Students' Perception on Causes and Consequences of Climate Change in Public Universities of Ethiopia

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Abstract

Climate change is impacting socioeconomic and biophysical environments at both Global and local scales. This paper presents the results of the assessment study of student perception on the information sources, occurrences, causes, impacts and solutions of climate change in the public universities of Ethiopia. A questionnaire survey was conducted on a total of 357 university students attending undergraduate and postgraduate courses to generate the required data. The data gathered in this way was analyzed using descriptive and inferential statistics. The results indicated that over 57% of the students get climate change information from different sources. The main climate change information sources identified by the students include television, radio, friends, internet, government reports and school teachers. Among these, teachers are the major (82%) of the studied students. Over 60% of the students reported that they do not have sufficient knowledge about climate change. Giving special concern to climate change information, obeying the laws of nature, limited interference in nature, developing awareness among the public and adopting safe industrial environments are suggested solutions to minimize the hazards of climate change. It is suggested that state agencies should design ways to deliver climate information to the wider public so as to develop awareness on the causes and consequences of climate change among the public. Local agencies and land users need also to adhere with the natural laws and adapt proper interferences in the local natural environment.

Keywords: Climate variability, Information sources, Causes, Consequences, Solutions, Ethiopia

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1. Introduction

Climate change is happening and will continue in the future; regardless of what investments in mitigation measures are made (Mertz *et al.,* 2009). This is evidenced by the fact that the Earth's temperature has changed considerably over the past millions of years (Robert *et al.,* 2011). Currently, this change is rapidly emerging and the world is facing a greater challenge of accelerated human-induced climate change than ever before (Klein *et al*., 2003; Aklilu and Dereje, 2010). Destruction of forests, carbon dioxide emissions, emissions from transport and emissions from power stations are major contributors to climate change (Lorraine, 2005). The tragedy is that those countries who contributed little to the causes of greenhouse gas emissions are the ones most affected by climate related shocks. This made climate change to be the most illustrious environmental issue since the late 20th century (Muhammad, 2013). The same author further pointed that climate change is primarily driven by greenhouse gas (GHG) emitting from human activities, such as the burning of fossil fuels and the accumulation of some dangerous gasses in the atmosphere. It was believed that human activity has caused the Earth's temperature to rise higher than it has been since civilization developed about 10,000 years ago. This is largely the result of changes in GHG-emitting that increased substantially following the Industrial Revolution. Hence, human behavior is changing the climate, and humans are in turn impacted by climate change **(**Lorraine, 2005). Put differently, the consistency of observed significant changes in physical and biological systems and observed significant warming across the globe very likely cannot be explained entirely by natural variability (IPCC, 2007).

Public perceptions on climate change and its risks are critical in achieving low carbon emission environment. However, research conducted over the past 3 to 4 years for example, in America and the United Kingdom evidenced that concern on climate change has declined dramatically (Spence *et al*., 2011). Particularly those located in the geographically south are more concerned about climate change and these countries do not have the resources and capability to deal with these impacts. Zaki (2011) noted that perception of climate change is highest in developed parts of the world compared to developing countries. However, country-by-country response showed that 31% in the USA perceived that climate change is a very serious agenda against 85% in Bangladesh and 75% in Kenya (Zaki, 2011). With evidences, the same author also noted that 13% respondents from USA and 63% from Vietnam and 53% from Kenya gave high priority to the issue of climate change. This is in line to the premises of Bast (2010) who argued that developed parts of the world such as USA believe that global

warming is dominantly the result of natural causes than human beings- they are climate change denials.

There are studies in relation to students' perceptions on climate change/variability across the world. Pitpitunge (2013) for example, assessed high school natural science students' perception related to aspects of climate change in the Philippines. The same author further confirmed that students are deficient on the causes and impacts of climate change knowledge in the Philippines. Deepak (2014) studied the perception of postgraduate students on the Mass Media related to creation of awareness over climate change in Agartala, India. Caranto and Pipitunge (2015) demonstrated the climate change awareness of 230 students registered for specialized science courses into two public high schools in the province of Pampanga, the Philippines. Christensen and Knezek (2015) analyzed middle school (Grade 5-8) 1576 students' beliefs and intentions towards the environment with a focus on climate change in the USA. Flores (2017) assessed the feelings of high school students towards climate change in Mexico City. Boon (2010) made a comparison study over the knowledge and understanding of climate change between secondary school students and pre-service teachers in Australia. Cornforth (2011) examined the variation of concern on climate change with level of knowledge focusing on young, adult and elder participants in New Zealand. Studies on climate change show that students have lack of perceptions on ozone layer depletion and global warming, on climate and weather.

More importantly, Alan (2013) made a study on students' perceptions on climate change in Hong Kong, Christensen (2015) in USA, Boon (2010) in Australia, Deepak (2014) in India, Arnold (2013) in Philippines, Viscusi and Zeckhauser, (2006) in USA, Lorraine (2005) in England. However, students' perceptions on climate change in Africa in general and Ethiopia in particular are overlooked. Besides, this study has attempted to compare different universities across the Amhara National Regional State that could sufficiently represent the country- Ethiopia. This is because university students are coming from different regional states of Ethiopia. This particular comparison is the focus of this study. More importantly, climate change perception is dynamic that needs up - to - date and reliable information. Hence, this study tries to fill these gaps and add knowledge to the existing literature. To be more specific, university students are key factors in making future generations, in making decisions about mitigation and amelioration strategies, as well as potential leaders in changing the lives of the wider community. Hence, understanding how much university students

perceive climate variability, which is a serious problem across the world, could help to inform policy makers about the issues.

The general objective of the study is to assess university students' perceptions on climate variability in the Amhara National Regional State of Ethiopia. The specific objectives include to:

(i) Assess students perceptions about climate variability

(ii) Assess sources of information on climate variability

(iii) Identify potential indicators of climate variability perceived by the students

2.2. Research Methodology

2.2.1. Research Design

Growing number of studies have examined that perceptions of climate change could be assessed using in-depth methodologies such as focus groups, semi-structured interviews, surveys using experimental study designs and case studies (Johanna and Susanne, 2011). These enhance the power in understanding people's thought processes, barriers, and what might serve to motivate people to act on climate change. Such kinds of studies reveal differences in individual understandings, perceptions and levels of engagement among fresh and senior university students. As the subjects of this study are university students attending undergraduate and postgraduate courses, a quantitative cross-sectional survey design was employed here expecting the students can easily provide the required information about their perception on climate information sources, and on causes and consequences of climate change and variability.

2.2.2. Sampling techniques

Multi-stage sampling techniques were used to select the respondents to fill the questionnaire. Amhara Region universities were selected using purposive sampling techniques. This is due to their accessibility and familiarity of the principal investigators. Besides, students are coming from different parts of the country; hence, representation could not be a problem. There are eight universities in the region. Using simple random sampling techniques four universities (Bahir Dar, Gondar, Debremarkose and Deberberhan) were selected for the study. Considering availability of time and financial resources, a total of 357 students attending classes in 2017/2018 were included in the study. The subject of the study was students from Geography and Environmental studies. Of these students, 307 were enrolled for their first

degree and 50 for their second degrees. The majority of the students (137) were third year, 119 first years, and the rest 101 were second year.

2.2.3. Data Collection techniques

Survey questionnaire: A mix of close and open-format questions expected to capture students' climate change perceptions were developed and filled by the 357 students. The questions covered students' perceptions about climate variability/change, the causes of climate change, and indicators of climate variability and sources of climate change/variability information. The enumerators and supervisors were first trained by the principal investigator on how to present and explain each question to the respondents. Besides, they were trained to inform some ethical issues that should be kept confidential to the participants before the actual interview. The principal investigator, four enumerators and four supervisors conducted the survey. The principal investigator and the supervisors monitored and checked the way questionnaires were filled for further data analysis.

2.2.4. Data analysis

The data captured in the questionnaire survey were edited, coded and entered into the statistical package of the social sciences (SPSS- Version-22) and analyzed using the descriptive and inferential statistics. For descriptive statistics tables, frequencies and percentages were employed for analysis. Inferential statistics such as Chi-square test and ordered logit model were used.

Ordinal logistic regression model

Ordinal logistic regression model is used to predict the odds of having lower or higher value for the dependent variable (y) based on the values of the predictor (x) variables. In this model, the dependent variable is categorical variable (accumulation of greenhouse gas in the atmosphere with four ordered categories: 1 = strongly agree, 2 = agree, 3= disagree, 4 = strongly disagree (a reference category). The independent variables include poor waste management, deforestation, agricultural expansion, volcanic eruption and air pollution with four ordered categories: (1 = strongly agree, 2 = agree, 3= disagree, and 4 = strongly disagree (a reference category)). Unlike the linear regression, ordinal regression focuses on odds ratio (OR) by taking the exponent of the estimates: exp (estimates). The OR is interpreted as for every one-unit increase in x; y increases/decreases of the (OR). The model is specified as… $\ln\left(\frac{prob\,(event)}{(1-prob\,(event))}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \ldots + \beta_k X_k$. This can be specified as $\beta 0 + \beta_1$ (poor waste

management) + β_2 (deforestation) + β_3 (agricultural expansion) + β_4 (volcanic eruption) + β_5 (air pollution).

Checking the Fitness of the Model (Testing Parallel Lines)

When an ordinal regression is fitted, it is assumed that the relationships between the independent variables and the logits are the same for all the logits. This means that the results are a set of parallel lines or planes—one for each category of the outcome variable. You can check this assumption by allowing the coefficients to vary, estimating them, and then testing whether they are all equal. In the test of parallel lines, the column called **sig** shows the **p-value** for the test of the parallel lines assumption. If the p-value is greater than 0.05, the test is non-significant and the assumption is not violated to run the regression model and hence the model is fitted.

Goodness-of-fit measures

From the observed and expected frequencies, it is possible to compute the usual Pearson and Deviance goodness-of-fit measures. If the model fits well, the observed and expected cell counts are similar, the value of each statistic is small, and the observed significance level is large. Then null hypothesis could be rejected if the observed significance level for the goodness of- fit statistics is small. It is believed that good models have large observed significance levels (greater than 0.05).

Assumptions

1. Dependent variable should be measured at the ordinal level or likert type of variables
2. Independent variables are measured at continuous, ordinal or categorical variables
3. There should not be multicollineraity, because it leads the problem of which variable contributes to the explanation of dependent variable.
4. Assumptions of proportional odds which means that each independent variable has an identical effect at each cumulative split of the ordinal dependent variable

3. Results and Discussion

3.1. Background of the Studied Population

The studied populations were from first and second generation Universities in northwest Ethiopia with majorities from Bahir-Dar University. As shown in Figure 1, about 60% of postgraduate students in Bahir Dar University filled the questionnaire. Relatively larger

number of undergraduate students in Debre-Tabor University responded to the questionnaire. Under graduate students in the selected universities were proportional in filling the questionnaire. However, small number of postgraduate students in Debre-Tabore University filled the questionnaire.

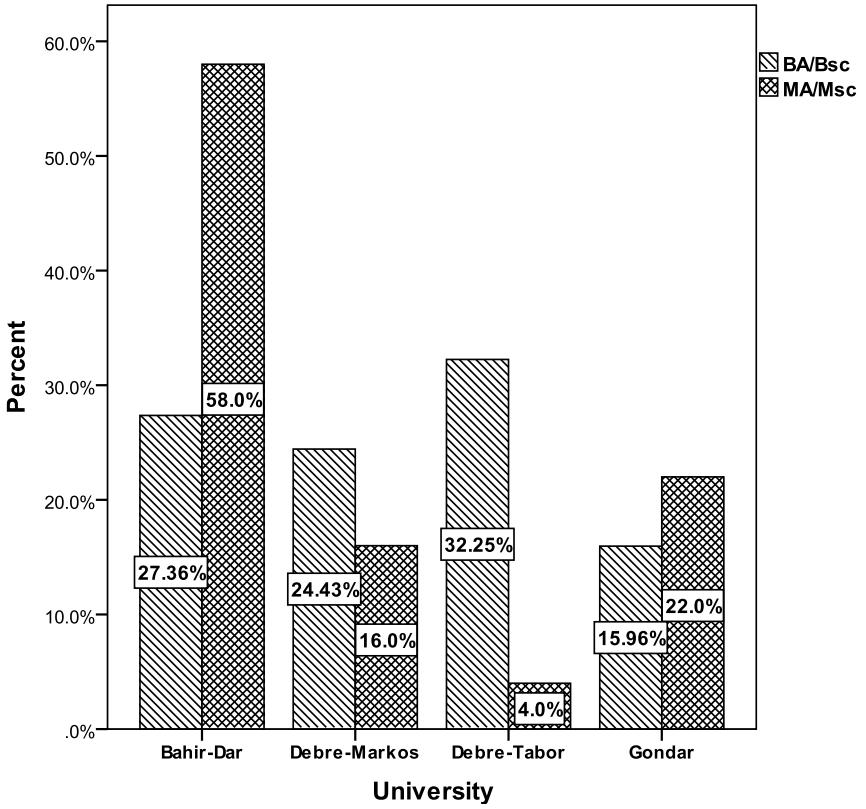

Figure 1. Name of university and degree sought

As shown in Table 1, a total of 357 students (of which 72% were male and 28% female) with gender ratio of 7.4:2.6 were studied. About 86% of these students were attending their BA classes and the rest 14% were registered for MA degree. One-third (33.3%) were first year; 28.3% second year and 38.4% third year students. The origins of over 58% of the respondents were from Amhara Region and 24.4% were from Gambela (Table 1). As shown from the Table 1, the mean age of respondents was 22 years with a standard deviation of 4.389 and a minimum 18 years and a maximum of 68 years. The majority of the respondents (over 96%) have an age between 18 and 28 years. Likewise a study made by Buggy and McGlynn (2014) evidenced that the majority of university students (90%) in Tanzania range between 19 and 30 years of age with a gender ratio of 7:3 male: female distribution.

Table 1. Background information on students studied (N=357)

Information type		**N^0**	**%**
Sex	Male	256	71.7
	Female	101	28.3
Degree sought	BA/Bsc	307	86.0
	MA/Msc	50	14.0
Year of study	First	119	33.3
	Second	101	28.3
	Third	137	38.4
Place of origin	Addis Ababa	38	10.6
	Amhara	209	58.5
	Banishangul	17	4.8
	Gambella	87	24.4
	Oromiya	1	0.3
	Somali	5	1.4

Age	**Frequency**	**Percent**	**Cumulative Percent**
18-28	344	96.4	96.4
29-38	7	2.0	98.3
39-48	3	.8	99.2
49-58	2	.6	99.7
59-68	1	.3	100.0
Total	357	100.0	

3.2. Sources of Climate Information

Examination of students' opinions about climate change shed light on their scientific literacy for climate and related issues. As can be seen in Table 2, the main climate change information sources for the majority (83.3%) of the students studied are school teachers. Over 79.3%, 78.2% and 76.8% of the students reported that their climate change information sources are Radio, Internet and television, respectively.

Table 2. Perceived climate change information sources

Sources of information	Responses		Percent of Cases
	N	Percent	
TV	271	15.0%	76.8%
Radio	280	15.5%	79.3%
Friends	223	12.3%	63.2%
Books/magazines	257	14.2%	72.8%
Internet	276	15.3%	78.2%
Government reports	206	11.4%	58.4%
Teachers	294	16.3%	83.3%
Total	1807	100.0%	511.9%

These figures were low with findings of Emmanuel and Kofi (2016) such that TV (42%), print media (24%), and text books and teachers (34%) as a major sources climate information.

3.3. Students Perception on Climate Change

The studied students were asked their sufficient knowledge on climate change so as to evaluate the overall understanding of the students on the perils of climate change. This is due to the fact that the more respondents know about climate related issues, the stronger their concern related to climate change (Skalik, 2015). Accordingly, about 60% of the studied students replied that they do not have sufficient knowledge on the issue. This indicates that there is still a doubt and blurred perception on the issue among the students. This is almost consistent with the report of Pitputinge (2013) in the Philippines who indicated that secondary school students are deficient on the causes and impacts of climate change knowledge. Likewise, a study made by Boon (2010) in Australia pointed that students have blurred information about greenhouse gas and global warming. Agozie-Ezeudu *et al*. (2016) a study made in Nigeria senior secondary schools also reached similar results.

Contrary to the above report, about 85% of the studied students indicated that they have knowledge on Global warming. Around 84% believe that there is climate change in Ethiopia and 89.8% reported the occurrence of weather change in their local area. Majority of the students (75.4%) feel that temperature in Ethiopia is getting warmer and warmer. Over 90% of the students perceive that there is rainfall fluctuation in Ethiopia and 53.7% reported that it frequently occurs during the harvesting season. More than half of the students (52.4%) indicated rainfall has decreased during the last ten years (Table 3).

Table 3. Occurrences, causes and consequences of climate change

Options	Responses		Percent of Cases
	N	Percent	
Weather change occurs in your local area	318	9.6	89.8
Rainfall fluctuation occurs in Ethiopia	322	9.8	91.0
There is climate change in Ethiopia	296	9.0	83.6
Climate change is a real problem in Ethiopia	259	7.9	73.2
Climate change reduces crop production	321	9.7	90.7
Climate change affects Ethiopian economy	321	9.7	90.7
Knowledge on the causes of Global warming	301	9.1	85.0
Global warming affects our way of life	313	9.5	88.4
Rainfall has decreased for the last ten years	184	5.6	52.0
Rainfall occurs during the harvesting seasons	190	5.8	53.7
Temperature has changed for the last ten years	205	6.2	57.9
Temperature is getting warmer in Ethiopia	267	8.1	75.4
Total	3297	100	931.4

3.4. Causes of Climate Change

Climate change and/ global warming are important areas of interest around the world and still under discussion. Every day, our world is affected more by disturbing climate change. Air pollution, global warming, climate change, greenhouse effect, acid rain, and ozone layer depletion constitute some of the major environmental problems in every parts of the world (Seyide *et al*., 2016). Past climate change literatures indicate the causes of climate change are diverse and complex, ranging from natural to anthropogenic issues. Considering this, a five level likert measurement scale (Table 4) was developed to evaluate the perception of students on diverse issues expected to cause climate change risks. Based on that 47.9% and 41.5% of the students correspondingly agree and strongly agree on climate change is human induced. Skalik (2015) on the other hand, indicated that half of the university students studied underestimated the scientific certainty that climate change is caused by humans.

Table 4. Perceived causes of climate change

Perceived causes		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Climate change is human induced	N^0	148	171	26	5	7
	%	41.5	47.9	7.3	1.4	2.0
Deforestation	N^0	244	88	13	11	1
	%	68.3	24.6	3.6	3.1	0.3
Overpopulation	N^0	187	135	20	10	5
	%	52.4	37.8	5.6	2.8	1.4
Agricultural expansion	N^0	142	162	40	8	5
	%	39.8	45.4	11.2	2.2	1.4
Urbanization	N^0	144	157	37	14	5
	%	40.3	44.0	10.4	3.9	1.4
Air pollution	N^0	169	138	34	13	3
	%	47.3	38.7	9.5	3.6	0.8
Poor waste management	N^0	143	136	54	14	10
	%	40.1	38.1	15.1	3.9	2.8
Ozone depletion	N^0	149	133	52	16	7
	%	41.7	37.3	14.6	4.5	2.0
Emission from different sources	N^0	141	164	39	11	2
(vehicles, industries)	%	39.5	45.9	10.9	3.1	0.6
Climate change is nature induced	N^0	100	146	73	26	12
	%	28.0	40.9	20.4	7.3	3.4
Volcanic eruption	N^0	115	125	82	25	10
	%	32.2	35.0	23.0	7.0	2.8
God/nature	N^0	84	91	102	55	25
	%	23.5	25.5	28.6	15.4	7.0

Associated to anthropogenic causes of climate change, 68.3%, 52.4%, 39.8%, and 40.3%, of the students, respectively strongly agree it is due to deforestation, overpopulation, agricultural expansion, and urbanization. The result also showed that 40.9% and 28% of the students respectively agree and strongly agree with the premise of climate change as nature induced. Considerable numbers of students 7.3% and 20.4% correspondingly disagrees and strongly disagree on this conclusion. Seyide *et al*. (2016) indicated that students had low level knowledge and perception about environmental problems such as air pollution, greenhouse effect, global warming, acid rain, and depletion of ozone layer although they took a course related to global environmental problems in the high schools and universities. Ho (2009) indicated that "Pollution" most often referred to emissions from factories, vehicles, and houses, as well as garbage, waste, and littering were causes of climate change according to students' perception.

As shown in Figure 2, there are variations between age of respondents and perception on causes of climate change. In all the cases, there is a tendency of percieving the causes of climate change in between the age group 39 and 48.

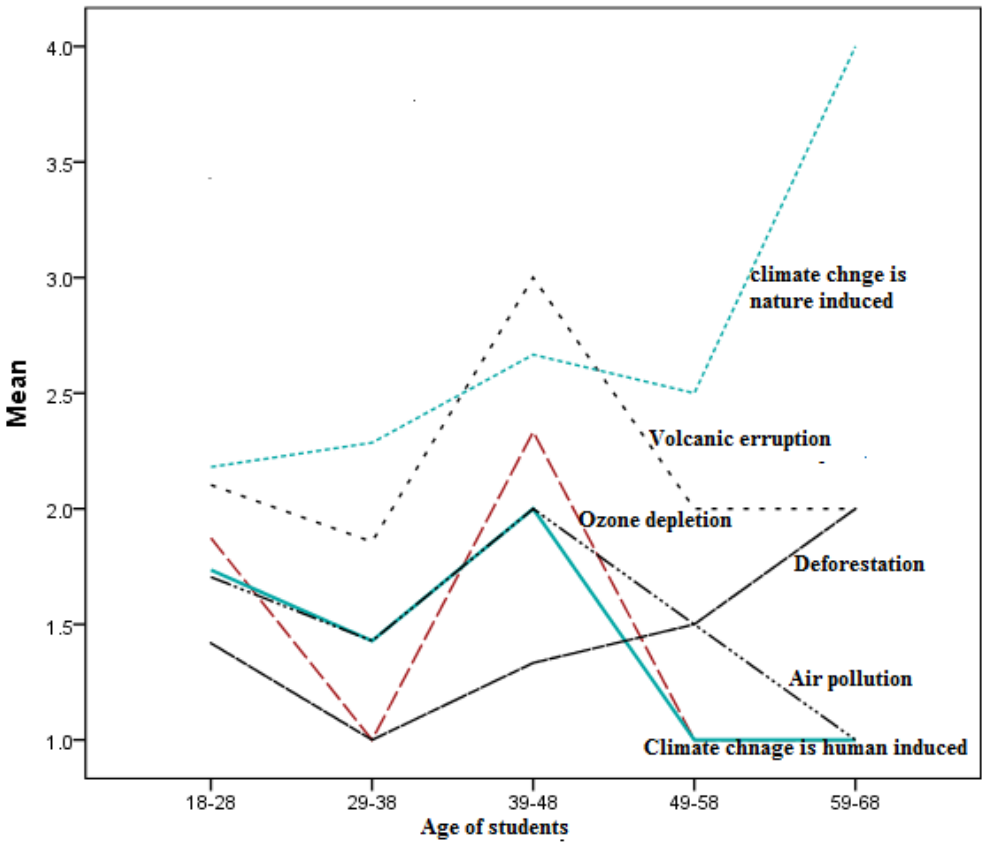

Figure 2. Perceived causes of climate change by age of respondents

However, there is a strict difference between the two options such as climate change is nature induced and cliamte change is human induced. Accordingly, older students percived that the causes of climate change is nature induced while more young students percieved the causes of climate chnage as human induced. The Chi-Square test indicates that there is significant association in perception between age of respondents and the causes of climate change at $P < 0.01$.

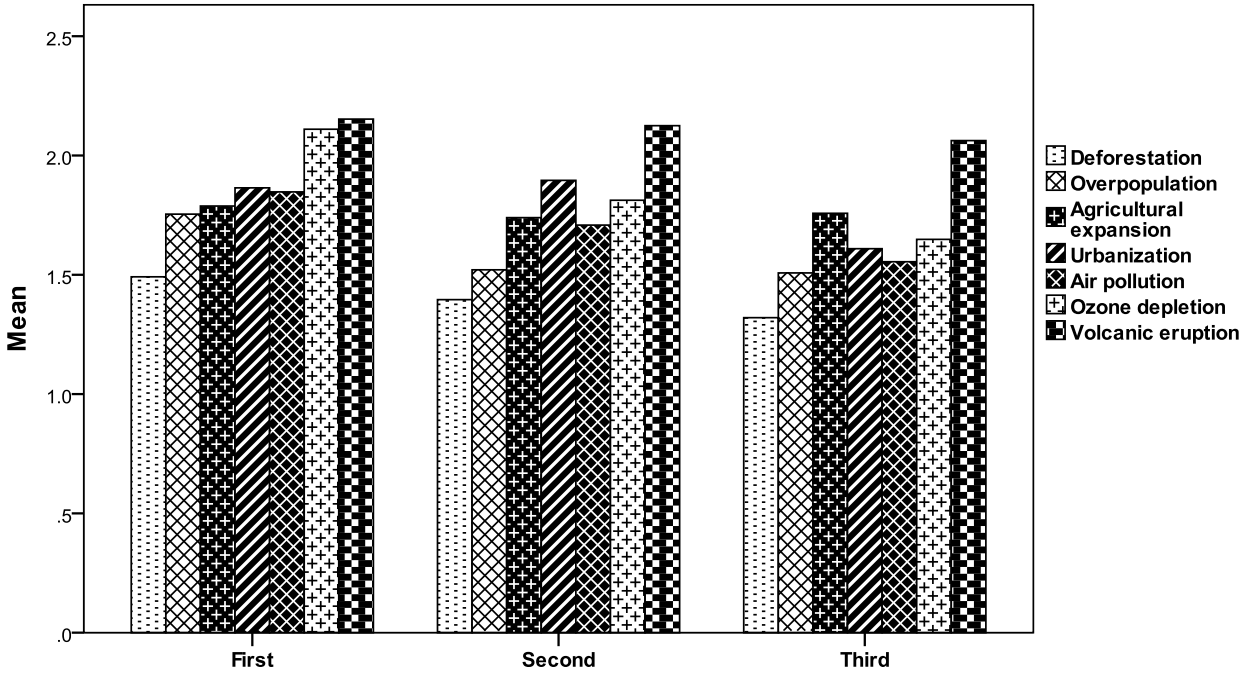

Figure 3. Perceived causes of climate change by year of education

As shown in Figure 3, there is no significnat dfferences between year of education and causes of climate change. In all years of eduction volcanic erruption rated the highest followed by ozone depeletion. Urbanization was the third rank as a cause of climate change. However, deforestation as a cause of climate change is the least percieved by all years of students. In genral the tendency to percive the causes of climate change dercreses with respect to their years of stay in the university. Emmanuel and Kofi (2016) also reached similar results and found out that senior students' involvement in climate change awareness creation is low compared to junior students.

As shown in Figure 4, perception on the causes of climate change based on sex does not show significant variations. However, there is a tendency of slight increment on male perception than female students' perception on the causes of climate change. Volcanic eruption as a cause of climate change is ranked first in both students. Ozone depletion is the third cause for climate change while ozone depletion is for male students. The Chi Square test indicates that

there is no significant association in perception between the male and female students on the causes of climate change at P > 0.05. Agozie-Ezeudu *et al.* (2016) also evidenced that there is no significant different between the male and female students mean score on climate change awareness and attitude.

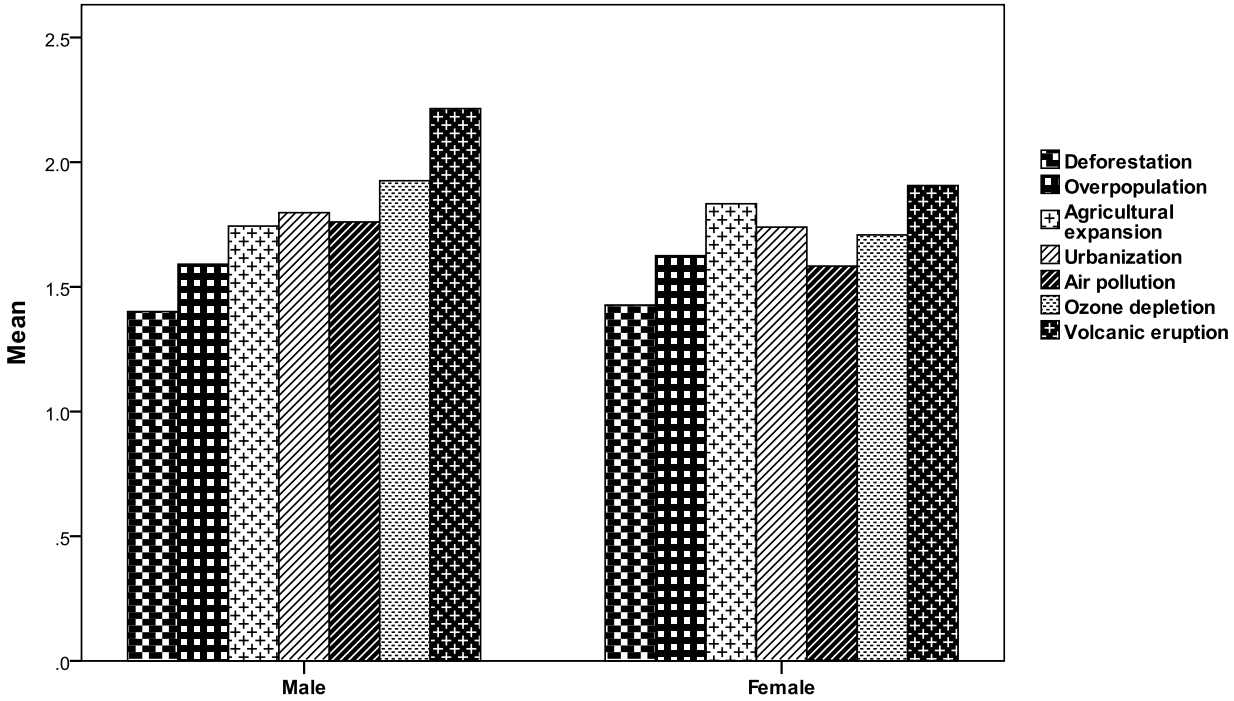

Figure 4. Perceived causes of climate change by sex of respondents

From the preliminary results it is clear that the university students have reasonable perceptions on what the principal causes of climate change are and what anthropogenic activity is contributing to climate change (urban expansion, agricultural expansion, urbanization and deforestation). However, students showed a low understanding of the natural factors (28% strongly agree) that influence climate change. In this regard, Buggy and McGlynn (2014) pointed that in several studies globally, there is a decline in the level of knowledge of university students related to climate change. In combating this decline at various levels of education should be undertaken in order to ensure that the next generation of adults is fully aware of the causes and consequences of climate change (Buggy and McGlynn, 2014).

3.5. Consequences of Global Warming Vis-à-Vis Climate Change

As shown in Table 5, loss of plant and animal species (52.4%), the decline of available water (45.1%) and decline of agricultural yield (48.7%) of the students reported to strongly agree with the consequences of global warming. The results also showed that 44.5%, 55.2%, 39.2%, 44.3%, and 40.6% students correspondingly strongly agree that rainfall comes early or lately,

drought has increased, heat is getting more intense, health hazards have increased and greenhouse gas concentrations are increased in the atmosphere (Table 5). In relation to the results, Oreskes and Conway (2008) supplemented that anthropogenic theory and climate simulations models suggest that global warming might lead to an increase in either the frequency or intensity of extreme weather events such as hurricanes, heat waves, storms and droughts. Khandekar *et al.* (2005) indicate that global warming leads to the increasing mean temperature of the earth, associated with extreme weather events such as melting of the polar ice caps, and the related phenomenon of rising global sea levels. All these result in famine, starvation, hunger, population displacement/migration and political chaos which many developing countries are experiencing.

Table 5 Perceived consequences of global warming

Perceived consequences		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Loss of plant & animal species	N^0	187	140	20	9	1
	%	52.4	39.2	5.6	2.5	0.3
Decreased available water	N^0	161	161	25	9	1
	%	45.1	45.1	7.0	2.5	0.3
Decline of soil	N^0	177	126	42	9	3
fertility/productivity	%	49.6	35.3	11.8	2.5	0.8
Declined agricultural yield	N^0	174	142	30	11	-
	%	48.7	39.8	8.4	3.1	-
Rainfall come early or lately	N^0	159	147	36	10	5
	%	44.5	41.2	10.1	2.8	1.4
Increased drought	N^0	197	119	22	17	2
	%	55.2	33.3	6.2	4.8	0.6
Heat is more intense	N^0	140	156	45	13	3
	%	39.2	43.7	12.6	3.6	0.8
Increased health hazards	N^0	158	151	26	17	5
	%	44.3	42.3	7.3	4.8	1.4
Accumulation of green house	N^0	145	161	26	16	9
gases in air	%	40.6	45.1	7.3	4.5	2.5

From the discussions, it can be concluded that the links between the causes and consequences of global warming are highly contested (Sylvén *et al*., 2008). Lee *et al.* (2007) indicated the perceptions of students related to the consequences of climate change in terms of glaciers melting, sea levels rising, and species extinction. Ho (2009) also mentions students perception on the consequences of climate change as polar ice melting, that it would have a negative impact on animal populations (not including humans), that it would result in increased temperatures, and also result in increased flooding or sea level rises.

In general, climate change associated with global warming is a debatable issue among politicians, academicians and scientific society. All sides of the debate agree that there is global warming with empirical evidence (IPCC, 2007; Strauc and Guest, 2016; Meredith, 2012). For example, flooding, sea level rise, melting of ice and species extensions and other extreme events are caused by global warming (Oreskes and Conway, 2008; Khandekar *et al*., 2005).

4.6. Perceived Solutions of Climate Change

Both adapting to unavoidable climate change and mitigating future greenhouse gas emissions are required to manage the risks of extreme weather at present. Since limiting the amount of CO_2 in the atmosphere limits the influence of climate change on people's life. Hence, a number of climate change coping and adapting solutions and strategies ranging from anticipatory and reactive measures have been proposed and used since the past many decades. Nevertheless, many of the measures and strategies have been observed not to trim-down the impact to the desired level.

Perceiving this constraint, the current study presents perceived solutions of climate change impacts expecting that they can be used in future climate change coping strategies. For this a five level likert measurement scale was designed to identify possible climate change solutions (see Table 6). Accordingly, 43.7% of the students strongly agree to provide special focus on getting climate change news. About 50% also agree on this measure against 4.5% and 0.6% corresponding students who disagree and strongly disagree on the proposed solution. A few students (1.4%) failed to decide on this solution. Climate change information can improve people awareness on the occurrence, causes and impacts of climate. The proposed strategy is thus believed to yield significant contribution in the fight against climate change. Over 42% of the studied students indicated that they agree and strongly agree developing people's awareness is the best solution although 9% and 2% of the students correspondingly replied disagree and strongly disagree on this measure (Table 6). In relation to this, Nkoana *et al.* (2016) mentioned that awareness about climate change impacts is also a critical determinant of human response and adaptation, as communities first have to be aware about the impacts of climate change to be able to adapt. Nkoana *et al*. (2016) further noted that the level of awareness influences communities' ability to adapt to climate change. The lack of climate change awareness can lead to complacency increasing people's vulnerability to climate change and climate variability in the near and far future. Huber and Gulledge (2011)

differently indicate that since climate change is already underway, some impacts are unavoidable and society must adapt to them. In order to be effective, adaptation actions must be commensurate with the magnitude of the risk. Adger *et al.* (2008) cited in Nkoana *et al.* (2016) similarly informed that climate change awareness is a precursor of climate change adaptation and local communities should be aware of climate change in order to adapt to it. The solutions to climate change according to students perception indicated by Ho (2009) were reduce waste, call for increased support and action from governments, and increase energy efficiency and use of car pools.

Table 6. Perceived solutions for climate change

Perceived solutions		Measurement scales				
		Strongly agree	Agree	Disagree	Strongly disagree	Undecided
Giving special attention to climate change news	N^0	156	178	16	2	5
	%	43.7	49.9	4.5	0.6	1.4
People must obey the laws of nature	N^0	124	167	42	16	8
	%	34.7	46.8	11.8	4.5	2.2
Less interfere with nature	N^0	80	125	108	30	14
	%	22.4	35.0	30.3	8.4	3.8
Developing peoples' awareness	N^0	164	151	32	7	3
	%	45.9	42.3	9.0	2.0	0.8
Establishing safe industrial environment	N^0	163	126	49	14	5
	%	45.7	35.3	13.7	3.9	1.4

4.7. Factors that Determine Ozone Depletion

The assumptions noted were thoroughly considered and no significant violations observed. The test of parallel lines showed that the p-value of the general model is greater than 0.05 (X^2 (24) = 0.560). This showed that the test is non-significant and the assumption is not violated. However, the results of the Pearson Chi square goodness-of-fit is < 0.01 (X^2 (420) = 1180.451, p = 0.000). This showed that the null hypothesis is rejected violating the assumptions. However, the Deviance goodness of fit is not significant with p value greater than 0.05. The Nagelkerke pseudo R square showed that the independent variables explained 58.2% of the total variations of the dependent variable (ozone depletion).

From the observed significance levels as shown in Table7, it was learnt that poor waste management systems, deforestation, agricultural expansion, volcanic eruption and air pollution have relations with ozone depletion in the atmosphere and reject the null hypothesis

of zero assumptions. Besides, the Wald test showed that there is a strong relationship between ozone depletion in the atmosphere and predictor variables. Respondents ratings strongly agree to poor waste management systems as a cause of ozone depletion in the atmosphere are more likely to assign higher value than those who rated as strongly disagree (reference category) with the odds ratio of 5.296, while other variables in the model are held constant. It is also significant at $p < 0.001$. Likewise, respondents who rated agree to volcanic eruption, is more likely to assign higher value than who rated strongly disagree with the odds ratio of 5.243, controlling for poor waste management, deforestation, agricultural expansion and air pollution. However, those rated disagree is less likely to increase ozone depletion in the atmosphere held other variables constant. In general, volcanic eruption has positive relationship with ozone depletion in the atmosphere. This means that as volcanic eruption increases it is more likely to increase ozone depletion in the atmosphere, which is significant at $P < 0.001$ held other variables constant.

The model also revealed that overpopulation has strong relationship to ozone depletion in the atmosphere and highly significant at $p < 0.001$. A unit increase of strongly agree to overpopulation as compared to strongly disagree (reference category) increases the odds ratio by 2.403, while other variables in the model are held constant. Likewise, those who rated agree to overpopulation is more likely to increase ozone depletion in the atmosphere with the odds ratio of 2.661, held other variables constant. As shown in Table 7, air pollution has positive relationship with ozone depletion in the atmosphere. However, those rated disagree is not significant which is greater than 0.05. This showed that a unit increase of those rated strongly agree to air pollution as a cause of ozone depletion in the atmosphere increases the odds ratio by 44.701 held other variables constant.

The result of the model also revealed that volcanic eruption and ozone depletion in the atmosphere have strong relationship and statistically significant at $p < 0.001$. Those who rated strongly agree to volcanic eruption as compared to strongly disagree is more likely to increase ozone depletion with the odds ratio of 5.296 being other variables constant in the model. However, those rated disagree to volcanic eruption is less likely to increase ozone depletion with the odds of 0.294 being other variables are adjusted for.

Table 7. Ordinal logistic regression results

	Variables description	Estimate	Std.error	Wald	Sig.	Exp(B)
Threshold	[ozone = 1]	2.239	2.027	36.461	.000***	9.38
	[ozone = 2]	4.847	2.001	55.076	.000***	127.35
	[ozone = 3]	5.809	1.984	63.521	.000***	330.299
Location	[Volcanic=1]	1.666	0.574	21.589	.000***	5.296
	[Volcanic=2]	1.657	0.544	9.260	.002***	5.243
	[Volcanic=3]	-1.224	0.535	5.231	.022*	0.294
	[Volcanic=4]	0[a]	.	.	.	
	[waste management=1]	1.179	0.867	13.437	.000***	3.251
	[waste management =2]	2.525	0.854	8.751	.003***	12.490
	[waste management =3]	-1.919	0.871	4.858	.028*	0.146
	[waste management =4]	0[a]	.	.	.	
	[Air pollution=1]	3.805	0.801	22.562	.000***	44.701
	[Air pollution=2]	1.978	0.773	6.557	.010**	7.228
	[Air pollution=3]	-0.689	0.788	0.764	.382	0.502
	[Air pollution=4]	0[a]	.	.	.	
	[agri expansion=1]	1.455	1.785	13.074	.000***	4.284
	[agri expansion=2]	1.045	1.779	11.543	.001***	2.843
	[agri expansion=3]	0.655	1.794	13.769	.000***	1.925
	[agri expansion=4]	0[a]	.	.	.	
	[Deforestation=1]	1.895	0.589	10.360	.001***	6.652
	[Deforestation=2]	0.915	0.604	2.295	.130	2.496
	[Deforestation=3]	-1.162	0.659	3.114	.078	0.312
	[Deforestation=4]	0[a]	.	.	.	

Note that *** = significant at 0.001, **= significant at 0.01, * = significant at .05

5. Conclusions and the Way Forward

This study was intended to evaluate perception of students on the information sources, occurrence, causes, impacts and solutions of climate change in public universities of the Amhara Region of Ethiopia. A questionnaire survey was conducted on a total of 357 university students attending undergraduate and postgraduate courses to generate the required data. The data gathered in this way were analyzed using descriptive statistics (in percentiles) and inferential statistics. The results indicate that over 57% of the students get climate change

information from different sources. The main climate change information sources identified by the students include television, radio, friends, books/research journals, internet, government reports and school teachers. Teachers are main information sources for over 82% of the studied students. The results revealed that majority of the students do not have awareness about climate change. Students are selected from the department of Geography and Environmental studies. Climate courses are given at different levels; however, students' conceptualization is low indicating that the curriculum prepared for teaching or teachers performance failed to change the behavior of students. Giving special concern to climate change information, obeying the laws of nature, limited interference in nature, developing awareness among the public and adopting safe industrial environments are suggested solutions to minimize the hazards of climate change. It is suggested that state agencies have to design ways to deliver climate information to the wider public so as to develop awareness on the causes and consequences of climate change among the public in general and students in particular. Local agencies and land users need also to adhere with the natural laws and adapt proper interferences in the local natural environment.

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