Factors Affecting People's Environmental Awareness in the Urban Areas: A case of Addis Ababa, Ethiopia

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Abstract

In developing countries, the urban environment is deteriorating over time. In the meantime, people's demand for clean and green residential and recreational places has increased. If so, why has it been hard to keep cities clean and green? This study investigates the level and determinants of environmental awareness in Addis Ababa. From three sub-cities, three-stage sampling procedure has been applied to select 293 respondents. A five-point Likert scale was used to classify the levels of awareness and an ordered logit model was applied to analyze its determinants. The result shows a high level of knowledge on forest degradation, while a medium level of attitude on the possible cause of acid rain. From the marginal effect result, the probability of low (13%) and medium (25%) levels of environmental awareness increases for the income group of 601 to 1650.

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Likewise, for the age of 50 to 59, the likelihood of having low and moderate levels of environmental awareness rises by 8% and 11%, respectively. For respondents at TVET educational level, the chance of having low and medium levels of awareness reduces by 8% and 12%, respectively. In conclusion, being in a high-income category and education levels have more probability to a better level of environmental awareness while young respondents have a high probability for better environmental awareness. So, improving the income and access to higher education will assure clean and green cities, particularly in young populated urban areas. Besides formal education, adult education, training, and workshops are alternatives to enhance environmental awareness.

Keywords: Addis Ababa; environmental awareness; Likert scale; urban environment; ordered logit

JEL Classification: C10; Q53; Q57; Z13

1. Introduction

In the production of goods and services, every socio-economic activity is tied-up with resource extraction and waste emission. There is no perfect process that efficiently converts inputs into useful output; however, waste is released as a byproduct (Hill, 2010). When this waste occurs in the wrong place, at the erroneous time, and in the way-out amount affects the carrying capacity of the environment (Hoornweg et al., 2011) and causes environmental pollution (Metcalfe and Derwent, 2005).

Environmental pollution is highly related to waste management (Hoornweg et al., 2011), greenhouse gas emission (Shanmugam and Hertelendy, 2011), and urban planning (Liu et al., 2015; Colombani et al., 2018). In addition, lack of standard inbuilt sewerage system, poor solid waste management (Gondo et al., 2010), and failure to neutralize volatile gases from dumpsites and industries (Kaushal and Sharma, 2016; Kumar et al., 2016) exacerbate the environmental pollution. In this regard, households and institutions are the eminent contributors to environmental pollution (Gücker et al., 2006; Satterthwaite, 2008; Getahun et al., 2012; Do et al., 2013). So, environmental pollution is anything discharged into the air, water, soil, or food; it threatens the existence of living organisms (Miller, 2006) and poses an impact on human health and wellbeing (Corvalan et al., 2005; Zommers et al., 2014).

Environmental pollution is also associated with people's environmental awareness (ECLAC, 2004; Momoh and Oladebeye, 2010) and their consumption behavior (Xu et al., 2019). Considering several factors such as education (Mutisya and Barker, 2011), residential places (Bickersta and Walker, 2001), and technological knowledge (Giudici et al., 2019) which determine environmental pollution, a society with lower environmental awareness has been highly labeled to a polluted environment (Partanen-Hertell et at., 1999).

Rivers and groundwater deterioration (Ademe and Molla, 2014; Eriksson and Sigvant, 2019) and air pollution are more common in urban areas (UN Environment, 2018). Over the last 30 years, the urban environment in Ethiopia impaired following population expansion, industrialization, and urbanization (Akalu et al., 2011; Eriksson and Sigvant, 2019; Worku and Giweta, 2018). In this period, emphasis has been given to improving, sustaining, and keeping the environment (Ethiopian Environmental Protection Authority,1997) through green cities development, landfill gas control, wastes management (FDRE, 2011), and emission reduction from automobile (Ministry of Transport, 2011).

Considering the importance of environmental awareness training to keep the environment clean and green (Weinrach, 2002), efforts were made to enhance people's awareness in Ethiopia (MoFED, 2006). Nevertheless, the environment faces multi-dimensional problems (Danyo et al., 2017). Several studies in the urban areas focused on the human environmental impact, urban rivers, watershed land use, surface water pollution, and flood vulnerability (Akalu et al., 2011; Asnake et al., 2021; Eriksson and Sigvant, 2019; Mohamed and Worku, 2020). Moreover, studies in several parts of Ethiopia emphasized on solid waste (Beyene and Banerjee, 2011; Destaw et al., 2013; Getahun et al., 2012; Regassa et al., 2011), river and groundwater contamination (Awoke et al., 2016; Gebre and Rooijen, 2009; Gondo et al., 2010; Goshu et al., 2010; Mazhindu et al., 2010), and air pollution (Do et al., 2013). On the other hand, few studies could be found which focus on environmental awareness in the farming communities (Adem, 2017) and environmental awareness of higher education students' and the implications to the Paris agreement (Emiru and Waktola, 2018). Despite the importance of the topic, empirical studies hardly examined environmental awareness in Addis Ababa. Therefore, this study aims to address the literature gap and to provide empirical evidence on the level of people's environmental awareness and its determinants.

With the aim above mentioned, this article is organized into five sections: following the introduction, materials and methods section explains the conceptual framework, study area, sampling and questionnaire design, model specification, and variable characteristics. The result section explains the demographic characteristics, level of environmental awareness, and factors determining awareness. Following the result, the discussion section elaborates the key findings concerning the existing knowledge. Last, the conclusion section summarizes the main findings and forwards recommendations.

2. Materials and Methods

2.1 Conceptual Framework

The basis for this conceptual framework is to provide the interconnection between environmental knowledge-belief, environmental attitude-feeling, and environmental behavior-intention. This framework aims to expose readers to the theoretical viewpoint, while at the same time combining these variables to overview the overall people's awareness of environmental concern. Although the concept is complicated with wider theoretical underpinnings, the researchers have made it specific to the topic of interest and explained it simplistically.

Environmental concern is a multifaceted concept consisting of two major components, environment, and concern. Environment represents the core object of the general environmental events such as quality, pollution, degradation, and conservation. Whereas, the concern aspect is a psychological state of the attribute that represents people's beliefs, feelings, and intent to environmental events (Pellow et al., 2003). So, environmental concern examines the degree of people's environmental awareness in terms of environmental knowledge, environmental attitudes, and environmental behavior (Fishbein and Ajzen, 1975). Henceforth, the phrase 'environmental awareness' will be used instead of environmental concern.

Environmental knowledge is conceptualized based on the theoretical ground of propositional, acquaintance, and "how-to" knowledge which focuses on the extent of people's belief, familiarity, and engagement, respectively (Lemos, 2007). In this regard, belief represents information about the events and the associated attribute (Fishbein and Ajzen, 1975) corresponds to the fact of a circumstance which is verbally predetermined as the concept, source, causes, and effect of environmental pollution (Newman, 2004; Pollock and Cruz, 1999).

Unlike the belief, acquaintance knowledge is acquired in the day-to-day contact with an event, while "how-to" knowledge is developed through involvement in environmental circumstances. On the other way, Morreale et al. (2007) divided knowledge into content knowledge and procedural knowledge. Content knowledge is a literal understanding of the subjects, words, or meanings, while procedural knowledge emphasizes practicing the content knowledge. Even though knowledge is a process that can develop and grow constantly (Watson and West, 2006), it is a combination of belief and fact (Williams, 2002). So, from the theories of knowledge, we conclude that there is no clear-cut boundary within different types of knowledge; however, belief is the common foundation for all types of knowledge.

Given the importance of knowledge, people's attitude to react with a certain degree of satisfaction to an event is the other component of environmental awareness. (Fishbein and Ajzen, 1975) theorized attitude as the level of affect in which people feel concerning an event. Affective reactions are the verbal expression of feelings, facial expressions, and nonverbal signs of emotion (Ajzen, 1993). Indeed Fazio (1990) noted that attitude is the association between an object and the evaluation of that object. Although attitude is viewed as a latent variable that influences an individual's behavior, there is no clear demarcation between attitude and behavior (Borba, 2004; Fazio, 1990). However, Borba (2004) put the distinction between attitude and behavior as:

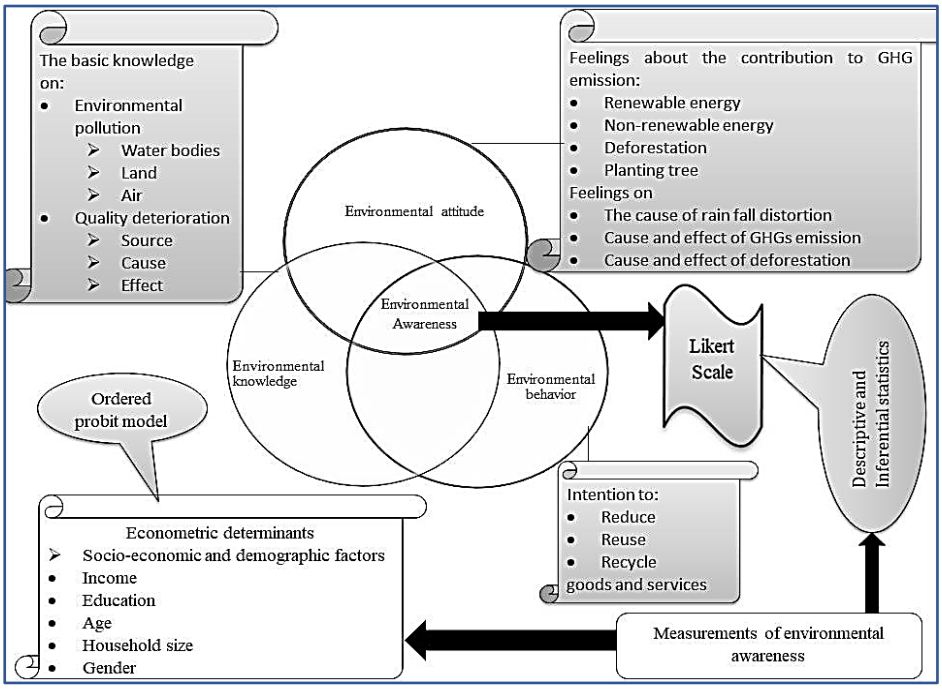
> *Behaviors are on the surface; attitudes run deep. Behaviors are actions; attitudes are a way of looking at life. Behaviors you can see the; attitudes are often hidden and hard to figure. Behaviors are more reactive and impulsive; attitudes are long term* (P.8).

Taking into account the basic concept of attitude, behavior stands for an observable act on an event that can be studied in its own right (Fishbein and Ajzen, 1975). Considering environmental behavior as an observable action, the theory of planned behavior focuses on how people intended to act on environmental events (Ajzen, 1993).

Environmental awareness helps to assess people's consciousness in their day-to-day environmental activity (Partanen-Hertell et al., 1999). According to Rohrer (2002), awareness is the sum of all abilities which permits humans to respect fundamental rights. Thus, a high level of awareness correlates with the

conscious choice of environmentally friendly practices (Partanen-Hertell et al., 1999). Hence the conceptual framework in Figure 1 below shows that there is a nexus among environmental knowledge, attitude, and behavior which collectively explains the level of people's environmental awareness. To this end, the socio-economic and demographic factors are expected to determine the level of environmental awareness.

Figure 1: Analytical framework for environmental awareness



Source: adapted from (Partanen-Hertell et al., 1999)

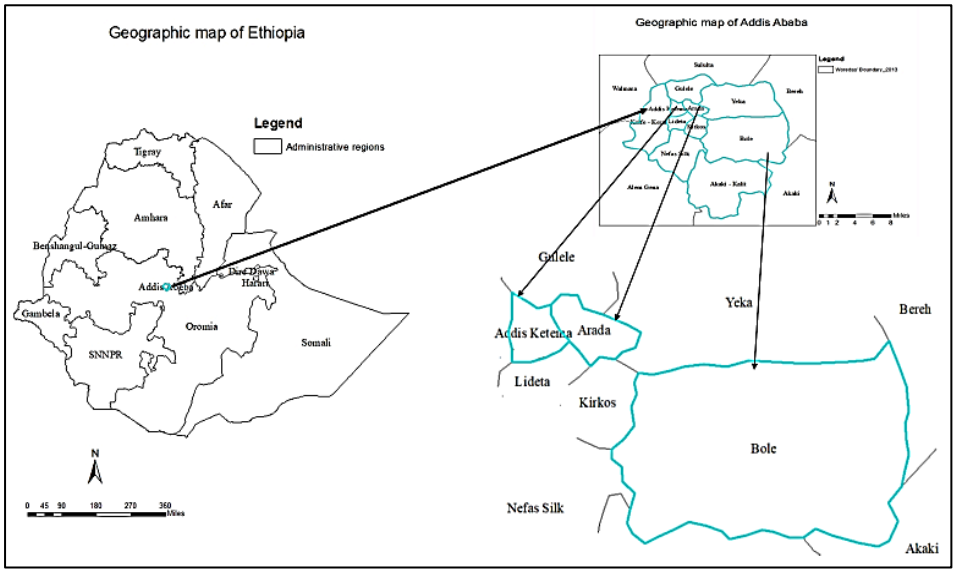
2.2 The Study Area

Figure 2 below depicts the geographic map of Addis Ababa, the capital city of Democratic Republic of Ethiopia. Addis Ababa was founded and got its name in 1886 by Emperor Menelik II and his wife, Empress Taitu (UN-Habitat, 2017). The city has an altitude between 2300 meters in the south and 3000 meters in the north. According to CSA (2013), the total population size and density were 3,434,000 and 6,516.25/ km^2, respectively. Among the total population, 47.3%

were male and 52.7% female. The annual fertility rate was 2.1 (CSA, 2013). The organization of the city was by ten sub-cities and 118 districts (Abebe et al., 2018).

Addis Ababa hosts 17 percent of the total urban population (UN-Habitat, 2017). Although the employment rate in the city was low, the majority were employed in low-skills, non-permanent, daily labor and related occupations (Erena et al., 2017). The environment in the city was unable to provide the functions of ecosystem services. Fast urbanization and built-up areas caused biodiversity loss and land degradations. According to the UN-Habitat report, densely populated sub-cities such as Addis Ketema, Arada, and Lideta were more vulnerable to environmental services, while Kolfe, Nifassilk Lafto, Kirkos, and Akaki Kality, sub-cities were less vulnerable. Bole, Gulele, and Yeka sub-cities were the lowest vulnerable for environmental services (UN-Habitat, 2017).

Figure 2: Geographic map of the study area



Source: Own sketch by using ArcGIS 10.5 adopting shape-file from Google search (2020)

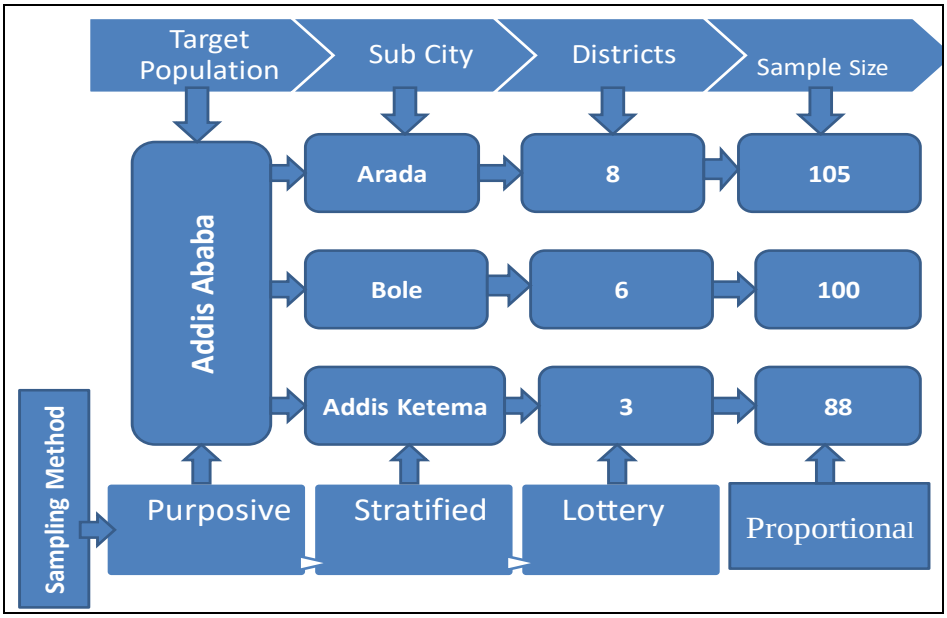
Biomass was the major source of energy for cooking and heating to the lower-income group. In the city, only 14% of the urban population used the sewerage system for liquid waste disposal while a quarter of the dry waste was collected. The remaining dumped to open space, drainage channels, and rivers which are the drivers of river and soil pollution. In addition, vehicles in the city committed 48% of the CO_2 and 90% of hydrocarbon and carbon monoxide

emissions (UN-Habitat, 2017). As a result, human health is impaired by indoor and outdoor pollution, and by consuming contaminated vegetables produced by wastewater irrigated fields.

2.3 Sampling and Questionnaire Design

Non-probability and probability sampling methods were adopted to collect primary data. As shown in Figure 3, the researchers followed a three-stage sampling procedure to determine the sample size. In the first stage, ten sub-cities were categorized into three strata based on their population density. The official document shows that six sub-cities such as Bole, Gulele, Kolfe-Keraniyo, Nifas Silk, Yeka and Akaki-Kality, had a population density lower than ten thousand which is the first stratum. The second stratum includes Arada and Kirkos sub-cities that had population density above ten thousand and below twenty-four thousand. Lideta and Addis-Ketema sub-cities were classified in the third stratum which contains population density over twenty-four thousand. So, one sub-city was selected in a lottery method from each stratum. In the second stage, one district was selected randomly using a lottery method from each sample sub-cities. Finally, sample HHs were proportionally identified from each district.

Figure 1: Summary of sampling and sample size determination



Thus, the total sample size were identified using the statistical formula developed by Yamane (1967 cited in, Israel 1992) which is a total of 293 HHs (Equation 1)

$$n = \frac{N}{1 + N(e)^2} \quad \textbf{(1)}$$

Where, n =Sample size, N = Total target HHs in the study area, e = precision at 5%. Consequently, the sample size from each district is proportionally computed using Equation 2.

$$S_i = \frac{D_i}{N} \times n \quad \textbf{(2)}$$

Where S_i is sample HHs from the i^{th} district, D_i is the total HHs in the district, and N is the total HHs in the three districts (Eq.3).

Hence, $n = \sum_{i=1}^{3} S_i$ **(3)**

So, from the document of HHs list found in the district, the first sample respondent was selected in a lottery approach from the first four consecutive lists of HHs. Then, interval method was applied to select all samples from each district. A questionnaire was developed and pretested to investigate peoples' environmental awareness. The tool contains questions on socio-economic variables such as income and education; demographic characteristics such as age, gender, and household size. Moreover, the questions on environmental items for knowledge, attitude, and behavior scaled to signify the dependent variable. Environmental knowledge addressed respondents' beliefs on the cause, source, and the effect of solid, liquid, and gaseous wastes. The attitude questions focused on respondents' feelings about the effect of consuming goods and services on the environment, for instance, using different types of energy sources, tree planting and deforestation, solid and liquid waste disposals. Behavioral questions reflect the respondents' intention to reduce, reuse, and recycle goods and services. In this regard, the respondents addressed the questions by giving rank on a five scale, '1= very less to 5 = very much'. Thus, the data were collected on a face-to-face basis for three weeks, starting from the end of May 2019 to mid-June 2019.

2.4 Model Specification and Data Analysis

Descriptive and inferential statistics were used to analyze the data. Five-point Likert scales (LS) were prepared to see the level of environmental awareness through the environmental items under the three components: environmental knowledge, attitude, and behavior. To avoid bias, environmental aspects are expressed in negative and positive statements. The response scale for each environmental item is 1 to 5. Thus, the response to the negative report has a reverse value. The sum of the scale is represented the full scale. The maximum total scale is 5*n, and the lowest possible scale is 1*n. Where 'n' is the total number of environmental items listed under the three components; each respondent's level of environmental awareness is computed by Equation 4.

$$EA_r = \frac{\sum_{i=1}^{n} LS}{n} \quad \textbf{(4)}$$

Where EAr represents the level of environmental awareness for the respondent (r); i represents the environmental questions listed in the three components (i = 1… n), LS represents the scale for each environmental question (1… 5). The value of EAr categorized as "1= very low if the value of EAr < 1.5", "2= low if 1.5 ≤ EAr < 2.5", "3= medium if 2.5 ≤ EAr < 3.5", "4= high if 3.5 ≤ EAr < 4.5", "5= very high if EAr ≥ 4.5=".

An econometric model was also used to examine factors affecting people's environmental awareness. Here, environmental awareness is a categorical dependent variable ordered as very high, high, medium, low, and very low. Although an unordered multinomial model can estimate such data, a much more economical and sensible model considers this ordering. Thus, the choice of the ordinal probit model fits more critically than the multinomial model to address the level of environmental awareness (Gujarati, 2004). Therefore, the starting point is an index model with a single latent variable, y* (Equation 5).

$$y_i^* = \sum_{k=1}^{k} X_{ki}\beta_k + \varepsilon_i = z_i + \varepsilon_i \quad \textbf{(5)}$$

$$Z_i = \sum_{k=1}^{k} X_{ki}\beta_k = E(Y_i) \quad \textbf{(6)}$$

Y is collapsing a version of y*, e.g., y* can take an infinite range of values which might be five orders of Y. As y* crosses a series of increasing unknown thresholds (Cut, αi), we move up the ordering of alternatives. For example, for y*< α1, awareness is very low, for y* > α1, awareness improved to the highest level. So, the observed variable 'Y' value depends on whether it crossed a particular threshold. Since there are five potential values for Y (Cameron and Trivedi, 2005; Greene, 2003), the respondents' awareness probability is in one of the fifth levels (Equation 7).

$$P(y_i *= m) = \frac{exp^{(X_i\beta - \alpha_{m-1})}}{1+[exp^{(X_i\beta - \alpha_{m-1})}]} \quad \textbf{(7)}$$

Where m is the level of awareness, α is a particular threshold (4 cuts) in which the value of the observed variable Y, Xi is an explanatory variable that affects the level of awareness, and β is the unknown estimated parameter. Therefore, factors affecting people's environmental awareness are analyzed by the Ordinal probit model expressed as Eq. 8 using STATA software version 15.

$$EA = \beta_0 + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_i \quad \textbf{(8)}$$

$$Z_i* = \sum_{k=1}^{k} \beta_k X_{ki} = E(y_i*) \quad \textbf{(9)}$$

Where y* is the unmeasured latent variable whose values figure the observed ordinal environmental awareness, EA, Xi is an explanatory variable such as income group (I), family member (F), educational level (E), age (A), and sex (S). So, the probability of environmental awareness being in one of the five levels is computed as in Eq. 10-14.

$$P(EA = 1) = \frac{1}{1+exp^{(Z_i - \alpha_1)}} \quad \textbf{(10)}$$

$$P(EA = 2) = \frac{1}{1+exp^{(Z_i - \alpha_2)}} - \frac{1}{1+exp^{(z_i - \alpha_1)}} \quad \textbf{(11)}$$

$$P(EA = 3) = \frac{1}{1+exp^{(Z_i - \alpha_3)}} - \frac{1}{1+exp^{(z_i - \alpha_2)}} \quad \textbf{(12)}$$

$$P(EA = 4) = \frac{1}{1+exp^{(Z_i - \alpha_4)}} - \frac{1}{1+exp^{(z_i - \alpha_3)}} \quad \textbf{(13)}$$

$$P(EA = 5) = 1 - \frac{1}{1 + exp^{(Z_i - \alpha_4)}} \quad \textbf{(14)}$$

Where,

EA= 1 if y*i ≤ α 1; very low level of environmental awareness

EA = 2 if α 1≤ y*i ≤ α 2; low level of environmental awareness

EA = 3 if α 2 ≤ y*i ≤ α 3; medium level of environmental awareness

EA = 4 if α 3 ≤ y*i ≤ α 4; high level of environmental awareness

EA = 5 if y*i ≥ α 4; very high level of environmental awareness

2.5 Variables Characteristic

Explanatory variables were identified and defined to assess the socio-economic and demographic factors that determine environmental awareness. As shown in Table 1, environmental awareness is an ordered categorical dependent variable. Individuals may have a very low, low, medium, high, and very high level of environmental awareness depending on socio-economic factors such as income, household size, education, age, and gender. Since a unit change in such variables might not show a variation in the level of environmental awareness, we have categorized them to see the difference among the group of respondents. Accordingly, income is a continuous categorical variable, grouped based on the personal income tax of Ethiopian tax revenue authority, which shows the family's total income in Ethiopian currency, Birr (ETB) (1USD = 38.02 ETB) per month. The household size is a continuous, categorical variable that shows the number of persons who lived together with the respondent. It was categorized into 1 to 5 household sizes, 6 to 10 household size, and over ten household sizes. Education level is the other continuous categorical variable which is measured by the attained education groups such as primary, secondary, Technical Vocational Educational and Training (TVET), and Higher education (First degree and above). The respondent's age is a continuous categorical variable that was arranged into six groups (17-29, 30-39, 40-49, 50-59, 60-69, and 70-100). Gender is the biological classification of the respondent's sex. It is a dummy variable that is assigned 1 if the respondent is male, otherwise 0 for female respondents.

Table 1: Definition of variables and expected sign

Variable	Type	Expected sign	Reference
Dependent Variable			
Environmental awareness	Ordered categorical variable 1. very low 2. low 3. Medium 4. High 5. Very high		
Explanatory variables			
Income levels	A categorical variable in Birr • 0-600 • 601-1650 • 1651-3200 • 3201-5250 • 5251-7800 • 7801-10900 • Over 10900	+ve/-ve	(Mehmetoglu, 2010) (Xu et al., 2019; Zhang et al., 2015)
Household size	A categorical variable in number • 1 to 5 • 6 to 10 • over 10	+ve/-ve	
Education levels	A categorical variable • primary • Secondary, and • TVET • Higher education	+ve/-ve	(Jorgenson and Givens, 2014; Mehmetoglu, 2010)
Age groups	A categorical variable in years • 17-29 • 30-39 • 40-49 • 50-59 • 60-69 • 70-100	+ve/-ve	(Jorgenson and Givens, 2014) (Ziadat, 2010) (Aminrad et al., 2013) (Karytsas and Theodoropoulou 2014) (Mehmetoglu, 2010)
Gender	A dummy variable • 0= Female • 1= Male	+ve /-ve	(Bhartiya, 2017) (Jorgenson and Givens, 2014)

3. Results

This section presents the environmental awareness components, socio-demographic characteristics, and order logit model results. The first three subsections explain statistical results regarding the respondents' environmental knowledge, attitude, and behavior. Then, respondents' demographic, economic characteristics, and ordered logit results are described.

3.1 Environmental Knowledge, Attitude, and Behaviour

Five Likert scales were applied to assess the level of people's environmental awareness. The first step undertaken was checking the reliability of questions using Cronbach's alpha test. Among the first 87 environmental questions, 46 questions were found to be reliable; hence, passed the test of Cronbach's $\alpha > 0.7$ and the item test correlation was found to be over 0.3. The high reliable index is evidence that the instrument is free from measurement error (Fishbein and Ajzen, 1975).

Table 2 shows respondents' answers to questions about environmental know led rated on a five-point scale. The questions focused on the concepts, causes, sources, and effects of pollution, degradation, and conservation. Accordingly, 45.7% of the respondents have lower knowledge about water shade management, while 46.8% and 37.2% of the respondents have medium knowledge about air pollution and natural resource conservation respectively. The majority of them have higher knowledge about the causes of groundwater pollution (53%), river and stream pollution (55%), solid waste (53%), and forest degradation (57%). Indeed, their knowledge on the effect of groundwater pollution (75%), river and stream pollution (72%), air pollution (65%), solid waste (70%), and forest degradation (57%) are also higher.

Table 2: Respondents' environmental knowledge in terms of percent and mean

Environmental items, n = 293, (%) Your knowledge about	Very less (1)	Less (2)	Medium (3)	Much (4)	Very much (5)	Mean (S.D)	Item test corr.	Alpha
groundwater pollution	14.3	5.8	35.8	6.8	37.2	3.47 (1.41)	0.71	0.95
river and stream pollution	13.3	7.2	32.1	11.6	35.8	3.5 (1.38)	0.74	0.95
air pollution	17.1	0.0	46.8	8.5	27.7	3.297 (1.34)	0.75	0.95
solid waste pollution	10.2	5.1	35.5	9.9	39.3	3.63 (1.32)	0.70	0.95
forest degradation	12.3	6.5	33.1	8.5	39.6	3.57 (1.38)	0.68	0.95
water shade management	36.5	9.2	33. 5	4. 8	16.0	2.546 (1.43)	0.57	0.96
natural resource conservation	28.3	5.5	37.2	8.5	20.5	2.87 (1.44)	0.60	0.95
the cause of groundwater pollution	11.3	6.1	29.7	14	38.9	3.631 (1.35)	0.77	0.95
the cause of river and stream pollution	9. 6	6.1	29.4	12.3	42.7	3.72 (1.33)	0.77	0.95
the cause of air pollution	16.4	8.5	32.4	9.9	32.8	3.34 (1.43)	0.78	0.95
the cause of solid waste	11.3	7.9	28	16.7	36.2	3.59 (1.34)	0.77	0.95
the cause of forest degradation	10.9	5.8	25.9	13.7	43.7	3.73 (1.36)	0.71	0.95
the source of groundwater pollution	18.8	8.9	30.7	12.3	29.4	3.25 (1.44)	0.73	0.95
the source of river and stream pollution	16.0	8.2	29.7	15.0	31.1	3.37 (1.41)	0.72	0.95
the source of air pollution	23.2	9.9	31.4	9. 6	25.9	3.05 (1.47)	0.74	0.95
the sources of solid waste	17.1	7.5	34.4	10.6	30.4	3.30 (1.41)	0.73	0.95
the source of forest degradation	17.1	6.1	27	11.6	38.2	3.48 (1.47)	0.71	0.95
the effect of groundwater pollution	7.2	2.7	14.7	7.5	67.9	4.26 (1.23)	0.65	0.95
the effect of river and stream pollution	7.2	3.1	17.4	9.2	63.1	4.18 (1.24)	0.64	0.95
the effect of air pollution	12	4.4	18.8	8.5	56.3	3.93 (1.42)	0.66	0.93
the effect of solid waste	8.19	3.1	18.4	10.9	59.4	4.10 (1.28)	0.66	0.95
the effect of forest degradation	6.5	2.1	15.0	8.5	67.9	4.29 (1.19)	0.65	0.95
Mean (unstandardized items)							0.47	0.95

Table 3 shows respondents' feeling on environmental issues. The questions focused on their attitude about energy use, deforestation, planting trees, and GHG. Accordingly, respondents have strongly agreed on the negative contribution of charcoal (42%), fuelwood (47%), fossil fuel (38%), burning waste (42%), and deforestation (56%) on GHG emission. Moreover, they have agreed on the contribution of planting a tree to reduce CO_2 (59%), disposing waste into a river that harms living organisms (75%), and the effect of deforestation on rainfall distortion (68%), wild life (74%), and soil degradation (74%). In contrast, the respondents have disagreed on the contribution of solar energy to reduce environmental pollution (41%), the cause of acid rain (43%), and the effect of accumulated GHG (51%).

Table 3: Respondents' environmental attitude (feelings)

Environmental items, n= 293	Str. disagree (1)	Disagree (2)	Medium (3)	Agree (4)	Str. agree (5)	Mean (S.D)	Item-test corr.	Alpha
Solar energy contributes the least to environmental pollution	35.5	5.8	22.9	5.5	30.4	2.89 (1.66)	0.6	0.91
Burning charcoal increases GHG in the atmosphere	29.0	7.5	21.2	10.6	31.7	3.09 (1.62)	0.66	0.91
Burning fuel wood increase the GHG in the atmosphere	22.5	8.5	21.2	10.9	36.9	3.31 (1.58)	0.78	0.91
Burning fossil fuel increases GHG in the atmosphere	28	6.1	25.9	7.5	32.4	3.10 (1.6)	0.75	0.91
Burning household waste increase GHG in the atmosphere	26.6	7.2	24.2	7.5	34.5	3.16 (1.60)	0.67	0.91
Deforestation increases the amount of CO_2 in the atmosphere	17.1	5.8	20.8	10.2	46	3.63 (1.52)	0.73	0.91
Planting trees decrease the amount of CO_2 in the atmosphere	15.4	7.5	17.8	10.6	48.8	3.70 (1.51)	0.67	0.91
Waste thrown into the river kills fish and other living organisms	10.2	2.4	12	6.5	68.9	4.22 (1.34)	0.56	0.91
Accumulation of GHG in the atmosphere increases acidic rain	45.1	5.5	15	4.4	30	2.69 (1.74)	0.65	0.91
Deforestation cause rainfall distortion	10.6	6.5	15	11.3	56.7	3.97 (1.39)	0.69	0.91
Deforestation affects the wildlife habitat and food	7.9	4.1	14	9.9	64.2	4.18 (1.27)	0.70	0.91
Deforestation cause soil degradation	7.9	4. 8	13	9.2	65.2	4.19 (1.28)	0.7	0.91
Cutting trees lead to CO_2 accumulation in the atmosphere	29.0	6.5	18.1	6.8	39.6	3.22 (1.69)	0.58	0.92
CO_2 accumulation cause global warming	37.5	4.1	25.9	4.4	28	2.81 (1.64)	0.77	0.91
Acidic rain can be caused by atmospheric pollution	38.6	4.4	23. 9	4.1	29	2.81 (1.66)	0.72	0.91
Mean (unstandardized items)							0.43	0.92

Table 4 shows behavioral questions that focus on respondents' intention to reduce the use of glass bottles, plastic bottles, cans, fossil fuels, and transportation services, which is likely to affect the environment. Accordingly, respondents have lower intention to reduce the use of bicycles (70%), taxis (68%), and private cars (74%) which is likely to increase the per capita GHG emission. Yet, most respondents show high intention to reduce the use of plastic bottles (38%), cans (56%), fossil fuels (68%), cylinder gas (76%), and fuelwood (64%).

Table 4: Respondents' environmental behaviour

Environmental items, n= 293 Your intention to	Very less (1)	Less (2)	Medium (3)	Much (4)	Very much (5)	Mean (S.D)	Item test corr.	Alpha
reduce the use of glass bottles	31.7	18.1	15.5	44.7	0	2.63 (1.33)	0.62	0.85
reduce the use of plastic bottles	25.6	10.2	26.3	4.4	33. 5	3.1 (1.58)	0.62	0.85
reduce the use of metal bottles	22.2	6.1	16.7	7.9	47.1	3.52 (1.63)	0.71	0.84
reduce the use of naphtha	15.0	7.2	9.2	1.4	67.2	3.99 (1.55)	0.68	0.85
reduce the use of cylinder gas	15.7	3.4	4. 8	0	76.1	4.17 (1.53)	0.76	0.84
reduce the use of fuelwood	15.7	7.2	13.7	5.5	58	3.83 (1.55)	0.7	0.84
the use of a bicycle to travel	21.2	2.7	5.8	6.1	64.2	3.89 (1.65)	0.64	0.85
the use a contractual taxi to travel	19.1	2.1	10.2	7.2	61.4	3.9 (1.59)	0.76	0.84
use a private car to travel	18.4	1.7	5.5	0.7	73.7	4.1 (1.59)	0.71	0.84
Mean (unstandardized items)							0.41	0.86

Table 5 summarizes respondents' level of knowledge, attitude, and behaviour about the listed environmental issues. According to the score, 57% have higher knowledge, 32% have medium and 12% of the respondents reflected lower knowledge. Likewise, the environmental attitude of respondents is expressed in terms of very low (5%), low (13%), medium (31%), high (29%), and very high (21%). In addition, the environmental behavior of the respondents is also classified as very low (8%), low (7%), medium (18%), high (37%), and very high (31%). To sum up, the descriptive result shows us most of the respondents have higher level of environmental knowledge, attitude, and behaviour. But it does not to mean that most of them have high level of environmental awareness since it is the combination of the three components. For instance, for a respondent to be considered to have higher environmental awareness, the scored average value of the three components should be greater than medium values.

Table 5: The proportion and mean value of environmental knowledge, attitude and behavior

Environmental components n=293 (in %)	Very low	Low	Medium	High	Very high
knowledge	2.05	9.56	31.74	36.86	19.8
Attitude	5.12	13.31	31.4	29.35	20.82
Behaviour	7.51	6.83	18.43	36.52	30.72

3.2 Respondents' Characteristics and Environmental Awareness

The descriptive result in Table 6 shows the variation in the level of environmental awareness. There are variations among the income groups, household size, educational level, age groups, gender, and districts. The Chi-square value shows that awareness varies significantly among income groups, education, age, and the gender of respondents. Nevertheless, the levels of environmental awareness do not show substantial variation within the family member and among districts.

Table 6: Socio-economic characteristics and environmental awareness of the respondents

Variables	Category	Environmental awareness level (%)					Total (n)	χ^2	Pr.
		V. low	Low	Medium	High	V. high			
Income group n=264	0-600	0.0	8.7	34.8	43.5	13.0	23	49.22	0.002
	601-1650	0.0	8.9	48.9	42.2	0.0	45		
	1651-3200	1.4	19.2	31.5	31.5	16.4	73		
	3201-5250	0.0	6.5	30.6	53.2	9.7	62		
	5251-7800	0.0	0.0	19.0	61.9	19.0	21		
	7801-10900	0.0	5.9	11.8	64.7	17.6	17		
	over 10900	0.0	0.0	8.7	56.5	34.8	23		
Family member n=293	1 to 5	1.1	9.4	32.8	42.2	14.4	180	10.58	0.210
	6 to 10	0	10	10	40	40	10		
	> 10	0.9	8.7	32.0	50.5	7.8	103		
Education n=293	Primary	1.9	14.0	37.4	40.2	6.5	107	36.25	0.000
	Secondary	1.4	11.6	39.1	42.0	5.8	69		
	TVET	0.0	4.8	22.2	55.6	17.5	63		
	Higher Edu.	0.0	1.9	22.2	46.3	29.6	54		
Age group n=280	17-29	0.0	4.5	28.4	43.3	23.9	67	31.06	0.054
	30-39	1.5	12.1	27.3	45.5	13.6	66		
	40-49	2.1	4.2	27.1	52.1	14.6	48		
	50-59	0.0	9.5	38.1	50.0	2.4	42		
	60-69	3.0	21.2	21.2	45.5	9.1	33		
	70-100	0.0	4.2	54.2	33.3	8.3	24		
Gender n=293	Male	0.0	5.4	24.7	49.5	20.4	93	12.12	0.016
	Female	1.5	11.0	35.0	43.0	9.5	200		
District n=293	District 3	1.1	6.8	29.5	44.3	18.2	88	10.02	0.264
	District 6	2.0	14.0	34.0	41.0	9.0	100		
	District 8	0.0	6.7	31.4	49.5	12.4	105		

The level of environmental awareness differs across income groups at $p < 0.01$. In all income groups high level of environmental awareness is the dominant, except the income group 601-1650. It is high and very high for 91% of respondents in the highest income group, while the remaining 8.7% have a medium level of awareness. Environmental awareness varies among educational groups at $p < 0.001$. Most TVET (55.6%) and higher education (29.6) score a high and very high level of awareness, respectively.

In contrast, the secondary academic level has a medium level of awareness (33%) compared to others. The primary education level has very low (1.9%) and low (14%) environmental awareness. It suggests that as the educational level increases, the level of environmental awareness shows improvement.

The levels of environmental awareness also vary within the respondents' age group at $p < 0.1$. The level of awareness is highest with the age group of 40-49, while it is the lowest for 17-29, 50-59, and 70-100 years old. Gender variation also shows a difference in the level of environmental awareness. Most male (50%) and female (43%) respondents have a high level of environmental awareness, while 24.7% of males and 35% of females have medium awareness. The number of male respondents with a high and very high level of environmental awareness is greater than female respondents.

3.3 Variation in the Level of Environmental Awareness

Table 7 shows the model fitness by Chi-square result, at $P<0.0001$ level of significance. It means the model has at least one explanatory variable which affects environmental awareness. The post estimation values such as Heteroskedasticity, omitted variables, and Multicollinearity reveal that the results are free from bias. The result shows variation in the level of environmental awareness within the income group, education level, and age group.

The respondents' environmental awareness level significantly varies within the income groups 0-600, 601-1650, 1651- 3200, and 3201-5250 as compared to the base, over 10900, which will be discussed in the marginal effect section. Similarly, levels of environmental awareness for respondents within TVET and first degree and above education levels significantly vary as compared to the base, secondary education. Moreover, the levels of environmental

awareness significantly vary within 50-59 and 60-69 years old as compared to the base, 17-29 years old.

Table 7: Determinants of the level of environmental awareness

The number of obs. = 252		LR chi2(17) =52.31		
		Prob. > chi^2 = 0.000		
Log likelihood = -284.21894		Pseudo R^2 = 0.0843		
Variables	**Coef.**	**Std. Err.**	**z**	**P>z**
Income group (ETB)				
0-600	-0.75328	0.381765	-1.97	**0.048**
601-1650	-1.21703	0.332743	-3.66	**0.000**
1651-3200	-1.0261	0.313493	-3.27	**0.001**
3201-5250	-0.86187	0.311043	-2.77	**0.006**
5251-7800	-0.50899	0.367378	-1.39	0.166
7801-10900	-0.59157	0.393753	-1.5	0.133
Family member (No.)				
6 to 10	0.242077	0.395909	0.61	0.541
Above 10	-0.04482	0.150611	-0.3	0.766
Educational Level				
Primary	0.230337	0.194481	1.18	0.236
TVET/College Diploma	0.588087	0.214887	2.74	**0.006**
First degree and above	0.489567	0.230648	2.12	**0.034**
Age group (Years)				
30-39	-0.38263	0.205987	-1.86	0.063
40-49	-0.14331	0.22975	-0.62	0.533
50-59	-0.54445	0.238923	-2.28	**0.023**
60-69	-0.54285	0.267771	-2.03	**0.043**
70-100	-0.35869	0.306406	-1.17	0.242
Sex				
Male	0.18405	0.1601	1.15	0.25
/cut1	-4.06703	0.563799		
/cut2	-2.62726	0.451448		
/cut3	-1.49643	0.439673		
/cut4	0.056353	0.430167		

Since the parallel regression assumptions were met (Annex Table 1), the marginal effect of the predicted value is described keeping other variables constant (Table 8). The results are interpreted compared with the base categorical variables. Accordingly, the base category for income is over 10900, household size is 1 to 5, education is secondary level, and age group is 17 to 29 years old. For the income 601 to 1650, the probability of respondents at low and a medium level of environmental awareness increases by 13% and 25%, respectively. Also, the probability of a very high level of environmental awareness decreases by 30% as compared to the base income group. Similarly, the probability of respondents in low and medium levels of environmental awareness increases by 9% and 21%, respectively, for the income group of 1651 to 3200. At the same time the probability of respondents in a very high level of environmental awareness decreases by 27%. The corresponding likelihood of low and medium levels of environmental awareness increases by 7% and 18%, while the probability of very high levels of environmental awareness decreases by 24%, for the income group of 3201 to 5250.

The marginal effect of TVET education shows that the odds of respondents being in low and medium levels of environmental awareness decreases by 8% and 12% as compared to the base, secondary education level. However, the chance of being in high and very high levels of environmental awareness increased by 9% and 11% respectively. Similarly, the probability of low and medium levels of environmental awareness declines by 7% and 10% for those who completed their first degree and above, while the odds of the high level of environmental awareness increases by 8%.

The marginal effect proves that age groups of respondents determine the level of environmental awareness. Being in 50-59 years old, the corresponding probability of low and medium levels of environmental awareness increases by 8% and 11%, whereas, the chance of very high levels of environmental awareness declines by 11% as compared to 17 to 29 years old respondents. For 60-69 years old respondents, the odds of medium and very high levels of environmental awareness increases and decreases by 11%.

Table 8: Marginal fixed effect for the levels of environmental awareness

Variables	1	2	3	4	5
Income group					
0-600	0.002(0.76)	0.054 (1.66)	**0.156*(2.05)**	0.007 (0.14)	-0.219(-1.92)
601-1650	0.008 (0.99)	**0.128***(3.31)**	**0.246***(3.97)**	-0.086 (-1.44)	**-0.296**(-2.97)**
1651-3200	0.005(1.00)	**0.093***(3.45**	**0.213***(3.54**	-0.041(-0.83	**-0.269**(-2.68**
3201-5250	0.003(0.89)	**0.068**(2.73)**	**0.179**(3.08)**	-0.009(-0.19)	**-0.241*(-2.40)**
5251-7800	0.001(0.66)	0.029(1.22)	0.101(1.42)	0.029(0.67)	-0.16(-1.37)
7801-10900	0.001(0.64)	0.036(1.18)	0.12(1.5)	0.024(0.5)	-0.181(-1.53)
Household size					
6 to 10	-0.002(-0.66)	-0.030(-0.70)	-0.048(-0.60)	0.027(0.86)	0.053(0.56)
Above 10	0.001(0.28)	0.006 (0.3)	0.008 (0.3)	-0.007(-0.29)	-0.009(-0.30)
Education level					
Primary	-0.003(-0.82)	-0.039(-1.15)	-0.041(-1.21)	0.047(1.17)	0.037(1.19)
TVET	-0.006(-1.03)	**-0.083*(-2.55)**	**-0.116**(-2.63)**	**0.091*(2.5)**	**0.114*(2.55)**
First degree and above	-0.006(-1.01)	**-0.073*(-2.11)**	**-0.095*(-1.97)**	**0.083*(2.11)**	0.090 (1.95)
Age group					
30-39	0.003(0.91)	0.048(1.79)	0.079(1.83)	-0.047(-1.70)	-0.082(-1.81)
40-49	0.001(0.52)	0.015 (0.61)	0.030(0.62)	-0.012(-0.58)	-0.034(-0.63)
50-59	0.005(0.95)	**0.075*(2.05)**	**0.107*(2.28)**	-0.079(-1.94)	**-0.108*(-2.28)**
60-69	0.005(0.9)	0.074(1.76)	**0.107*(2.09)**	-0.079(-1.64)	**-0.108*(-2.12)**
70-100	0.003(0.68)	0.044(1.03)	0.074(1.2)	-0.043(-0.92)	-0.078(-1.25)
Sex					
Male	0.002(0.81)	0.026(1.13)	0.034(1.15)	-0.027(-1.14)	-0.036(-1.15)

t-statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

4. Discussions

There is high knowledge about river deterioration, air pollution, and forest degradation in Addis Ababa. River pollution is common in most developing countries (Capps et al., 2016). Poor sewerage and inadequate infrastructure could aggravate the river and stream pollution (Colombani et al., 2018; Liu et al., 2015). Similarly, the quality of air and tree cover has reduced following the expansion of industries (Ejaz et al., 2010; Li and Lin, 2015), urbanization (Gasimli et al.,

2019; Kleppel, 2002; Li and Lin, 2015), and the population (Li and Lin, 2015). Besides, the respondents have strong feelings on the negative contribution of waste disposal and deforestation to wildlife disturbance and soil erosion.

There is an agreement on the effect of wastes on the environment. The feeling of the influence of deforestation on wildlife and soil erosion is also high. Nevertheless, respondents have a medium feeling on the cause of acidic rain. There is high and medium intention to reduce the consumption of cylinder gas and glass bottles respectively. It means environmental knowledge, attitude, and behavior vary between respondents because of heterogeneity in their socio-economic status.

Descriptive and ordered logit result shows variation in the level of environmental awareness within the income groups (Duroy, 2005; Ito and Kawazoe, 2017; Strieder et al., 2017). This finding is in line with Xun et al. (2017), Strieder Philippsen et al. (2017) and Altin et al. (2014), yet against Üstün and Celep (2007). This means, the higher the income, the more access to knowledge, attitude change, and behavioral improvement. Thus, higher income led to a high level of environmentally friendly actions (Xu et al., 2019; Zhang et al., 2015) and is likely to push to demand a better residential environment (White et al., 2007).

Respondents between the ages of 17-29 years old have a high and very high level of environmental awareness. The marginal effect shows a lower chance of high and very high levels of environmental awareness for the age greater or equal to 50 years old which is against Ziadat (2010) who investigated the high level of awareness for older ages. While the finding of this study is in line with Aminrad et al. (2013) and Karytsas and Theodoropoulou (2014) who explored young people to have better environmental awareness than the elderly ones. The reasons are as follows: first, they have had better access to information on the environmental damage in Addis Ababa for the last thirty years; second, they passed through the revised educational curriculum, which incorporates environmental items. Third, they are more popular with climate change and global warming in the last thirty years.

Education could influence the level of environmental awareness (Aminrad et al., 2011; Preston et al., 2000), which is against Üstün and Celep (2007) who found no evidence for the variation between lower education and university level. Peoples at higher educational levels have better environmental awareness levels. The finding of the present study agrees with Karytsas and

Theodoropoulou (2014) who found that being at higher education level positively influences their environmental knowledge. Similarly, education reduces the low and medium levels of environmental awareness and enhances the high and very high levels of awareness which is in line with Strieder Philippsen et al. (2017), Altin et al. (2014), Ziadat (2010), and Duroy (2005).

5. Conclusions

This article provides an insight into the measurement of environmental awareness through environmental knowledge, attitude, and behavior. Besides, to investigate factors that affect environmental awareness, the researchers used an ordered logit model. The questionnaire survey data was applied to conduct this study in Addis Ababa, Ethiopia.

From the empirical analysis, several interesting findings have been identified. First, the results of descriptive statistics show that there is a knowledge gap in watershed management, natural resource conservation, and air pollution. Besides, there are also sentiment gaps regards the cause of acid rain and global warming. Indeed, there is a lack of intention to reduce the use of bicycles, taxis, and private cars. This implies that there could possibly be high per capita GHG emissions in the future following population growth and income expansion. So, it would be crucial to manage people's behaviour at the infant stage. Thus, awareness creation training about the environmental and economic benefits of using public transport is substantial. Side by side, public transport agencies should plan and implement better transport services to attract residents. Furthermore, private companies should supply vehicles that consume nonrenewable energy. Considering the per capita GHG emission, people intend to reduce the use of nonrenewable energy for cooking and heating is an opportunity to reduce GHG by enhancing the supply of renewable energy.

Second, people's environmental awareness varies with income level, age group, and education level. Hence, most of the residents in Addis Ababa are low-income groups and employed as daily labor; improving the livelihood will improve the level of environmental awareness. Having a better income can influence their environmental mindset. In this regard, it is better to provide environmentally friendly income-generating activities for the urban low-income groups.

The respondents' age group also affects the level of environmental awareness. Young people have a better awareness than the elderly people. It might be associated with their information access and use of technologies. Hence, it will be better to use religious and informal institutions to address the environmental awareness of elderly people. Likewise, education was found to influence the level of environmental awareness. The higher the education, the better their environmental knowledge, attitude, and behaviour would be. In this respect, adult education, short-term training, and workshops are alternative options besides the formal education system to enhance environmental awareness.

This article has some limitations. First, using only quantitative analysis is one curb because environmental issues are not only expressed in verbal approaches of belief, feelings, and intention but also nonverbally reacted as a perceptual and physiological response. So, future research may benefit from a mixed approach. Second, the study area was delimited to in Addis Ababa. Hence, to get a better image, it would be more pragmatic to include regional towns. Therefore, it would be sound for future work to use an in-depth interview and ethnographic study.

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Annex Table 1: Tests of the parallel regression assumption

Tests	Chi2	df	P>Chi2
Wolfe Gould	11.19	15	0.739
Brant	-5638	15	1.000
score	10.66	15	0.777
likelihood ratio	11.63	15	0.707
Wald	9.946	15	0.823