid the most dangerous risks of climate change”. Surprisingly, though, there is very little existing research on what young people think about climate change and sustainable soil management for agricultural production, especially in less developed countries. It has been reported that “young people are a constituency that has traditionally been ignored when it comes to high-level negotiations” [2].

Climate change is defined by conditions of high atmospheric carbon dioxide concentrations (≥ 400 ppm), increasing air temperatures (2–4℃ or greater), significant and/or abrupt changes in daily, seasonal, and inter-annual temperature, changes in the wet/dry cycles (seasons), intensive rainfall and/or heavy storms and flooding, extended periods of drought, extreme frost, extreme heat waves and increased fire frequency [3]. In the last two centuries, there have been significant changes in the gas composition of the atmosphere due to natural phenomena and human activities, such as increasing energy consumption, industrialization, intensive agriculture, urban and rural development [4]. According to the Intergovernmental Panel on Climate Change [5], average global temperature will probably rise between 1.1 and 6.4℃ by 2090 – 2099 as compared to 1980 – 1999 temperatures, with the most likely rise being between 1.8 and 4.0℃.

Soil health/fertility on the other hand refers to the component of overall soil productivity that deals with its available nutrient status, and its ability to provide nutrients out of its own reserves and through external applications for crop production [6]. Soil health is an issue both for environment and agriculture since soil is a fundamental resource required for meeting the diverse needs of humans [7]. Human activities among other factors remain the principal drivers of processes of land degradation, desertification and climate change. Though highly complex and difficult to predict, interactions between climate change and soil fertility decline are likely to affect a range of different ecosystem functions and the services they deliver, with consequent impacts on food production, livelihoods and human well-being. According to Winterbottom et al. [8], the combined action of land degradation, land use pressures, and climate change is the greatest challenge for the world’s food production systems, and these challenges are particularly acute in Sub-Saharan Africa’s drylands, where land degradation, depleted soil fertility, water stress, and high costs for fertilizers contribute to low crop yields and associated poverty and hunger. With respect to crop production and food security, there exists a definite relationship between climate change and soil fertility decline, as reported in many studies [4,9,10,11,12,13,14]. In these studies, there is enough evidence that the climate change – soil health nexus is such that, the overall consequence of climate change on soil health is detrimental. The negative impact of climate change on soil fertility has been explained by various processes through which climate change reduces soil fertility and productivity, such as reduction of soil biodiversity [15,16], interruption of normal water cycling [17], destabilization of soil nutrient uptake kinetics [18], disruption of macronutrient cycles [19], reduction of soil water availability [4], decrease in nutrients and water use efficiency [10], reduction of growing period length [11], among others. From the above processes, the most common mechanisms through which climate change variables (mainly rainfall and temperature) reduce soil nutrient stocks are; reduced mineralization rates, accelerated weathering and leaching of minerals, reduced soil organic matter decomposition, decrease in nutrient dissolution and mobility, and soil erosion.

The Western Highlands of Cameroon (WHC) constitutes one of the agro-ecological zones of Cameroon where reliance for national food security resides. Unfortunately, the potentials of this agro-ecological zone are being threatened by the rapid degradation of water and land resources as influenced by demographic pressure and climate change. In the WHC, agriculture has been reported to be potentially vulnerable to climate variability [20,21,22], given that climate change variables have been observed to significantly reduce crop yields in this part of the country [21]. Furthermore, this vulnerability has been demonstrated by the devastating effects of recent flooding and various prolonged droughts, and also due to limited access to adequate information, technology, institutions and financial resources. Thus, for many poor countries that are potentially vulnerable, understanding responses to climatic variations and climate change is crucial for designing appropriate coping strategies [22]. These strategies include climate smart soil fertility management options [9,14], which mostly prioritize soil organic matter and moisture conservation.

Following the aforementioned, there is an urgent need to raise more awareness of basic and current notions about climate change, soil conservation and their relationship with respect to food security and strategies that can be used to mitigate climate change impacts on the environment. Unfortunately, such information is very much lacking and almost non-existent within the WHC. Very few studies have reported the impact of climate change on crop production within the WHC and other agroecological zones of Cameroon [21,22,23,24,25]. However these studies have focused on surveys with farmers and households relying on agriculture for livelihood. To our knowledge, the literature on this subject is scanty, for the case of young adults – a very strategic group of the population. Many studies envisage that climate change impacts will be more severe on the vulnerable groups such as the poor, women, children, old people and those that depend entirely on agriculture for their livelihoods, and worst still if there is limited knowledge or unawareness about climate change and its potential impacts [9,26]. Therefore, a potential challenge in the light of climate change is its awareness, especially by the young adults who face challenges of engagement and proper decision-making. In order to respond effectively and efficiently to this challenge, education will serve as an important tool, since it has a major role to play in enhancing individual understanding about climate change and its negative impacts on mankind, whether directly or indirectly. Unfortunately, climate change education is uncommon in most of the societies of developing countries, whether at formal or informal institutions, and this lack of education is one of the greatest factors hindering sustainable development. Therefore, the objective of this study was to assess the knowledge and opinions of “non-environmental science” high school students on two main environmental problems faced by less developed countries in general and the WHC in particular i.e., climate change and soil degradation, given that they find themselves in an environment where they are directly or indirectly affected by these threats. This study seeks to find out knowledge and opinion about two distinct, but definitely linked topics - climate change and soil fertility management, contrary to previous studies that have focused solely on climate change knowledge. The information to be obtained from this research shall certainly contribute to the achievement of sustainable development goals set by many developing countries.

2. MATERIALS AND METHODS

2.1 Biophysical Characteristics of the Study Area

The study was carried out in the West Region of Cameroon, precisely in Dschang, headquarters of Menoua division (Fig. 1). The division constitutes one of the main crop-producing areas in the Western Highlands agro-ecological zone of Cameroon, where intensive agriculture is carried out, in spite of soil fertility constraints [27,28]. Agriculture in the WHC is dominated by small-scale farmers and the agricultural population is estimated at more than 72% with over 160,000 households [29]. The population density is quite high with an average of 90 – 300 inhabitants/km^2 [30]. The topography is undulating and the vegetation is predominantly savannah, with patches of gallery forest containing a variety of agro-forestry tree species [30,31]. Wetlands within the area are dominated by raffia palms (*Raffia farinifera*). The terrain of the Western Highlands agro-ecological zone consists mainly of plateaus and depressions ranging from 300 to 3000 m above sea level.

The most striking feature of this region is the high cropping intensity, wherein about 40 –75% of the total area is planted with annual and perennial crops [30]. The climate is the tropical humid mountain type with two seasons: the rainy season that lasts from mid-March to October, and the dry season from November to about mid-March [32]. The annual rainfall varies from approximately 1,300 mm in plains to over 3,000 mm at higher altitudes. Mean monthly temperatures range from about 15℃ on the highlands to about 27℃ in low-lying regions [33] and can go up to 30℃ in some places [29].

2.2 Study Population

The study population consisted of high school students in the Menoua division of the West Region of Cameroon, who do not have any environmental science subjects or course within the school curriculum, but involve themselves in different agricultural (farming) activities outside normal school activities. This choice was made based on the assumption that although not

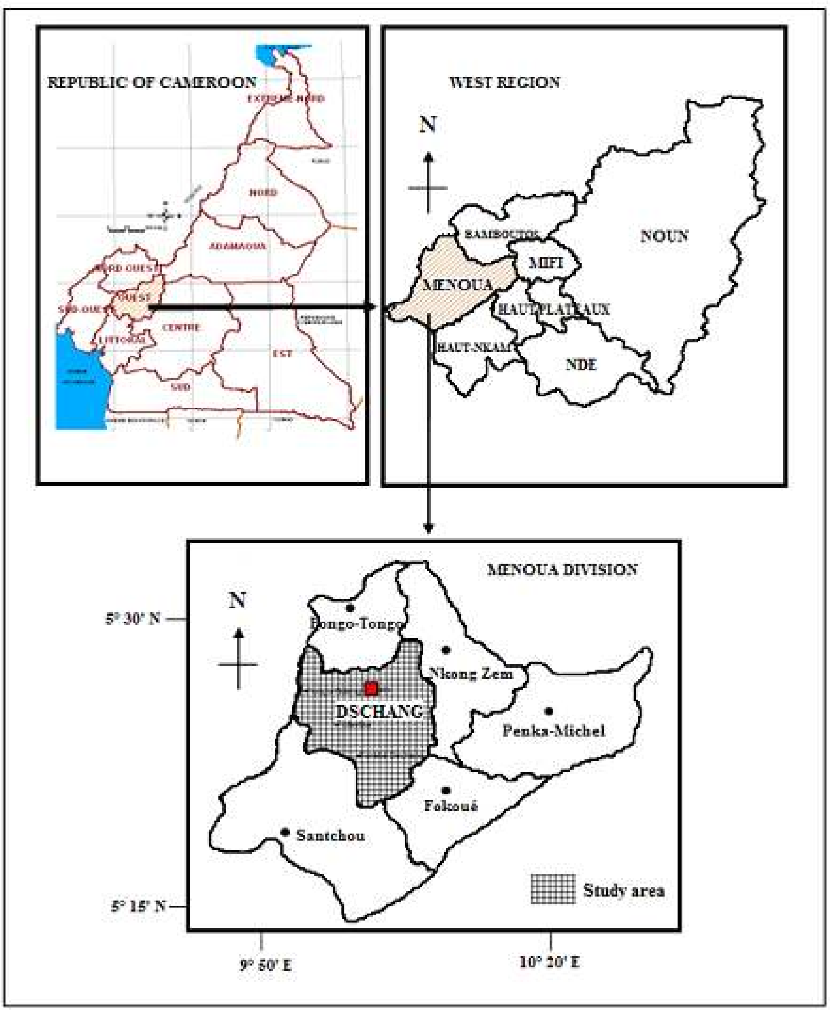

Fig. 1. Map of Cameroon showing the study area in the West Region

following any formal environmental science courses, current environmental issues such as climate change and soil degradation should be major topics of concern for all, especially from personal experiences. Thus, both arts and science inclined students constituted the study population. Arts-inclined students are those who read a combination of three or more (maximum of five) of the following subjects; History, Geography, Economics, English/French Language, Literature, and Philosophy while science-inclined students read a combination of three or more of the following subjects (maximum of five): Chemistry, Physics, Biology, Geology, Mathematics, and Computer science. The characteristics of respondents are shown in Table 1.

2.3 Estimation of Sample Size

The sample size was determined on the assumption that less than half (30%) of non-environmental science students are knowledgeable on climate change and soil fertility management, with 5% marginal error at 95% confidence interval and a non response rate of 1%. Based on these assumptions, the actual sample size for this study was determined using the proportions probability formula:

$$n = \frac{Z^2pq}{d^2} \quad (1)$$

Where

- n = Sample size
- Z= Parameter related to error risk (z-score), corresponding to 1.96 for an error risk of 5%
- p = expected proportion of knowledge of non-environmental science students on climate change and soil fertility management = 30% = 0.3
- q = expected proportion of non-environmental science students not knowledgeable, expressed as a fraction of 1. i.e. q = (1 - p) = (1 - 0.3) = 0.7
- d = absolute precision, expressed as a fraction of 1. In this study, d = 5% = 0.05

Therefore, $n = \frac{(1.96)^2 \text{x } 0.3 \text{ x } 0.7}{(0.05)^2} = 323$

Non response rate = 1% = (0.01 x 323) = 4

Therefore, sample size, n = 327 subjects

2.4 Instrumentation, Data Collection and Data Analysis

In this study, a paper questionnaire was designed for data collection, consisting of three main parts, excluding demographic characteristics of respondents. The first part consisted of nineteen closed-ended questions that sought to gather information on knowledge and opinion on climate change. To better quantify the responses from the respondents, questions were almost entirely closed-ended and were mostly restricted to those requiring “Yes” and “No” responses. This section consisted of questions related to definitions and misconceptions about climate change, sources of information on climate change, causes and effects of climate change. Part II was made up of ten questions, both open and closed questions, destined to capture information about knowledge and opinions on soil fertility management. The questions sought to find out students’ opinion and knowledge on methods used for identification of a fertile soil, practices that cause soil degradation and those that improve soil health. The third part had six questions that sought students’ knowledge and opinions on the relationship between climate change and soil health, and also on the best practical measures that could be used to combat climate change and soil degradation. The two last questions of this part sough to find out young peoples’ opinion with respect to environmental activism. Thus, the questionnaire had a total of thirty five questions aimed at achieving the set objectives of the study. Permission to administer the questionnaires was obtained from the respective principals of the high schools and a “consent to participate” notice was read to students and those who consented were given a questionnaire to complete - thus the sampling was random. During the exercise, some guidance was given to students in order to facilitate the exercise. It should be noted that before administering the questionnaires, no prior lesson whatsoever was delivered to the students. A total of 327 participants effectively filled and returned the questionnaires. Data obtained from the questionnaires was analyzed using descriptive and inferential statistics to describe and investigate the characteristics of respondents’ knowledge and opinions, using Microsoft Excel 2007 and SPSS (Version 19).

Table 1. Characteristics of study participants (n = 327)

Gender		Age range (years)			Household size			Length of farming (years)			Destination of farm produce		
Male	Female	15–17	18–20	21–23	1-5	6-8	>8	< 3	3–5	>5	H	M	H + M
135	192	151	159	17	162	103	62	82	36	209	137	9	181

Notes: H = Home consumption only, M = Market only (for sale), H+M = farm produce destined for home and market

3. RESULTS

3.1 Climate Change Opinion and Knowledge

Results on climate change knowledge and opinion are shown in Table 2. About 98% of respondents have heard about the terms climate change, global warming and greenhouse gases while 84.40% agree that the three terms are related to each other. However, only 55.96% of the students understand that climate change, global warming and greenhouse gases do not mean the same thing. Most students obtain climate change information primarily from school, television and the internet. Very few students (about 9%) obtain information on climate change from libraries and parents at home. A large majority (95.41%) understands that climate change is a serious threat to humans and the environment while a very small proportion (4.59%) of respondents says climate change is not a threat. Also, a very high proportion (93.58%) of respondents understands and affirms that climate change is currently happening while 6.42% say it is not. Of all respondents, a majority (79.51%) are aware of the causes of climate change while 20.49% are not. However, a larger majority (89.30%) understands that climate change is contributed by human activities. In the same light, a larger majority of respondents (89.91%) understands that climate change can be caused by pollution from heavy industries. A very high proportion (94.19%) understands and accepts that deforestation contributes to climate change whereas only a majority (71.86%) is of the opinion that the burning of fuel wood causes climate change. With respect to the natural causes of climate change, less than half (46.50%) understand that climate change can be caused naturally.

More than half (68.48%) of the study population have heard about greenhouse gases while 32.42% have not. Of the three groups of gases proposed, only a plurality (47.40%) of respondents understands that carbon dioxide (CO_2) and Methane (CH_4) are greenhouse gases.

As concerns the knowledge and opinion of respondents on the impacts of climate change, 97.85% of respondents understands and are of the opinion that climate change has negative consequences. However when it comes to specific effects, there are more diverse opinions. 80.43% of respondents understands that climate change can cause significant increases in air temperatures while 16.82% have no idea about climate change and rising temperatures. 85.93% of respondents understands that climate change can cause changes in wet and dry cycles while only about half (58.72%) of the respondents understands that intensive rainfall, heavy storms and floods can be caused by climate change, and 15.90% do not know about these phenomena. 85.01% also understands that climate change can lead to extended periods of drought while 11.01% have no idea about the impacts of climate change on water scarcity.

3.2 Knowledge and Opinions on Soil Fertility Management

Responses concerning knowledge and opinions on soil fertility management are shown in Table 3. In contrast to climate change and related terms such as global warming and greenhouse effect, that are common to a very high majority (97.86%) of the students, soil fertility management is not a very common term to the respondents since only 77.06% have heard about this term. In order of preference, the best characteristics that are used to identify a fertile soil, according to respondent opinions are: crop yield, soil texture, soil colour and topography. The least prioritized as indicators of soil fertility are soil depth and stoniness. Regarding soil fertility management, 94.49% of respondents understand that mulching increases soil fertility while only about half (53.52%) are of the opinion that the burning of farm residues can increase the soil's fertility. A majority (63.61%) recognize crop rotation as a method of maintaining soil health while 32.42% have a contrary opinion. A few (3.98%) have no idea about the effects of crop rotation on soil fertility maintenance. As concerns the use of inputs, a large majority (87.46%) is of the opinion that chemical fertilizers can increase soil fertility while 12.54% have a contrary view.

Compared to chemical fertilizers, 96.94% are of the opinion that manure (organic inputs) can increase the soil's productivity. 75% of respondents understand that pesticides and insecticides are chemical inputs that deteriorate soil health. However, a very small proportion (8.25%) is of the opinion that these chemical inputs are not harmful and can increase soil fertility while about 17% have no idea as to whether pesticides and insecticides can maintain or destroy soil health. With respect to the integrated use of farm inputs, a majority (68.19%) are of the opinion that the combined use of chemical fertilizers and manure can increase soil fertility. In the same way that crop yield is used as a measure of soil fertility, it is also used in appreciating declining soil fertility.

3.3 Relationship between Climate Change and Soil Fertility Management

Results relating climate change and soil health are shown in Table 4. From the various responses, 85.32% of young adults understand that climate change can affect soil fertility while 10.39% of the respondents have no idea about the relationship between climate change and soil fertility decline. Similarly, a large majority (88.07%) are of the opinion that climate change is capable of reducing crop yields while 9.78% have no knowledge as to whether climate change can reduce crop yields or not. Also, a considerable number of young people understand that climate change can affect soil fertility through water scarcity, high temperatures, reduction of soil nutrients, floods and soil erosion.

Table 2. Knowledge and opinions on climate change (n = 327)

Statement	**Response**		
	Yes frequency (%)	**No frequency (%)**	**No idea frequency (%)**
Have you heard about any of the terms "Climate change", "Global warming", "Greenhouse effect"?	320 (97.86)	7 (2.14)	
Do these three terms mean the same thing?	144 (43.04)	183 (55.96)	
In your opinion, are the three terms related to one other?	276 (84.40)	14 (4.28)	37 (11.32%)
In your opinion, do you think climate change is a serious threat to mankind and the environment?	312 (95.41)	15 (4.59)	
In your opinion, is climate change presently happening?	306 (93.58)	21 (6.42)	
Do you know the causes of climate change?	260 (79.51)	67 (20.49)	
In your opinion, are human activities responsible for climate change?	292 (89.30)	35 (10.70)	
In your opinion, can pollution from heavy industries cause climate change?	294 (89.91)	33 (10.09)	
In your opinion, can excessive cutting down of forest (deforestation) cause climate change?	308 (94.19)	19 (5.81)	
In your opinion, do you think the burning of fuel wood causes climate change?	235 (71.86)	92 (28.13)	
In your opinion, can climate change be caused naturally?	152 (46.48)	175 (53.51)	
Have you heard about the term "greenhouse gases"?	224 (68.50)	106 (32.42)	
In your opinion, has climate change got any negative consequences?	320 (97.85)	7 (2.14)	
Can climate change cause significant increase in air temperatures?	263 (80.43)	9 (2.75)	55 (16.82)
Can climate change cause changes in the wet/dry cycles?	281 (85.93)	14 (4.28)	32 (9.76)
Can climate change cause intensive rainfall and/or heavy storms and flooding?	192 (58.72)	29 (8.87)	52 (15.90)
Can climate change lead to extended periods of drought?	278 (85.01)	13 (3.98)	36 (11.01)

Where do you often obtain information about climate change?	**Source**	**School**	**Newspaper**	**Television**	**Radio**	**Internet**	**Library**	**Parents**
	Frequency (%)	252 (26.06)	86 (8.90)	258 (26.68)	116 (12.0)	132 (13.65)	15 (1.55)	72 (7.44)

From the list given, select a group of gases that you think are greenhouse gases	**Options**	**Methane (CH_4) Chlorofluorocarbons (CFCs)**	**Carbon dioxide (CO_2) Methane (CH_4)**	**Nitrous oxides (NO_x) Hydrogen (H_2)**
	Frequency (%)	88 (26.91)	155 (47.40)	84 (25.68)

Table 3. Knowledge and opinions on soil fertility management (n = 327)

Statement	Response		
	Yes frequency (%)	**No frequency (%)**	**No idea frequency (%)**
Have you heard about the term "soil fertility management"?	252 (77.06)	75 (22.94)	
In your opinion, can mulching increase soil fertility?	309 (94.49)	18 (5.50)	
In your opinion, can the burning of farms increase the soil's fertility?	175 (53.52)	152 (46.48)	
In your opinion, can crop rotation increase the soil's fertility?	208 (63.61)	106 (32.41)	13 (3.98)
In your opinion, can chemical fertilizers increase the soil's fertility?	286 (87.46)	41 (12.54)	
In your opinion, can manure increase the soil's fertility?	317 (96.94)	10 (3.05)	
Can the use of other chemicals such as pesticides and insecticides increase the soil's fertility?	27 (8.25)	244 (74.61)	56 (17.12)
Can the combined use of chemical fertilizers and manure on your farms increase soil fertility?	223 (68.19)	104 (31.80)	

In your opinion, how do you know that your soil's fertility is declining or reducing?	**Options**	**When the yield is reducing**	**When soil colour changes**	**When it has bad weeds**	**When it becomes very difficult to till**	**No idea**
	Frequency (%)	267 (52.25)	64 (12.52)	69 (13.50)	87 (17.02)	24 (4.69)

In your opinion, which of the following characteristics is the best you will use to identify a fertile soil?	**Options**	**From its texture**	**From soil colour**	**From the soil depth**	**From amount of stones present**	**From crop yield**	**Topography (Hill or valley)**
	Frequency (%)	77 (23.54)	75 (22.94)	9 (2.75)	7 (2.14)	112 (34.25)	47 (14.37)

Table 4. Knowledge and opinions on the relationship between climate change and soil fertility management

	Response		
	Yes Frequency (%)	**No Frequency (%)**	**No idea Frequency (%)**
In your opinion, can climate change affect soil fertility?	279 (85.32)	14 (4.28)	34 (10.39)
In your opinion, is climate change capable of reducing crop yields?	288 (88.07)	7 (2.14)	32 (9.78)

In your opinion, how would climate change affect soil fertility?	**Options**	**Through water scarcity (droughts)**	**Through high temperature**	**Through reduction of soil nutrients**	**Through floods**	**Throug h soil erosion**	**No idea**
	Frequency (%)	206	165	122	110	147	13

The following options are used to fight against climate change and soil fertility loss. What is your opinion?	Response			
	Strongly agree	**Agree**	**Disagree**	**Strongly disagree**
	Frequency (%)			
Planting of trees	240 (73.39)	75 (22.93)	12 (3.66)	00 (0.00)
Closing down industries that pollute the environment	61 (18.65)	137 (41.89)	107 (32.72)	22 (6.72)
Using little or no chemical fertilizers for the cultivation of crops	40 (12.23)	107 (32.72)	120 (36.69)	60 (18.34)
Avoid burning farms and forests for the cultivation of crops	175 (53.51)	92 (28.13)	39 (11.92)	21 (6.42)
Storing enough water during the rainy season and using it during the dry season	52 (15.90)	192 (58.71)	53 (16.20)	30 (9.17)

As concerns practical methods of mitigating climate change effects and preventing soil fertility decline, 73.39% of respondents strongly agrees on the planting of trees while a smaller proportion strongly agrees on the closing down of industries that pollute the environment (18.65%), on the use of little or no chemical fertilizers for crop production (12.23%), on the restriction to burn farms and forests for the cultivation of crops and on storing water reserves during the rainy season which can be used for irrigation in the dry season (Fig. 2). With respect to responses provided for closed questions, approximately 81% of respondents had a good understanding on basic concepts about climate change, its causes, and possible effects. Compared to climate change questions, only about 67% of respondents had a good idea about soil fertility management. However, over 86% of respondents understand that there is a link between climate change and soil fertility.

The opinions about which different groups of people (from students to leaders, scientists and development agents) are in the best position to solve climate change problems are given by students, as shown in Fig. 3.

Regarding the willingness of young people to get involved in climate change mitigation and soil conservation actions, a very large majority (86.5%) expressed their willingness to do so (Fig. 4).

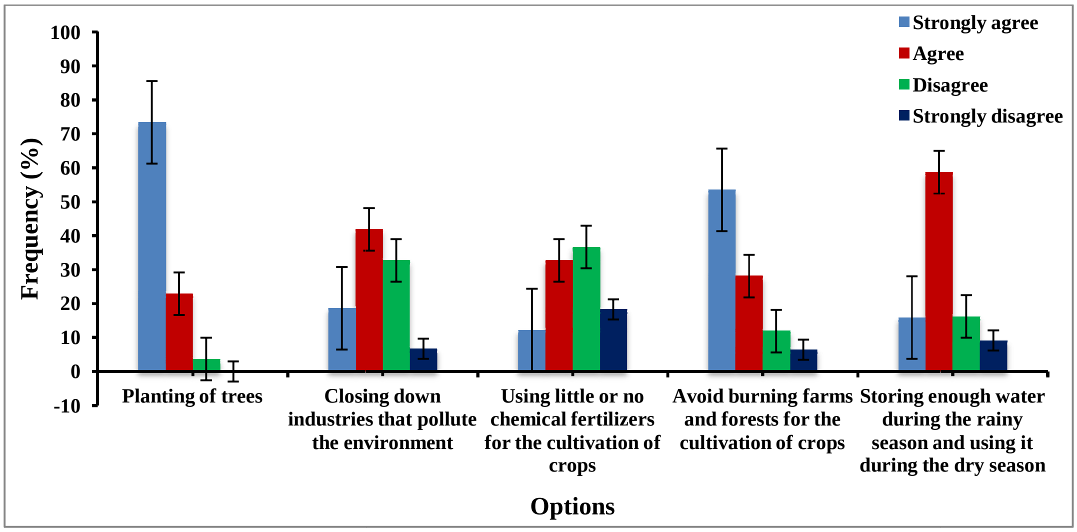

Fig. 2. Opinions on methods used for climate change and soil degradation mitigation

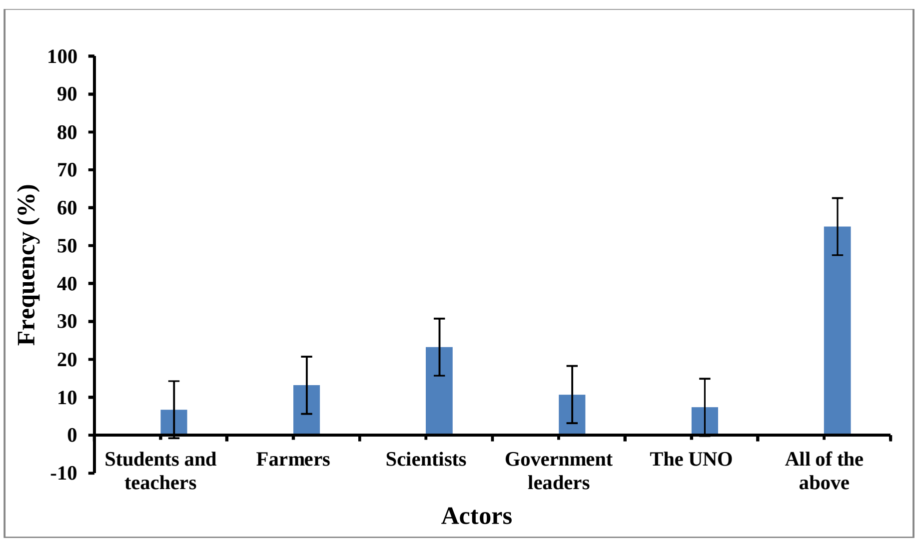

Fig. 3. Opinions about who should solve climate change problems

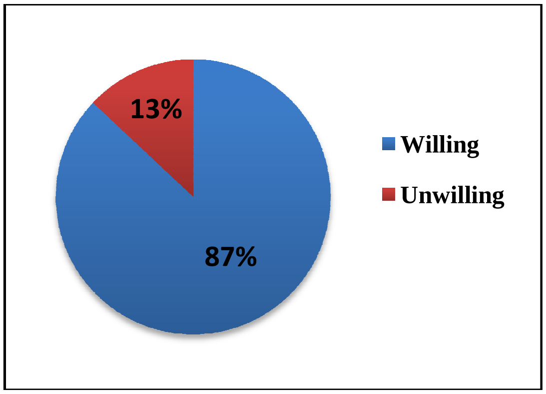

Fig. 4. Willingness of young people to become environmental activists

4. DISCUSSION

4.1 Knowledge and Opinions on Climate Change

The results reveal that a large majority of respondents (> 75%) actually have a good knowledge about climate change, soil fertility management, and ways of combating climate change and soil degradation. The terms "climate change", "global warming" and "greenhouse gases" are very common to these young adults, probably because they often hear about them in school or various electronic communication media. Our results show that the school milieu and television are the main sources of information on climate change. These results are similar to those reported by Dawson and Carson [34], in a survey carried out in Australia, where it was observed that television was the main source of information about climate change, with school science as second (although school science was seen as the most trustworthy). According to Sunstein [35], knowledge of a certain topic will usually enhance an individual's concern over that topic. Additionally, it has been reported that callousness of climate change science is the primary determining factor for an individual's motivation to feel concerned about climate change [36]. A survey conducted in Nigeria to determine the level of awareness of secondary school students about climate change and their perception about the causes of climate change, revealed that the level of awareness was moderate, with majority of students obtaining information about climate change from school and television (> 50%) followed by the radio and library [37]. Similarly, a study conducted in Tanzania revealed that about 50% of students mentioned school and television as the main sources of climate change information [38]. With respect to these sources of information, a potential question that arises is that of the reliability of the information propagated in school curriculum. With respect to climate change in school, Harker-Schuch and Bugge-Henriksen [39] reported that climate change lectures delivered to students in Denmark and Austria significantly improved knowledge development but did not affect opinions about climate change. Similar observations have been reported in other studies, with respect to students' knowledge, perceptions and opinions about climate change [40,41,42]. Following the results of many authors about students' knowledge on climate change awareness and opinions, various recommendations have been made including the implementation of environmental science in secondary and high schools and the development of practical actions to deal with problems associated with climate change. That is why "adequate knowledge on climate change is necessary to help prepare peoples' minds for climate change impacts" [43]. Studies reveal that students in schools without environmental science courses could obtain basic notions of climate change from related pure and social science subjects such as Geography, Chemistry, Biology etc. [37]. However, the knowledge acquired through this path is uncertain and will greatly depend on the students' interest in environmental issues. Most of the respondents in our study and those in other studies could not actually tell if climate change is related to global warming or greenhouse gases, certainly because they do not undertake any formal environmental science subjects where they can actually study in-depth of climate change. Moreover, some misconceptions were observed with respect to examples of greenhouse gases as respondents selected chlorofluorocarbons and hydrogen as being greenhouse gases. To our opinion, we think that respondents who identified carbon dioxide as a greenhouse gas did so due to the fact that carbon dioxide is the gas that is most commonly mentioned over the media in climate change discussions. In the survey conducted by Dawson and Carson [34], it was observed that up to 15% of students thought that carbon dioxide was the only greenhouse gas, due to the focus that carbon receives in debates on climate change, where the media talks mostly about "carbon taxes" and "carbon footprints". Additionally, a significant proportion (25%) of young people from Tanzania indicated that they did not know anything about greenhouse gases [38]. The fact that students in our study identified CFCs as greenhouse gases indirectly tells us that they also have misconceptions about the greenhouse effect and global warming. Generally, CFCs are associated with the degradation of the ozone layer, whereas greenhouse gases, such as carbon dioxide and methane, are involved in the greenhouse effect. In our study, the misconceptions about greenhouse gases are also reflected from the high percentage (32.42%) of respondents who say that they have never heard about the term “greenhouse gases”. However, this misconception is common to many people of different social and educational backgrounds. Following a series of surveys conducted in 1989, 1993 and 2005 in Norway, to assess 15 year olds’ understanding of the greenhouse effect and climate change, it was observed that although there was some improvement in students’ understandings of the causes and effects of the greenhouse effect, there was equally an increase in confusion between the greenhouse effect and the ozone layer [44].

As concerns direct impacts of climate change, a large majority of respondents in our study gave correct answers certainly because they are already witnessing these effects, such as shifts in rainy and dry seasons, abrupt increases in air temperatures and frequent storms and floods. Besides the effects, students are also aware that human activities such as the burning of fuel wood and various industrial processes, contribute to climate variability/change. In most developing countries, fuel wood remains the principal source of heat energy for households due to the low incomes. Due to this traditional practice, most people are not conscious of the significant contributions it can make to increased greenhouse gases. In our study, only about 72% of respondents were conscious of the fact that burning fuel wood contributes to global warming. As concerns deforestation, many more respondents (94.91%) were conscious of the fact that excessive cutting down of trees contributes to climate change. This differential in opinion about burning of fuel wood and deforestation gives evidence that many people still believe in fuel wood as a sustainable source of energy.

4.2 Knowledge on Soil Fertility Management

About 77% of respondents have heard about the term “soil fertility management”. This statistics was surprising to us because we had anticipated that the term will be strange to the respondents, given that it is mostly used by those in the fields of agronomy, agricultural sciences and soil science etc. Thus, we ask ourselves if respondents misunderstood the question that was asked – “Have you heard about the term soil fertility management?” Could it be that they interpreted the question as: - Do you understand the meaning of the term “soil fertility management”? which would normally be understood, according to them, as the management of soil fertility?. Regarding the identification of a fertile soil, only a very fine proportion (1.42%) could not identify a fertile soil. The various soil fertility indicators identified by the students, such as soil colour, texture, crop yield/quality, soil depth and topography, give an indication of possible farming experiences and soil fertility skills they possess. This is probably the reason why a very large majority of the respondents affirm that mulching, chemical fertilizers and manure can readily improve the soil’s fertility. However, only about half (53%) of the respondents think that the burning of farms (shifting cultivation or slash-and-burn) improves the soil’s fertility. 46.86% of the respondents say that slash-and-burn does not improve the soil’s fertility from their past experiences. Shifting cultivation is a common technique used to restore soil fertility within the WHC but the method is not sustainable, given that soil nutrients build up within the first two years of burning and later decline substantially [45]. Also, techniques such as burying of plant material below crop-bearing ridges (mulching), localized surface burning of plant material and the burying and burning of plant material (are used to improve on soil fertility, but the effects do not last long [33]. It was observed that over 30% of the respondents are of the opinion that the combined use of chemical fertilizers and manure does not improve the soil’s fertility. This could either be due to the fact that this proportion of young people do not practice integrated soil fertility management, or they carry out this practice but the proportions of inputs used are inadequate or disproportionate that the combined effect is not observable. Within the WHC, it has been reported that most farmers practice integrated soil fertility management with the aim of improving on soil fertility, usually through the combination of chemical fertilizers and animal manure in varying proportions [46]. With regards to soil health, 74.61% are of the opinion that pesticides and insecticides promote soil deterioration. Surveys conducted in the WHC reveal that most pesticides used by gardeners contain very harmful chemical substances such as Thiocarbonates, Organophosphates, Pyrethroids synthetic components and Organochlorines [47], and persistent organic pollutants in pesticides such as Lindane, Dieldrine, Endosulfan and DDT [48], which may lead to soil pollution and the eventual contamination of various food chains. In the present study, crop yield received more attention as an indication of soil fertility decline, compared to soil colour change, presence of weeds and others. The use of crop yield to assess soil fertility level is common with most farmers and even scientists and researchers, given that most soil fertility studies usually integrate crop yields or plant component yields [49].

4.3 Relationship between Climate Change and Soil Fertility

In the literature, there is enough evidence that climate change has potential impacts on soil fertility and consequently on food production [9], [12,13]. In this study, over 85% of young people are of the opinion that climate change can affect soil fertility while about 88% say that climate change can reduce crop yields. Droughts, high temperatures, reduction of soil nutrients, floods and soil erosion, were all given high consideration as processes through which climate change affects soil fertility. About 10% do not know if climate change is capable of affecting soil fertility or crop yields. This lack of knowledge can be attributed to a shortage of interest or deficiency of adequate information about climate change impacts. In general, a majority of the students agreed on the methods proposed for combating climate change and soil degradation.

It is worth noting that a very important piece of information we lack from this study is how much the young people can implement their opinions and knowledge in a practical manner. For example, we do not actually know the percentage of young people who might be willing to plant a tree in their local community, or reduce the quantities of chemical fertilizers and rather go in for organic farming or take up the challenge of economizing water and storing it for eventual use during periods of droughts, or advise local farmers on how to manage their farm residues (e.g. not to burn crop residues and biomass), etc. As concerns the question about which different groups of people (from students to leaders, scientists and development agents) are in the best position to solve climate change problems, 55% of young people express their inability to manage some critical environmental issues, because according to them, climate change problems should be a matter of a particular group of people. This inability could be related to their lack of knowledge on adapted technology and other resources to cope with climate change and land degradation. The last question of our survey gives an idea about the willingness and zeal of young ones to involve themselves in concrete actions that could mitigate climate change impacts and soil degradation. We also think from this last part, that, the students are certainly in thirst of knowledge about environmental issues, given that more than 85% of them expressed willingness to become environmental activists.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study, we sought to find out some basic knowledge about climate change and soil fertility management among young adults in Cameroon. Our results revealed that most of the young people had some basic knowledge about climate change and soil fertility management. Additionally, our results showed that most of the respondents, though not undertaking any formal environmental courses, had positive opinions and ideas over issues such as climate change and soil conservation. Furthermore, our results showed that most young people are eager to involve themselves into environmental challenges. It was observed that some students had lapses on current environmental topics such as greenhouse gases and the greenhouse effect. These lapses show that capacity building and reinforcement of knowledge is imperative. Conscious of these weaknesses, it will be necessary for young adults to obtain adequate and effective training on environmental sciences, not only through an implemented environmental science curriculum, but through a competence-base approach such that young people will be better armed and prepared for environmental challenges.

5.1 Recommendations

We recommend environmentalists, educationists, teachers and policy makers in developing countries, to promote environmental education at all levels, so as to develop skills and competences. Also, it is recommended that a comparative study be carried out in other agro ecological zones such as forest zones and arid/semi-arid environments in order to appreciate the opinions and knowledge of young people in these environments. This will permit an understanding of the influence of geographical environments on young adults' knowledge and opinions vis-a-vis climate change and soil degradation and the possible measures and policies to be implemented in order to achieve global food security and sustainable development. To nongovernmental organisations (NGOs) concerned with climate change and land degradation, we recommend that young people should be targeted and actively involved in learning activities that can improve capacity building for sustainable environmental management.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Corner A, Roberts O, Chiari S, Völler S, Mayrhuber ES, Mandl S, Monson K. How do young people engage with climate change? The role of knowledge, values, message framing, and trusted communicators. WIREs Climate Change. 2015;6(5):523–534.
Available:http://climateoutreach.org
2. UNICEF. 'The Challenges of Climate Change: Children on the front line', Innocenti Insight, Florence: United Nations Children's Fund Office of Research, Florence, Italy; 2014.
Available:https://www.unicef.org/publications/index_74647.html
3. Intergovernmental Panel on Climate Change (IPCC). Climate Change 2014: Impacts, Adaptation and Vulnerability; Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: New York, NY, USA; 2014.
4. Várallyay G. The impact of climate change on soils and on their water management. Agronomy Research (Special Issue II). 2010;8:385–396.
5. Intergovernmental Panel on Climate Change (IPCC). Summary for Policymakers. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (Eds) Climate Change: The Physical Science Basis; Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge, UK; 2007.
6. FAO. Plant nutrition for food security. A guide for integrated nutrient management. FAO fertilizer and plant nutrition bulletin 16, Rome, Italy. ISBN: 92-5-105490-8. 2006;348.
7. Chauhan A, Mittu B. Soil health - An issue of concern for environment and agriculture. Journal of Bioremediation and Biodegradation. 2015;6(3):286- 289.
DOI:10.4172/2155-6199.1000286.
8. Winterbottom R, Reij C, Garrity D, Glover J, Hellums D, Mcgahuey M, Scherr S. Improving land and water management. Working Paper, Installment 4 of Creating a Sustainable Food Future. World Resources Institute Washington DC; 2013.
Available:http://www.worldresourcesreport.org.
9. Lal R. Climate Strategic Soil Management. Challenges. 2014;5:43-74.
DOI:10.3390/challe5010043.
10. Brouder SM, Volenec JJ. Impact of climate change on crop nutrient and water use efficiencies. Physiologia Plantarum. 2008; 133:705–724.
DOI: 10.1111/j.1399-3054.2008.01136.x
11. Sarr B. Present and future climate change in the semi-arid region of West Africa: a crucial input for practical adaptation in agriculture. Atmospheric Science Letters. 2012;13(2):108–112.
DOI: 10.1002/asl.368
12. Brevik EC. The Potential Impact of Climate Change on Soil Properties and Processes and Corresponding Influence on Food Security. Agriculture. 2013;3:398-417.
DOI:10.3390/agriculture3030398.
13. St. Clair BS, Lynch JP. The opening of Pandora's Box: climate change impacts on

soil fertility and crop nutrition in developing countries. Plant Soil. 2010;335:101–115. DOI: 10.1007/s11104-010-0328-z.

14. Shrestha A, Bishwakarma BK, Allen R. Climate Smart Management Options for Improving the Soil Fertility and Farm Productivity in the Middle Hills of Nepal. Universal Journal of Agricultural Research. 2014;2(7):253-263.
DOI: 10.13189/ujar.2014.020705

15. Chapin FS. Effects of plant traits on ecosystem and regional processes: a conceptual framework for predicting the consequences of global climate change. Annals of Botany. 2003;91:455–463.
DOI: 10.1093/aob/mcg041

16. Swift MJ, Andren O, Brussaard L, Briones M, Couteaux MM, Ekschmitt K, Kjoller A, Loiseau P, Smith P. Global change, soil biodiversity, and nitrogen cycling in terrestrial ecosystems: three case studies. Global Change Biology. 1998;4:729–743. DOI:10.1046/j.1365-2486.1998.00207.x

17. Pendall E, Bridgham S, Hanson PJ, Hungate B, Kicklighter DW, Johnson DW, Law BE, Luo Y, Megonigal JP, Olsrud M, Ryan MG, Wan S. Below-ground process responses to elevated CO_2 and temperature: a discussion of observations, measurement methods, and models. New Phytologists. 2004;162:311–322.
DOI: 10.1111/j.1469-8137.2004.01053.x

18. Bassirirad H. Kinetics of nutrient uptake by roots: responses to global climate change. New Phytologists. 2000;147:155–169.
DOI: 10.1046/j.1469-8137.2000.00682.x.

19. Whitehead PG, Crossman J. Macronutrient cycles and climate change: Key science areas and an international perspective. Science of the Total Environment. 2011;434:13-17.
DOI: 10.1016/j.scitotenv.2011.08.046.

20. Munang T, Rivington M, Bellocchi G, Azam-Ali S, Colls J. Effects of climate change on crop production in Cameroon. Climate Research. 2008;36:65–77.
DOI: 10.3354/cr00733.

21. Munang T, Rivington M, Bellocchi G. Adaptation assessments for crop production in response to climate change in Cameroon. Agronomy for Sustainable Development. 2009;29:247–256.
DOI: 10.1051/agro:2008053

22. Ngondjeb DY. Agriculture and Climate Change in Cameroon: An Assessment of Impacts and Adaptation Options. African Journal of Science, Technology, Innovation and Development. 2013;5(1):85–94.
DOI: 10.1080/20421338.2013.782151.

23. Molua E, Lambi C. The economic impact of climate change on agriculture in Cameroon. CEEPA Discussion Paper no. 17, Centre for Environmental Economics and Policy in Africa, University of Pretoria, Pretoria, South Africa; 2006.

24. Molua E. Turning up the heat on African agriculture: the impact of climate change on Cameroon's agriculture. African Journal of Agricultural and Resource Economics. 2008;2(1):45–64.
Available:http://www.aaae-africa.org/afjare/doc

25. Fonteh MF, Tabi FO, Wariba AM, Zie J. Effective water management practices in irrigated rice to ensure food security and mitigate climate change in a tropical climate. Agriculture and Biology Journal of North America. 2013;4(3):284-290.
DOI:10.5251/abjna.2013.4.3.284.290

26. Jerumeh EG, Jerumeh TR, Okoruwa VO. Perception and Adaptation of Yam Based Farmers to Climate Change in Edo State, Nigeria. Academia Journal of Agricultural Research. 2016;4(8):501-510.
DOI: 10.15413/ajar.2016.0174.

27. Tankou CM, de Snoo GR, de Iongh HH, Persoon G. Soil Quality Assessment of Cropping Systems in the Western Highlands of Cameroon. International Journal of Agricultural Research. 2013; 8(1):1–16.
DOI: 10.3923/ijar.2013.1.16

28. Tankou CM, de Iongh HH, Persoon G, de Bruijn M, de Snoo GR. Determinants and Impacts of Human Mobility Dynamics in the Western Highlands of Cameroon. International Journal of Scientific and Technology Research. 2014;3(8):40-50. Available:http://www.ijstr.org/research-paper-publishing.php?month=aug2014

29. Goufo P. Rice Production in Cameroon: A Review. Research Journal of Agriculture and Biological Sciences. 2008;4(6):745-756.
Available:http://www.aensiweb.net/AENSIWEB/rjabs/rjabs/2008/745-756.pdf

30. Asaah E, Takoutsing B, Njong J, Mundi A, Iseli J, Degrande A, Tsobeng A, Tchoundjeu Z. Agroforestry making the difference in the western highlands of Cameroon. In: World Agroforestry Centre (ICRAF) Annual report 2009. Agroforestry and Landscapes. 2010;19-21.
31. Yerima BPK, Van Ranst E. Introduction to Soil Science: Soils of the Tropics. Trafford Publishing, Canada. ISBN: 1-41205853-8. 2005;396.
32. Yengoh GT, Hickler T, Tchuinte A. Agro-climatic resources and challenges to food production in Cameroon. Geocarto International. 2011;26:251–273.
DOI:10.1080/10106049.2011.556756
33. Yengoh GT. Determinants of yield differences in small-scale food crop farming systems in Cameroon. Agriculture and Food Security. 2012;1(19):1–17.
DOI:10.1186/2048-7010-1-19.
34. Dawson V, Carson K. Australian Secondary School Students' Understanding of Climate Change. Teaching Science. 2013;59(3):9-14.
Available:http://search.informit.com.au/documentSummary;dn=687801424068812;res=IELHSS
35. Sunstein C. The availability heuristic, intuitive cost-benefit analysis and climate change. Climatic Change. 2006;77:195–210.
DOI: 10.1007/s10584-006-9073-y
36. Tjernstrom E, Tietenberg T. Do differences in attitudes explain differences in national climate policies? Ecological Economics. 2008;65:315–324.
Available:http://dx.doi.org/10.1016/j.ecolecon.2007.06.019
37. Bello TO. Assessment of Secondary School Students' Awareness of Climate Change. International Journal of Scientific Research and Education. 2014;2(12): 2713-2723.
38. Carr P, Buggy CJ, McGlynn G. Climate change awareness amongst secondary level students in a Dar es Salaam University College of Education (DUCE) affiliated school in urban Tanzania. United Nations Sustainable Development Network 3rd Annual International Conference on Sustainable Development Practice, Columbia University, New York, USA, 23 - 24 September 2015.
Available:http://hdl.handle.net/10197/7397.
39. Harker-Schuch I, Bugge-Henriksen C. Opinions and Knowledge about Climate Change Science in High School Students. AMBIO. 2013;42:755–766.
DOI: 10.1007/s13280-013-0388-4.
40. Fortner R. Climate change in school: Where does it fit and how ready are we? Canadian Journal of Environmental Education. 2001;6:18–31.
Available:https://cjee.lakeheadu.ca/article/view/285
41. Schreiner C, Henriksen EK, Kirkeby Hanse PJ. Climate education: Empowering Today's Youth to Meet Tomorrow's Challenges. Studies in Science Education. 2005;41(1):3-49.
Available:http://dx.doi.org/10.1080/03057260508560213
42. Markowitz E. Is climate change an ethical issue? Examining young adults' beliefs about climate and morality. Climatic Change. 2012;114:479–495.
DOI:10.1007/s10584-012-0422-8.
43. Ojomo E, Elliott M, Amjad U, Bartram J. Climate change preparedness: A knowledge and attitudes study in Southern Nigeria. Environments. 2015;2:435-448. DOI:10.3390/environments2040435.
44. Hansen PJK. Knowledge about the greenhouse effect and the effects of the ozone layer among Norwegian pupils finishing compulsory education in 1989, 1993, and 2005—What Now? International Journal of Science Education. 2010;32(3): 397-419.
Available:http://dx.doi.org/10.1080/09500690802600787
45. Neba NE. Cropping systems and post-cultivation vegetation successions: Agro-ecosystems in Ndop, Cameroon. Journal of Human Ecology. 2009;27(1):27-33.
46. Tabi FO, Bitondo D, Yinda GS, Kengmegne SSA, Ngoucheme M. Effect of long-term integrated soil fertility management by local farmers on nutrient status of a Typic Dystrandept under potato-based cropping system. International Research Journal of Agricultural Science and Soil Science. 2013;3(4):134-140.
Available:http://www.interesjournals.org/IRJAS
47. Kamga A, Kouamé C, Tchindjang M, Chagomoka T, Drescher AW.

Environmental impacts from overuse of chemical fertilizers and pesticides amongst market gardeners in Bamenda, Cameroon. Revue Scientifique et Technique Forêt et Environnement du Bassin du Congo (French). 2013;1:6-22.

48. Tarla DN, Tchamba NM, Baleguel NP, Fontem DA, Baleguel PD, Hans D. Inventory of obsolete pesticide stockpiles in Cameroon. Scholarly Journal of Agricultural Science. 2014;4:43-50.

49. Vanlauwe B, Descheemaeker K, Giller KE, Huising J, Merckx R, Nziguheba G, Wendt J, Zingore S. Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation. SOIL. 2015;1:491–508.

DOI:10.5194/soil-1-491-2015.

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