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Psychological factors influencing pro-environmental behavior in developing countries: evidence from Colombian and Nicaraguan students

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Abstract: Identifying the determinants of human behavior is useful to adjust interventions and lead the civil society towards a stronger commitment with climate change mitigation and adaptation objectives, achieving greater support for successfully implementing environmental policies. Existing research has largely focused on case studies of pro-environmental behaviors (PEBs) in developed economies but there is yet very little evidence for developing countries. This study provides estimations of the effect of internal factors, such as sociodemographic variables, and four psychological dimensions (climate change knowledge, environmental attitudes, self-efficacy, trust in sources of environmental information) on PEBs. Data was obtained through a survey applied with future decision makers - university students - from Colombia (n = 4769) and Nicaragua (n = 2354). Indices were generated for PEBs and the psychological dimensions, using z-scores and Principal Component Analysis. Partial correlations were evaluated through the Ordinary Least Squares method. Our results suggest that, in order to reach the planned emission reduction targets, policy approaches should more strongly focus on educating and motivating citizens and prepare them for contributing to the environmental cause, as well as provide individual solutions to combat climate change, rather than providing only information on its causes and consequences.

Keywords: awareness of sustainability, education, psychological adaptation, environmental attitudes, policy support

1. Introduction

As part of the commitment with the Sustainable Development Goals (SDG) and the Paris Agreements (COP 21), developing countries have been increasing their responses to climate change (CC), especially since evidence suggests that the impacts of CC would have larger impacts in the global south, strengthening structural inequalities and leading to a vicious circle (Burke et al., 2015; UN, 2016). This panorama has led to a change in the development model of nations with a deliberate direction towards sustainability (Bárcena et al., 2018; IPCC, 2018), resulting in programs and strategies for CC mitigation and adaptation, which demand context specific approaches. However, the success of such approaches depends largely on the social norms, preferences, beliefs and values of the targeted individuals (Adger et al., 2009). Factors such as public awareness and knowledge of CC, attitudes and opinions regarding environmental problems and knowledge about appropriate behaviors determine the public support or opposition of

environmental or CC policies, strategies and initiatives (Howe et al., 2015; Leiserowitz, 2006; Lorenzoni et al., 2007; Arcury, 1990). Lee et al. (2015) argue that some countries are more advanced than others in terms of executing environmental policies resulting from differences in risk perception of the targeted populations.

During the last four decades, important advances were made in the identification of factors influencing environmental perceptions and Pro-Environmental Behaviors (PEBs). Nevertheless, most of these studies were conducted in North America, Europe and other developed regions (Salehi et al., 2016; Vignola et al., 2013; Cordano et al., 2010; Lorenzoni and Pidgeon, 2006). While research on PEBs has been growing in Latin American countries recently (Ideam et al., 2016; Pávez-Soto et al., 2016; González and Maldonado, 2015; Barazarte et al., 2014; Sánchez et al., 2014; Bertoni and López, 2010; Calixto and Herrera, 2010; Pato et al., 2005; Padilla and Luna, 2003). These studies have covered different groups such as students (e.g. Salehi et al., 2016; Palavecinos et al., 2016; Spellman et al., 2003; Tikka et al., 2000), consumers (e.g. Yadav and Pathak, 2016; Tobler et al., 2012a; Tobler et al., 2012b), citizens with diverse political and religious positions (e.g. Tobler et al., 2012b; Arbuthnot, 1977), professors (e.g. Pe'er and Goldman, 2007) and communities related to recycling (e.g. Sidique et al., 2010).

This study aims at enhancing the knowledge base for the Latin American context by evaluating perceptions and behavior towards CC with a large sample of university students in Colombia and Nicaragua. Knowledge and attitudes about CC, self-efficacy and trust in different information sources are measured, and relationships within PEBs, knowledge, attitudes and socioeconomic characteristics of the selected population are explored.

The applied approach leads to two questions: 1) Why choosing this segment of the population as study group, and 2) why identifying relationships among the variables? According to Bradley et al. (1999), university students - future scientists, legislators, consumers and voters - will be responsible for generating solutions to environmental problems and thus should be persuaded to adopt and pay the costs of future environmental policies. Likewise, students will have to make complex political decisions about CC mitigation and should do so from an informed perspective. Consequently, current and future educators require a better understanding of the dimensions affecting the students' perceptions, in order to develop teaching programs that contribute in a more effective way to the fight against CC (Wachholz et al., 2014). Secondly, identifying the relationships between PEBs and the variables that affect them provides a clearer landscape to define strategies and prioritize efforts for increasing the level of environmental awareness. Accordingly, this research allows identifying the most reliable agents in disseminating information, and provides guide on the type of knowledge that should circulate in order to improve the efficacy of both public and private communication strategies. In addition, policy approaches will be more effective when taking into account the psychosocial context and factors that influence environmental actions (Stern, 2011; Steg and Vlek, 2009), considering that students not only increase their own contribution to CC mitigation, but also their empowerment to become change agents and influencers for other segments of the population (González and Maldonado, 2015).

2. Theoretical Framework

2.1 The Theory of Planned Behavior (TPB)

TPB (Ajzen, 1991, 1985) is considered an extension of the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980), which explains behaviors under a logical framework: behavioral

beliefs are supported by a favorable or unfavorable attitude about a certain behavior. Normative beliefs refer to the subjective norm and thus the social pressure associated with behavior. In this sense, actions are supported by individual attitudes, available information and subjective norms, which are based on beliefs formed through knowledge, understood as the element that allows evaluating the consequences of actions. TPB introduces an additional element: *the control of perceived behaviors*. This element refers to the understanding of the factors that can hinder the performance of actions and the subsequent behavior derived from them (Ajzen, 1991). The theory suggests that people are much more likely to adopt a certain behavior when they feel able to perform it successfully, a dimension also affected by self-efficacy (Bandura, 1977). This concept refers to “*people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives*” (Bandura, 1991, p. 257).

While TRA and TPB models do not include sociodemographic variables, the authors do not deny their importance. Rather the opposite: they argue that any external variable can influence the intention - and indirectly, the actual behavior - if it influences the attitudinal and/or the normative component. Although some studies have not taken into account sociodemographic variables to relate PEBs with the theories presented above (e.g. Beckage et al., 2018; Paul et al., 2016; Mishra et al., 2014; Bang et al., 2000), others did (e.g. Paço and Lavrador, 2017; Kim et al., 2013; Goldenhar and Connell, 1993). The latter shows that the relationship between knowledge, attitudes, behaviors and external variables differ among contexts change over time and are perceived differently from one culture to another. This highlights the importance of combining sociodemographic and cognitive factors to study PEBs in context-specific cases.

Similar to the approach used by Yadav and Pathak (2016), the present study applies an introspection of the TPB to the extent that it involves dimensions prior to the main ones described above, such as knowledge of CC and self-efficacy. Additionally, other potentially related dimensions are included with the aim of exploring both the individual and broader explanatory factors. The next section presents the selected dimensions and their importance for the present study.

2.3 Explanatory variables

Similar studies have addressed topics such as energy saving (e.g. Sapci and Considine, 2014), recycling (e.g. Paço and Lavrador, 2017; Sidique et al., 2010; Goldenhar and Connell, 1993) or the willingness to pay for environmentally friendly products (e.g. Bedard and Tolmie, 2018; Paul et al., 2016; Furlow and Knott, 2014), using a broad set of possible explanatory variables. These range from psychological dimensions (Arbuthnot, 1977; Helm et al., 2018), to the orientation of messages (Gifford and Comeau, 2011), geographical variation (Howe et al., 2015), or a combination of both (Zhang et al., 2018).

For this study, socioeconomic characteristics and four dimensions were determined for their potential explanatory relationship with PEBs. PEBs can be understood in two ways: first, as behavior that “*harms the environment as little as possible, or even benefits the environment*” (Steg and Vlek, 2009, p. 309) and second, as behavior “*that is undertaken with the intention to change (normally, to benefit) the environment*” (Stern, 2000, p. 408).

2.3.1 Sociodemographic variables

Gender: Women and men do not experience CC in the same way. Literature shows that women, particularly in rural areas, present greater concerns about CC since they carry out activities such as raising children, or planting and harvesting, which depend largely on both natural resources and a healthy environment (Vicente-Molina et al., 2018; FAO, 2015; Davidson and Freudenberg, 1996; Blocker and Eckberg, 1989). In that sense, women are strongly affected by changes in the environment and show to be more committed to mitigating actions (Paço and Lavrador, 2017; Palavecinos et al., 2016; Ideam et al., 2016; Perez et al., 2015; Gifford and Comeau, 2011; O'Connor et al., 1999; Bord et al., 1998). Among younger people, women have also shown better environmental attitudes and knowledge, are more concerned about environmental problems and are more involved in CC mitigation actions (e.g. McCright, 2010; Freudenburg and Davidson, 2007).

Age: Children and elderly experience more aggressively the effects of CC. Both populations present higher mortality and disease rates due to hurricanes, floods and droughts (IPCC, 2014b). Though Otto and Kaiser (2014) found that older people have better PEBs than younger individuals, the effect of age is ambiguous and appears to be affected by access to information. Bedard and Tolmie (2018) and Furlow and Knott (2014) argue on the importance of the internet and digital communications for younger generations, who tend to be better informed and more concerned about social and environmental issues. As a result, younger individuals have more tools to understand CC and consequently generate environmental actions.

Geography: Similar demographic and cultural characteristics tend to cluster (Howe et al., 2015; Motyl et al., 2014; Leiserowitz, 2006). Likewise, perceptions of CC exhibit geographic patterns due to differences in experiences with extreme weather events and climate variability (Howe et al., 2015; Akerlof et al., 2013). In their analysis in 89 countries, Howe et al. (2013) found that people living in places more susceptible to CC are the most concerned about the phenomenon.

Field of study: Students of certain academic fields show a better understanding of CC. Several authors (e.g. Salehi et al., 2016; Pe'er et al., 2007; Spellman et al., 2003; Tikka et al., 2000) found that students from disciplines related to environmental and natural sciences possess a significantly higher level of environmental knowledge and attitudes than those from other programs.

Education level and academic cycle: Educational achievements are the strongest predictor for environmental knowledge and understanding of CC (Lee et al., 2015; Polonsky et al., 2011). According to Meyer (2015), education can lead people to care more about general social welfare, including the external benefits of their actions. Furthermore, the time spent at university can have a positive impact on individuals, since higher education institutions tend to encourage students to incorporate principles of environmental responsibility (Emanuel and Adams, 2011; Kagawa, 2007). Paço and Lavrador (2017), Meyer (2016) and Spellman et al. (2003) have found significant differences between students of higher semesters and those who have recently started their studies. However, other authors did not find significant relationships between knowledge of CC and the academic cycle (e.g. Salehi et al., 2016).

Income level/Socioeconomic strata: People with less resources are the most affected by CC despite not being the main emitters of GHG (Bárcena et al., 2018; IMF, 2017; Hallegatte and Rozenberg, 2017; IPCC, 2014a; Mendelsohn et al., 2006). Low-income people are often located in places more vulnerable to climatic phenomena and experience higher levels of worries and a greater sense of insecurity. They are the ones who know more about the effects of CC, but lack an adequate

understanding of the causes as well as strategies for coping with the consequences (Hardoy and Pandiella, 2009), and therefore the relationship with PEBs may be ambiguous.

2.3.2 Dimensions of reference

CC knowledge: A higher knowledge about CC leads to increasing concerns about it. Consequently, informed citizens are more likely to perform actions that promote environmental protection and support related policies (Shi et al., 2016; Kellstedt et al., 2008; Bord et al., 2000; O'Connor et al., 1999; Ramsey and Rickson, 1976). However, CC is a complex phenomenon that encompasses multiple causes and a great variety of consequences. Various authors found that, in order to properly face CC, knowledge about the anthropogenic causes of CC might be more relevant than, for example, knowledge about its physical effects (Shi et al., 2016; Lee et al., 2015; Bord et al., 2000). Other studies (e.g. Salehi et al., 2016; Tobler et al., 2012a) present the need to know and differentiate the causes and consequences of CC, as well as the knowledge of concrete actions to mitigate it. However, Shi et al. (2016) state that it is essential to focus studies on all dimensions since measuring the perceptions of the phenomenon transversally becomes necessary.

Self-efficacy: This dimension is of special relevance for the TPB since it contributes to the determination of perceived behavioral control and thus to PEBs. Expectations such as motivation, performance, and feelings of frustration determine behavioral reactions. Some studies demonstrate the perceived efficacy of individual actions in the fight against CC, showing how deeply they influence PEBs and environmental knowledge (Kellstedt et al., 2008; Heath and Gifford, 2006). Not only that, high self-efficacy can influence the transition from easy-to-perform PEBs to those with a greater degree of difficulty (Lauren et al., 2016).

Trust in sources of environmental information: Neither TRA nor TPB consider this dimension within their models. However, decision-making is dependent not only on the availability of information but also on the level of trust in different sources (Dietz et al., 2007). Lorenzoni et al. (2007) describe that public distrust in media constitutes an important impediment to CC adaptation. According to them, media tactics such as exaggeration, sensationalism or partiality (in addition to contradictory frames) end up generating confusion. Gifford and Comeau (2011) found that the orientation of messages influences both the commitment towards mitigation and the intentions of the behavior. Kellstedt et al. (2008) state that trust in Non-Governmental Organizations (NGOs), media or political institutions can facilitate or obstruct the understanding of CC. Spence and Pidgeon (2010) found that the effectiveness of the messages also varies according to the geographic location where the information circulates, with different effects on the recipient's behavior.

Environmental attitude: The inclusion of attitudes as an explanatory factor of behavior is the most adopted approach (Li et al., 2019). Authors such as Arcury (1990) and Kaiser et al. (1999) affirm that there exists a link between knowledge and PEBs, and that they are generally connected by attitudes. To measure this dimension, the present study adopts the New Environmental Paradigm (NEP) scale. Dunlap and Van Liere (1978) propose NEP to respond, not only to different development theories, but also to a new way of understanding the relationships between human beings and their environment, which translates into a radical change in attitudes. By covering different environmental issues with relative standardization, the NEP has become a conventional scale to capture this information.

3. Methodology

3.1 Data collection

In addition to sociodemographic information, data to measure different dimensions was obtained using a five-point Likert-type survey. The instrument included five modules with a series of questions and statements related to the previously described dimensions, presenting 48 affirmations. To verify and maximize the internal consistency of the instrument, a pilot test was conducted with 100 students from the city of Cali (Colombia) and a Cronbach's alpha coefficient was calculated for each variable (Table 1).

Table 1. Dimensions of the survey

| Dimension | Selected references | Selected items | Total values | Cronbach's alpha (α) pilot test |
|--|---|----------------|--------------|--|
| <i>CC knowledge</i> | Spellman <i>et al.</i> , (2003) | 16 | 80 | 0.64 |
| <i>Self-efficacy</i> | Kellstedt <i>et al.</i> , (2008) | 4 | 20 | 0.62 |
| <i>Trust in sources of environmental information</i> | Kellstedt <i>et al.</i> , (2008) | 6 | 30 | 0.65 |
| <i>Pro-environmental behaviors</i> | Markle (2013); Paço and Lavrador (2017) | 14 | 70 | 0.73 |
| <i>New Environmental Paradigm (NEP)</i> | Dunlap and Van Liere (1978) | 8 | 40 | 0.71 |

For data collection, a sample frame was developed consisting of a list of universities from four cities in Nicaragua and ten in Colombia, respectively (Figure 1). A simple random sampling was carried out to select the universities and the survey was applied in those programs where authorization was granted. Information on income was captured differently in both countries: in Nicaragua, the level of income was measured in monetary terms. In Colombia, the measurement was in accordance with the national socioeconomic stratification categories¹, ranging from one to six (the higher the number, the better the living conditions in the place where the respondent's household is located), which normally is used to relate to the level of income and socioeconomic conditions of an individual. In both countries, the survey was mainly conducted at university classrooms through self-administered questionnaires. In Colombia, some students participated through an online survey, which was sent to their institutional emails by the respective university authorities. Table 2 shows the most relevant educational and socio-demographic characteristics of the sample.

Table 2. Educational and sociodemographic characteristics of the study population in Nicaragua and Colombia

| | Nicaragua (%) (n=2354) | Colombia (%) (n=4769) |
|-------------------------------|---------------------------|--------------------------|
| Age (average in years) | 19.6 ($\sigma = 2.62$) | 21.3 ($\sigma = 4$) |
| Gender* | | |

¹ Socioeconomic stratification in Colombia categorizes housing units in a scale of one to six according to their physical characteristics, immediate surroundings and rural or urban context. It was implemented for assigning differential public utilities rates to different strata, enabling higher strata (five and six) to pay higher rates and subsidize the costs for lower strata (one, two and three) (Departamento Administrativo Nacional de Estadística, Colombia). Retrieved from: <https://www.dane.gov.co/index.php/servicios-al-ciudadano/servicios-informacion/estratificacion-socioeconomica>

| | | |
|--|------|------|
| Female | 44.3 | 49.5 |
| Male | 54.4 | 50.1 |
| Income level (Nic – US\$) / Socioeconomic strata (Col)* | | |
| ≤ US 250 / 1 | 31.5 | 13.9 |
| 251 – 500 / 2 | 35.6 | 31 |
| 501-750 / 3 | 7.6 | 33.9 |
| 751-1000 / 4 | 3.7 | 10.7 |
| 1001-1250 / 5 | 6.7 | 4.9 |
| ≥ 1251 / 6 | 11.7 | 2.1 |
| Education level | | |
| Candidate undergraduate degree (BSc) | 99.6 | 97.3 |
| Candidate postgraduate degree (MSc, PhD) | 0.4 | 2.7 |
| Academic cycle* | | |
| First year | 35.9 | 31.7 |
| Second year | 20.7 | 19.3 |
| Third year | 17 | 16.2 |
| Fourth year | 14.5 | 18.4 |
| Fifth year | 11.9 | 13.8 |

* Not all percentages add up to 100%. Some participants did not provide all the requested information.

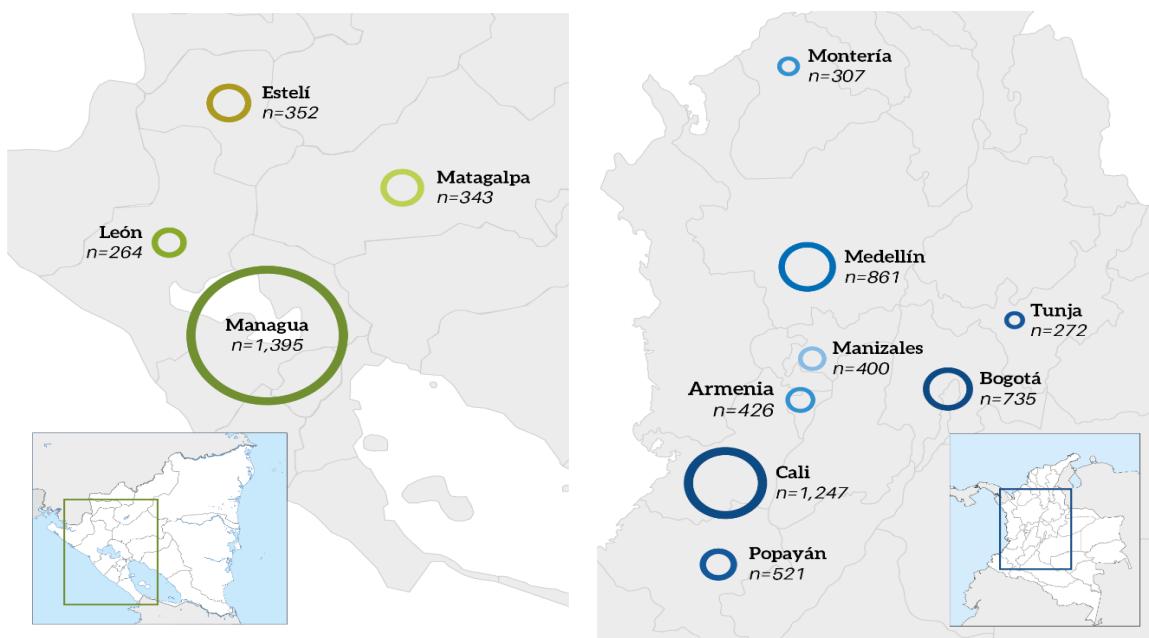


Figure 1. Geographical distribution of the study population for Nicaragua and Colombia

3.2 Data analysis

3.2.1 Exploration of data

An index was calculated for each of the modules that made up the questionnaire. These indices were obtained by granting five points for answers that were a) in accordance with the dimension *CC knowledge* or b) consistent with the dimensions *environmental attitude (NEP)*, *self-efficacy*, *trust in sources of environmental information* and *PEBs*. This score decreases as the selection moves away from the desired response. However, there was no discount if the answer was wrong. In this way, maximum and minimum scores were established, and intervals were created with the aim of classifying all the variables within the established ranges (Figures 2 and 3). In the following section, the mean values and the observed deviations for each variable are presented using as reference the values presented in Table 1.

The effects of sociodemographic variables on the reference dimensions were analyzed through tests of mean differences. As a first measure, the normality of the dimensions was analyzed through the Shapiro-Wilk test. Next, a Student's *t*-test, ANOVA and a *Kruskal-Wallis* one-way analysis of variance were conducted. For the latter, *post-hoc* tests were also carried out, such as *Tukey* and *post-hoc Kruskal-Wallis Dunn*, in order to identify which group showed the largest differences.

3.2.2 Regression Model: Ordinary Least Squares (OLS) and Principal Component Analysis (PCA)

PEBs were evaluated through the OLS method. As a first measure, the variables were standardized and five *z-score* indices were created (Equation 1), which were defined as the weighted average of the *z-score* of their variables, following the methodology proposed by Kling and Liebman (2004), and Kling et al. (2007). Next, the following regression was made:

$$y_{ic} = \alpha_{ic} + \beta \times \text{Knowledge}_{ic} + X'_{ic} + \varepsilon_{ic} \quad (1)$$

Where y_{ic} is the result of interest (*Pro-Environmental Behaviors*), i and c are identifiers for the individuals and the country. X'_{ic} is the vector of sociodemographic and educational characteristics, and ε_{ic} is the standard error. β is the coefficient that measures the effect of knowledge about climate change on the PEBs of students. In the absence of identifiable exogenous shocks or other means to establish causality, estimates should be interpreted as (partial) correlations.

As a way to mitigate omitted variable biases, the variation of the β coefficient was observed when adding the covariates to the initial regression. Five different specifications were used in two phases. First, a regression of the result of interest on knowledge. Second, the inclusion of the sociodemographic characteristics of the individuals. Third, in addition to the previous models, the educational characteristics of the students were included. Fourth, in the second phase, a regression of student behavior was performed in all *z-score* indices. Fifth, all the indices and sociodemographic characteristics of the students, as well as the educational variables were included in the model (Equation 2):

$$y_{ic} = \alpha + \beta_1 \times \text{Knowledge} + \beta_2 \times \text{Efficiency} + \beta_3 \times \text{Trust} + \beta_4 \times \text{NEP} + X'_{ic}\gamma + \varepsilon \quad (2)$$

Here, α is the constant parameter and β_1 , β_2 , β_3 and β_4 are the coefficients for each of the *z-scores*. γ is the vector of coefficients for the matrix of sociodemographic and educational variables, and ε is the standard error of the model. The PCA method was used as an additional robustness test. This statistical procedure uses an orthogonal transformation to convert a set of observations of possibly

correlated variables into a set of values of variables that are not linearly correlated. Thus, the same indices used in the OLS method were recreated with the PCA and variables were regressed on the PCA indices.

4. Results

4.1 Exploratory analysis Nicaragua

The majority of the population (71.6 percent) possess moderate knowledge about CC ($\bar{x}=51.5$; $\sigma=9.1$) while only a small portion of the sample possess high CC knowledge (16.5 percent). As shown in Figure 2, the values obtained are slightly higher for the country's capital, Managua, which, in turn, also has the lowest proportion of the population unaware of the causes and effects of CC. Although the mean differences in knowledge scores were low, they were significant between Managua and León ($p <0.01$) and Managua and Matagalpa ($p <0.01$). Men possess significantly higher CC knowledge ($p <0.01$), but the absolute mean differences were not very strong. No significant differences were found for both income and education level.

Regarding CC knowledge, data reveals that the vast majority of students are aware of the responsibility of humans in global warming, and consider that individual actions can have an influence on global warming. Despite this awareness, important gaps were found. The majority of students consider that nuclear energy contributes to climate change (false), that global warming does not affect agricultural activities such as agriculture and fishing (false), and that the industry sector produces the largest amount of GHG emissions (false). About half of the sample is unaware of the importance of clouds and water vapor in the atmosphere – in fact, the majority of the sample affirmed that without clouds, the earth would not be in danger (false). Despite this, a correct understanding was observed of the problems that ultraviolet radiation can cause in people's health and of the consequences of ozone depletion (Appendix A).

Regarding self-efficacy, students are, on average, akin to 76.3 percent of the items ($\bar{x}=15.4$; $\sigma=3.4$), corresponding to a high level of affiliation with a perceived importance of individual actions in the environment. No significant differences on self-efficacy were found for any of the sociodemographic variables. Responses of younger people show that they are less prone to carry out active and participatory processes in mitigation and adaptation strategies to CC. In contrast, 88.8 percent of the surveyed population expressed high levels of awareness about the impact of human actions on CC (Appendix B).

In contrast, the results of trust in the institutions that provide environmental information were ambivalent. Although the total trust level was above 50%, this variable was not concentrated in any extreme ($\bar{x}=19.5$; $\sigma=4.66$). With a shared perspective between both genders, the national government presents the lowest trust levels. Students have more trust in Non-Governmental Organizations (NGOs), educational institutions and the scientific community. The latter exhibits the highest trust levels (Appendix C).

As shown in Figure 2, the students' scores on PEBs are mostly favorable ($\bar{x}=47.7$; $\sigma=9.8$). However, several discrepancies were identified regarding the students' real behavior: Household waste separation receives a low qualification across the whole sample. Likewise, about half of the sample prefers to use private instead of public transport. It is worth highlighting that most people

tend to pay attention to savings in water and electricity consumption and decide to adopt practices that contribute to preventing the waste of these resources (Appendix D).

The surveyed population showed affinity with ecological premises of the NEP scale. On average, 78.2 percent of the population respond in accordance with the overall statements ($\bar{x}=31.1$; $\sigma=6$). No significant differences were observed when testing for gender. Managua showed the best results, with significant differences to Matagalpa ($p < 0.01$) and León ($p < 0.05$). It was evidenced that students assign importance to building a better balance between humans and nature. However, affinity with the statement *"The ultimate goal of plants and animals must be to serve the needs of the population"*, presented an important variability in the distribution of the degree of affinity, and it is observed that the response rate decreases drastically compared to the previous questions (Appendix E).

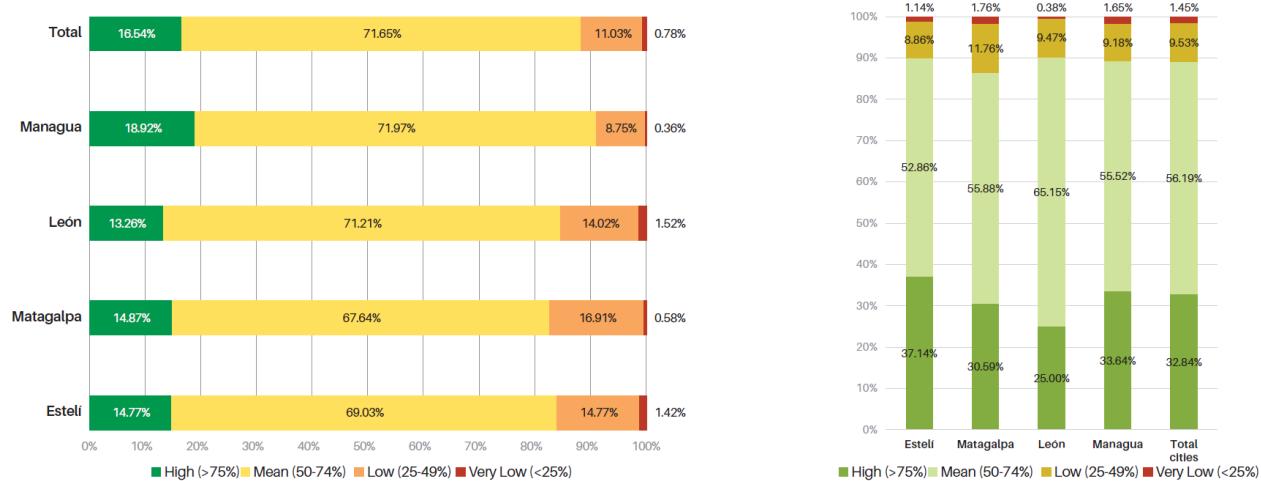


Figure 2. Knowledge about climate change (left) and PEBs (right) by cities in Nicaragua

4.2 Exploratory analysis Colombia

In general, it was observed that students from cities possess middle to high knowledge regarding CC ($\bar{x}=51.6$; $\sigma=7.8$). Figure 3 shows that the majority of the student population (78.3 percent) is located within the intermediate knowledge and to a lesser extent within the high knowledge levels (14.3 percent). Regarding gender, the Colombian students show similar results as their Nicaraguan peers. However, for Colombia the differences are significant: men possess higher CC knowledge ($p < 0.01$), while women show better environmental behavior ($p < 0.01$), greater self-efficacy ($p < 0.01$) and better environmental attitude ($p < 0.01$).

Bogotá (the capital city) has the most informed student population ($\bar{x}=54.2$; $\sigma=7.5$), followed closely by Tunja ($\bar{x}=53$; $\sigma=8$), an intermediate city close to Bogotá. Armenia, on the other hand, has the least informed student population ($\bar{x}=50.2$; $\sigma=7.5$). The latter and Bogotá stand out for presenting more significant differences compared to the other cities of this sample. Though students show a high understanding of the impact of global warming on agriculture and fishing, they present a wrong understanding of the contribution of nuclear energy and the industrial sector to CC. Students also ignore the relationship between ozone and ultraviolet radiation, but are aware of the effects that the latter has on people's health (Appendix A). There were no significant mean

differences observed for the effects of the academic cycle and socioeconomic strata on CC knowledge.

High scores were found for self-efficacy ($\bar{x}=16.3$; $\sigma=2.9$), especially in terms of individual actions to reduce global warming and CC. Although both genders show a high degree of awareness about the impact of human actions on the environment, in all items women presented a greater degree of affinity towards the statements (Appendix B).

With regard to trust in institutions that provide environmental information, positive responses were observed, although the means are mainly concentrated within intermediate ranges ($\bar{x}=19.2$; $\sigma=4.2$). Perceptions about the institutions were widely divergent. On average, students rather trust the scientific community, educational institutions and NGOs, but are reluctant to the information offered by the government (Appendix C).

The dimension PEBs, on the other hand, is located in the upper part of the mean range ($\bar{x}=50.6$; $\sigma=9$). A slight relation among PEBs per city and CC knowledge can be observed (Figure 3). Tunja stands out because it ranks second in the proportion of students with more CC knowledge and first in PEBs. In fact, it is the only city with significant differences. No significant differences were found for this dimension when analyzing for socioeconomic strata. Similarities were observed with the Nicaraguan sample: students pay special attention to avoid waste of electricity and water, but the proportion drops drastically when it comes to household waste separation (Appendix D).

Environmental attitude presents the highest score among the Colombian students, who particularly display a high level of affinity with the importance of building a better balance between humans and nature ($\bar{x}=33$; $\sigma=5.2$). On average, the attitude's score increases as the academic cycle progresses. When analyzing this variable by socioeconomic strata, the means of the attitudes show a uniform behavior. Significant differences among strata can be observed, but these differences do not have a definite pattern, or in other words, it is not possible to state whether as the strata increases there are better attitudes or vice versa. Cali stands out as the city with the highest mean behavior for this dimension ($\bar{x}=34.3$; $\sigma=5.2$) and presents significant differences with all other cities of this sample ($p <0,01$). Unlike in Nicaragua, the Colombian students' responses on the usefulness of plants and animals for the satisfaction of human needs show greater homogeneity in their distribution, mostly rejecting the statement. Likewise, it is observed that students are aware of the human-induced impact over natural resources (Appendix E).

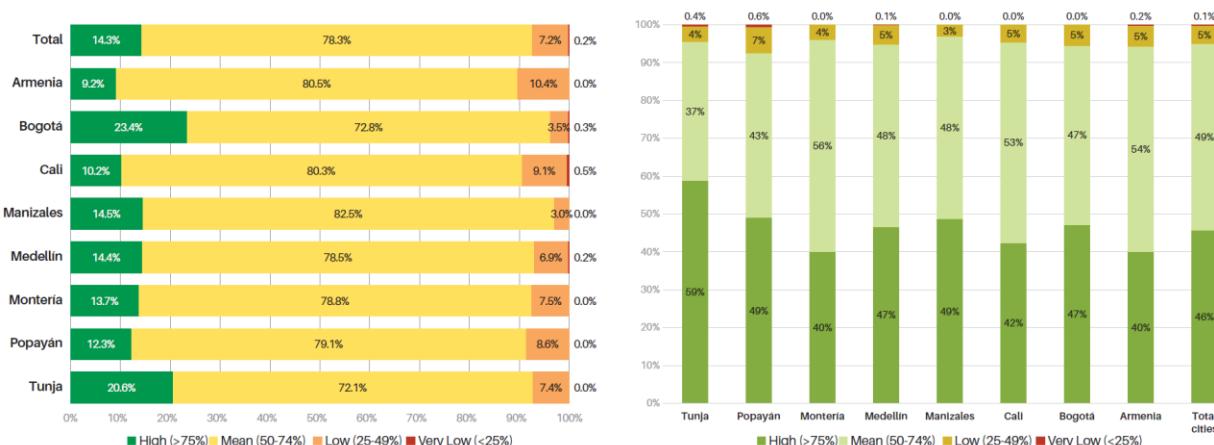


Figure 3. Knowledge about climate change (left) and pro-environmental behaviors (right) by cities in Colombia

4.3 Regression Model: Ordinary Least Squares (OLS) and Principal Component Analysis (PCA)

OLS regressions were estimated for the integrated environmental behavior index. Tables 3 and 4 show the results of the OLS model with the *z-score* indicators for Nicaragua and Colombia, while tables 5 and 6 show the results of the PCA. For both cases, the first column shows the result of the first regression, which measures the relationships between CC knowledge and PEBs without including control variables. The second column shows the relationships between PEBs and CC knowledge, adding sociodemographic variables, while the third column shows the relationship between the dependent variable and CC knowledge, controlling both the socioeconomic and educational variables. Finally, the fourth and fifth columns include all the indicators for the different dimensions of the regression, i.e. self-efficacy, trust in the institutions that provide environmental information and NEP.

Table 3. Results of the OLS model for Nicaragua

| | (1) | (2) | (3) | (4) | (5) |
|-------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| CC Knowledge | 0.538*** (0.035) | 0.561*** (0.041) | 0.563*** (0.043) | 0.113*** (0.032) | 0.119*** (0.039) |
| Self-efficacy | | | | 0.160*** (0.020) | 0.162*** (0.023) |
| Trust | | | | 0.140*** (0.016) | 0.126*** (0.019) |
| NEP | | | | 0.235*** (0.023) | 0.249*** (0.026) |
| Observations | 2312 | 1872 | 1713 | 2253 | 1677 |
| R ² adjusted | 0.152 | 0.161 | 0.172 | 0.353 | 0.370 |
| Socio-economic controls | No | Yes | Yes | No | Yes |
| Education controls | No | No | Yes | No | Yes |

* p<0.10, ** p<0.05, *** p<0.01

Table 4. Results of the OLS model for Colombia

| Dimension | (1) | (2) | (3) | (4) | (5) |
|-------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| CC Knowledge | 0.383*** (0.030) | 0.404*** (0.031) | 0.408*** (0.031) | 0.084*** (0.022) | 0.097*** (0.023) |
| Self-efficacy | | | | 0.229*** (0.013) | 0.211*** (0.012) |
| Trust | | | | 0.065*** (0.011) | 0.069*** (0.011) |
| NEP | | | | 0.180*** (0.014) | 0.200*** (0.014) |
| Observations | 4764 | 4563 | 4460 | 4744 | 4442 |
| R ² adjusted | 0.070 | 0.111 | 0.128 | 0.271 | 0.320 |
| Socio-economic controls | No | Yes | Yes | No | Yes |

| Education controls | No | No | Yes | No | Yes |
|---------------------------------|----|----|-----|----|-----|
| * p<0.10, ** p<0.05, *** p<0.01 | | | | | |

In line with the expectations, adequate CC knowledge is associated with better PEBs, both in Colombia and in Nicaragua, although with greater magnitude in the latter. The coefficients are statistically significant at the 1% level in all specifications. In particular, the inclusion of sociodemographic and educational control variables does not determine relevant changes in the correlation between the variables. While the coefficient decreases when adding other indexes of the survey to the regression, it is suggested that the correlation between PEBs and attitudes is explained mostly by self-efficacy, trust in the institutions that provide environmental information and NEP.

In both countries, both NEP and self-efficacy are more correlated with PEBs than CC knowledge itself. In Nicaragua, the NEP coefficient indicates that for each increment of a standard variation, the behavior changes 0.25 standard deviations in the same direction; an increase in affinity with the NEP indicator represents a greater increase in PEBs compared to the other dimensions analyzed. The same happens in Colombia, but with self-efficacy. For each variation of one standard deviation, PEBs increases by 0.21 standard deviations.

The consistency of the results was evaluated through a PCA (Tables 5 and 6). When all the variables are included, the explanatory factor measured by the R squared indicator is higher, which indicates a clear correlation between the behavior and the variables analyzed. Even at a disaggregated level, results were similar, meaning that significant results are not due to the aggregation of the variables in each index. In fact, the knowledge index for the survey questions has been decomposed and the correlation between each *z-score* has been estimated (Annex 6 and 7), showing that most of the coefficients are positive and statistically significant at 1 percent, with the exception of the outliers mentioned in the previous subsection.

For both countries, statements with negative coefficients were identified. In Colombia and Nicaragua, the statement "*the industry is the sector that produces the highest level of GHG emissions*" presented this effect. The same was found in Colombia with the statement "*the high amounts of ozone in the atmosphere increase the ultraviolet radiation on the surface of the earth*" and in Nicaragua with the statements "*Nicaragua is one of the main producers of GHG*" and "*the use of renewable energy can increase global warming*".

Although the results indicate patterns, they might be biased due to omitted variables. Given the cross-sectional nature of the data used, it is not possible to identify the causal effect of CC knowledge, environmental attitudes or trust in the institutions that provide environmental information on PEBs. However, the data allows controlling for the sociodemographic characteristics and educational level, and confirm the meaning and orientation of the proposed estimates.

Table 5. Results PCA Nicaragua

| Dimension | (1) | (2) | (3) | (4) | (5) |
|---------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| CC Knowledge | 0.455*** (0.045) | 0.494*** (0.050) | 0.475*** (0.053) | 0.087* (0.048) | 0.103* (0.058) |
| Self-efficacy | | | | 0.614*** (0.145) | 0.621*** (0.162) |
| Trust | | | | 0.526*** | 0.458*** |

| | | | | | |
|-------------------------|-------|-------|-------|----------|----------|
| NEP | | | | (0.115) | (0.137) |
| | | | | 1.038*** | 1.181*** |
| | | | | (0.176) | (0.202) |
| Observations | 736 | 625 | 583 | 730 | 579 |
| R ² adjusted | 0.219 | 0.236 | 0.236 | 0.378 | 0.383 |
| Socio-economic controls | No | Yes | Yes | No | Yes |
| Education controls | No | No | Yes | No | Yes |

* p<0.10, ** p<0.05, *** p<0.01

Table 6. Results PCA Colombia

| Dimension | (1) | (2) | (3) | (4) | (5) |
|-------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| CC Knowledge | 0.434*** (0.037) | 0.447*** (0.039) | 0.466*** (0.040) | 0.120*** (0.035) | 0.140*** (0.036) |
| Self-efficacy | | | | 0.950*** (0.099) | 0.901*** (0.095) |
| Trust | | | | 0.306*** (0.080) | 0.329*** (0.079) |
| NEP | | | | 0.527*** (0.106) | 0.578*** (0.104) |
| Observations | 1216 | 1174 | 1148 | 1213 | 1145 |
| R ² adjusted | 0.183 | 0.218 | 0.237 | 0.332 | 0.378 |
| Socio-economic controls | No | Yes | Yes | No | Yes |
| Education Controls | No | No | Yes | No | Yes |

* p<0.10, ** p<0.05, *** p<0.01

5. Discussion

Our results can contribute to policy formulation and indicate the direction of future research in various ways. First, results show that the R square is very similar between countries with considerable similarities but also important cultural and social differences (38%). This reveals that the measured psychological and socioeconomic factors have similar effects on PEBs across two cultures, but also that there is still a need to identify other dimensions or factors that explain the remaining variability of the PEBs and if these too are consistent. Some studies suggest that a greater degree of explanation can be achieved by taking into account external forces and contextual factors. These include e.g. physical infrastructure, technical facilities, availability of products and their characteristics (Steg and Vlek, 2009), environmental policies, financial strategies (Bertoldi, 2017), social norms and the influence of the social nuclei of an individual and the duration of and adaptation to a technology (Li et al., 2019; Truelove and Gillis, 2018). Recently, Truelove and Gillis (2018) revealed a new explanatory dimension: CC impacts on health and safety, which is of major relevance in developing countries since they are the most vulnerable to CC.

Secondly, based on the psychological factors included in this research, our results allow providing recommendations for the design of policies and other instruments intended to modify student behavior towards a more sustainable direction. Although CC knowledge and trust in institutions showed significant correlations with PEBs, attitudes and self-efficacy exhibit a much stronger relationship, which is why it could be fruitful to focus strategies on these dimensions. Following Spence and Pidgeon (2010), emphasizing on the potential negative impacts of not carrying out actions, abandoning alarmist paradigms and generating more binding strategies (combining personal and collective solutions) - arise as directive vectors, which have been proven useful

techniques for students (Parant et al., 2016). Nevertheless, transmission of motivational communication should be carried out carefully, as people may not respond adequately. Students in Colombia and Nicaragua (contrary to the results presented by Vignola et al. (2013) for the case of Costa Rica) do not have sufficient trust in the institutions that generate such communications, particularly in governmental sources. Thus, actions addressed at increasing trust of public sources, while better leveraging on the credibility of NGOs and the scientific community in the communication strategies for adaptation and mitigation, may provide better results.

The present study did not consider the impact of economic incentives and disincentives on PEBs, which could be an additional explanatory factor. However, it was observed that students weigh the effort or the costs related to certain PEBs. This allows establishing a clear differentiation between low-cost behaviors and mobility behaviors, as described by Tobler et al. (2012b). In both countries, commitment with certain environmental actions varied according to their rigidity. While closing the water tap and turning off the light or the fan when not in use are commonly applied actions among the studied population, other, more determinant actions, like traveling less, recycling waste or using the bicycle instead of a car are less common. These results are in line with several other studies, such as Tobler et al. (2012b), Steinhorst et al. (2015) or Truelove and Gillis (2018), and can be explained not only from the psychological dimension but also from an overlapping economic dimension. Although the social benefit of a given environmental action is greater than the individual cost, the agent may prefer not to apply it given his or her own assessment of the personal effort or cost involved. Truelove and Gillis (2018) found that for so-called *laypeople* (people who are not experts in PEBs), the monetary costs of carrying out a certain behavior outweighs the frequency a behavior needs to be carried out. However, several other studies (e.g. Steinhorst et al., 2015, Schwartz et al., 2015 and Delmas et al., 2013) show that monetary incentives are not a good stand-alone solution and might even be counterproductive if they form the sole base of environmental behavior campaigns. It is much more useful to take into account the psychological, social and civic stimuli of conservation, especially when it comes to a population group such as university students. While monetary framing might be efficient for one particular environmental action/behavior, environmental framing goes beyond that and can motivate additional non-targeted actions or behaviors (Steinhorst et al., 2015). Thus, monetary incentives should rather be considered a complementary element in pro-environmental campaigns. This is also consistent with findings from Gifford and Comeau (2011), who observed that young people participate to a lesser extent in mitigation actions and thus should be a target of motivational strategies.

Finally, the fact that in many cases no significant differences were found could be a result of the measurement scale, which was used to provide continuity. Knowledge about CC has multiple evaluation dimensions and not all of them have the same effect on attitudes and/or behaviors towards mitigation. Given that the knowledge dimension featured here was not only focused on the causes but also on the manifestations of CC, important information might have been lost in the aim of establishing a stronger relationship. It is important to note that this situation does not imply that the used scale has measured knowledge incorrectly. On the contrary, Shi et al. (2016) recognize that CC is a complex phenomenon, which results from a function of multiple causes and presents various characteristics and consequences. Therefore, it is important to measure the perceptions of CC transversely.

6. Study limitations

The methodology used for this study assumes that students accurately reflect their perceptions and behaviors. However, there is no certainty of their actual behaviors. In order to examine a correlation between the real and stated behavior of a certain population, long-term observations become necessary. Given the large sample size, time and financial limitations, and the high amount of required permits, it was not possible to adopt such approach in the methodology. The above indicates that there may be an important difference between what students say they do and what they actually do: correlations between the analyzed dimensions may suffer some variability when taking into account the actual behaviors. However, literature is not homogeneous in relation to this issue. Corral-Verdugo and Figueredo (1999) and Kormos and Gifford (2014) suggest that results based on information declared by a study population may have high levels of validity in terms of predicting real behavior. Other researchers, such as Fuj et al. (1985) and Sheeran (2002), argue that these types of measurements explain a minimum percentage and may have inherent distortions in the process of explaining such behavior.

7. Conclusions

This study examined the relationships of four psychological dimensions on PEBs of higher education students from two developing countries, Colombia and Nicaragua. This investigation responds to the tendency towards decentralization of global governance in environmental issues, in which more cost-efficient strategies and policies are needed. Therefore, this work is a contribution to creating empirical evidence for multiple authorities and decision-makers and helps in assessing the capacity of the civil society to contribute to the fight against CC, and thus provides valuable inputs for the design of more effective and efficient environmental initiatives.

By comparing countries with different cultural contexts and political systems, this study provides strong evidence that CC knowledge, trust in sources of environmental information, self-efficacy and environmental attitudes are important predictors of PEBs in a developing country's population.

Our literature review revealed an increasing preponderance of the topic, with studies being conducted around the globe. In Latin America, a constant rise of such studies was observed, appearing largely in South American countries, while in the Central American region they were conducted rather sporadically. Yet, findings remain obscure. Therefore, our study contributes to expanding the body of knowledge for the region and provides a point of comparison for further research within the region and across other cultures.

Our results highlight the importance of the scientific community and activists of generating and communicating information on CC for guiding public concerns towards appropriate environmental behavior, and suggest that efforts should focus on teaching and communicating CC, emphasizing on the potential impact of private and collective action, establishing trust in institutions and reducing an anthropocentric vision of the world. This, in turn, can help people and policy makers to better address the risks and consequences of CC, and thus gain support in the construction and implementation of effective adaptation and mitigation policies and plans.

It should be noted that the relationships found in this study are dynamic and can vary as personal values, educational processes or exposure to CC alter. What is not in doubt is that these changes are strongly dependent on the effectiveness of public policy and its congruency with the specific realities of a target population. Thus, promoting a continuous measurement of the analyzed variables will help to improve policy design and communication strategies over time.

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1 Appendices

2 Appendix A. Frequency and mean distribution of the knowledge of Climate Change

| Statements | Nicaragua | | | | | | | Colombia | | | | | | | | |
|---|-----------|------|---------|---------|---------|---------|---------|----------|--------|------|--------|-------|-------|-------|--------|------|
| | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom |
| Carbon dioxide in the atmosphere contributes to the global greenhouse effect (True) | F | 943 | 4,77% | 3,29% | 15,27 % | 37,75 % | 38,92 % | 4,03 | F | 2263 | 2% | 2% | 7% | 31% | 58% | 4,41 |
| | M | 1189 | 6,98% | 3,62% | 10,01 % | 31,71 % | 47,69 % | 4,10 | M | 2322 | 3% | 2% | 6% | 28% | 61% | 4,43 |
| Violent volcanic eruptions have effect on global climate (True) | F | 1009 | 4,36% | 8,13% | 15,26 % | 46,09 % | 26,16 % | 3,82 | F | 2198 | 4% | 10% | 19% | 36% | 31% | 3,80 |
| | M | 1220 | 5,49% | 8,11% | 18,28 % | 39,84 % | 28,28 % | 3,77 | M | 2237 | 5% | 9% | 19% | 35% | 33% | 3,82 |
| Burning of fossil fuels, especially coal, will enhance the greenhouse effect (True) | F | 968 | 5,17% | 5,68% | 10,33 % | 36,88 % | 41,94 % | 4,05 | F | 2303 | 2% | 1% | 5% | 30% | 62% | 4,49 |
| | M | 1216 | 5,84% | 3,78% | 9,54% | 30,92 % | 49,92 % | 4,15 | M | 2347 | 3% | 1% | 5% | 28% | 62% | 4,46 |
| If global warming occurs, it will probably have little impact on agriculture and fishing activities in central America (False)) | F | 980 | 25,61 % | 13,67 % | 10,20 % | 22,65 % | 27,86 % | 3,13 | F | 2299 | 56% | 16% | 5% | 11% | 12% | 2,07 |
| | M | 1215 | 28,64 % | 16,05 % | 9,88% | 20,25 % | 25,19 % | 2,97 | M | 2324 | 51% | 17% | 7% | 12% | 13% | 2,19 |
| Nuclear energy production contributes to global warming intensification (False) | F | 939 | 4,37% | 6,18% | 18,96 % | 41,96 % | 28,54 % | 3,84 | F | 2086 | 5% | 6% | 19% | 34% | 36% | 3,90 |
| | M | 1188 | 7,74% | 7,07% | 21,46 % | 31,99 % | 31,73 % | 3,73 | M | 2118 | 9% | 12% | 23% | 29% | 27% | 3,53 |
| Without clouds and water vapor in the atmosphere, the earth is endangered (True) | F | 913 | 18,29 % | 21,58 % | 22,45 % | 24,10 % | 13,58 % | 2,93 | F | 1924 | 28% | 22% | 21% | 16% | 13% | 2,64 |
| | M | 1153 | 25,24 % | 23,24 % | 20,99 % | 15,87 % | 14,66 % | 2,71 | M | 2084 | 36% | 21% | 16% | 14% | 13% | 2,47 |
| Without the ozone layer in the atmosphere, life on earth is endangered (True) | F | 1007 | 6,16% | 2,09% | 3,57% | 19,66 % | 68,52 % | 4,42 | F | 2309 | 3% | 1% | 2% | 15% | 80% | 4,69 |
| | M | 1230 | 6,59% | 2,44% | 2,76% | 15,85 % | 72,36 % | 4,45 | M | 2319 | 4% | 1% | 2% | 13% | 80% | 4,63 |
| Large amounts of ozone gas in the atmosphere increases ultraviolet radiation on the earth's surface (True) | F | 892 | 16,14 % | 12,67 % | 19,39 % | 27,24 % | 24,55 % | 3,31 | F | 1926 | 30% | 18% | 16% | 17% | 19% | 2,77 |
| | M | 1169 | 24,21 % | 18,99 % | 20,02 % | 17,88 % | 18,91 % | 2,88 | M | 2056 | 41% | 18% | 14% | 14% | 13% | 2,41 |
| Chlorofluorocarbons (CFCs) are the most serious threat to the ozone layer (True) | F | 713 | 3,79% | 6,31% | 37,45 % | 31,42 % | 21,04 % | 3,60 | F | 1489 | 2% | 4% | 26% | 34% | 34% | 3,92 |
| | M | 948 | 4,64% | 5,27% | 36,08 % | 28,48 % | 25,53 % | 3,65 | M | 1584 | 3% | 5% | 27% | 31% | 35% | 3,90 |
| | F | 993 | 4,73% | 2,62% | 6,04% | 28,40 % | 58,21 % | 4,33 | F | 2275 | 2% | 2% | 4% | 22% | 69% | 4,54 |

| | | | | | | | | | | | | | | | | |
|--|---|------|---------|---------|---------|---------|---------|------|---|------|-----|-----|-----|-----|-----|------|
| The reduction of the ozone layer contributes to the increase of global warming (True) | M | 1219 | 5,58% | 2,54% | 5,09% | 26,83 % | 59,97 % | 4,33 | M | 2306 | 3% | 3% | 5% | 22% | 66% | 4,45 |
| The felling of tropical forests intensifies the global greenhouse effect (True) | F | 952 | 3,89% | 3,68% | 8,51% | 29,83 % | 54,10 % | 4,27 | F | 2291 | 2% | 2% | 6% | 23% | 67% | 4,51 |
| | M | 1205 | 6,14% | 3,82% | 6,80% | 26,47 % | 56,68 % | 4,28 | M | 2300 | 2% | 3% | 5% | 26% | 64% | 4,46 |
| Nicaragua/Colombia is one of the world's largest producer of greenhouse gases (False) | F | 847 | 20,31 % | 26,92 % | 31,05 % | 14,05 % | 7,67% | 2,62 | F | 1893 | 18% | 32% | 35% | 11% | 5% | 2,55 |
| | M | 1146 | 30,45 % | 27,92 % | 25,74 % | 10,12 % | 5,76% | 2,33 | M | 2045 | 26% | 32% | 28% | 9% | 4% | 2,33 |
| With the use of renewable energy (solar and wind), global warming will intensify (False) | F | 967 | 37,95 % | 26,99 % | 14,27 % | 12,82 % | 7,96% | 2,26 | F | 2271 | 64% | 23% | 6% | 4% | 4% | 1,60 |
| | M | 1222 | 50,00 % | 22,83 % | 11,70 % | 8,59% | 6,87% | 2,00 | M | 2327 | 69% | 17% | 6% | 3% | 4% | 1,55 |
| Greater exposure to ultraviolet radiation generally increases the risk of contracting skin cancer and developing cataracts of the eye (True) | F | 1028 | 5,64% | 1,26% | 4,18% | 25,68 % | 63,13 % | 4,40 | F | 2310 | 2% | 1% | 4% | 23% | 71% | 4,61 |
| | M | 1242 | 5,07% | 2,25% | 3,46% | 29,15 % | 60,06 % | 4,37 | M | 2314 | 2% | 2% | 3% | 23% | 70% | 4,56 |
| Scientists have found sufficient evidence to affirm that in Nicaragua atmospheric ozone levels are being reduced (False) | F | 751 | 7,06% | 12,12 % | 47,27 % | 23,04 % | 10,52 % | 3,18 | F | 1413 | 6% | 14% | 44% | 25% | 12% | 3,22 |
| | M | 1032 | 8,24% | 12,21 % | 46,90 % | 23,06 % | 9,59% | 3,14 | M | 1490 | 7% | 11% | 46% | 25% | 10% | 3,19 |
| Industry is the sector that produces the most greenhouse gas emissions worldwide (False) | F | 924 | 3,46% | 4,65% | 15,26 % | 34,52 % | 42,10 % | 4,07 | F | 2251 | 2% | 4% | 11% | 35% | 49% | 4,24 |
| | M | 1180 | 5,34% | 4,49% | 12,97 % | 32,37 % | 44,83 % | 4,07 | M | 2264 | 4% | 5% | 11% | 32% | 48% | 4,15 |

Note: F=Female, M=Male, SD= Strongly Disagree, D=Disagree, N= Neutral, A= Agree SA= Strongly Agree

4 Appendix B. Frequency and mean distribution of self-efficacy in Nicaragua and Colombia

| Statements | Nicaragua | | | | | | | Colombia | | | | | | | | |
|---|-----------|------|--------|-------|---------|---------|---------|----------|--------|------|--------|-------|-------|-------|--------|------|
| | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom |
| I consider that individual actions have an influence on global warming and climate change | F | 1020 | 5,20% | 3,92% | 10,78 % | 31,47 % | 48,53 % | 4,15 | F | 2340 | 1% | 2% | 8% | 28% | 60% | 4,44 |
| | M | 1239 | 6,05% | 4,52% | 14,04 % | 34,38 % | 40,92 % | 4,00 | M | 2347 | 3% | 3% | 11% | 32% | 51% | 4,26 |
| My actions to reduce the effects of global warming and climate change will encourage others to reduce their relevant effects in the community | F | 1015 | 4,14% | 6,01% | 22,86 % | 34,68 % | 32,32 % | 3,85 | F | 2334 | 2% | 6% | 23% | 35% | 34% | 3,93 |
| | M | 1235 | 6,56% | 7,85% | 22,02 % | 33,44 % | 30,04 % | 3,73 | M | 2344 | 4% | 7% | 22% | 34% | 32% | 3,82 |
| In my opinion, humans are the main responsible of global warming and climate change | F | 1018 | 4,32% | 1,96% | 4,62% | 20,24 % | 68,86 % | 4,47 | F | 2339 | 2% | 2% | 5% | 21% | 71% | 4,58 |
| | M | 1241 | 4,19% | 2,34% | 4,67% | 17,73 % | 70,91 % | 4,50 | M | 2351 | 3% | 3% | 6% | 20% | 68% | 4,48 |
| I try create awareness of the risk of global warming | F | 964 | 5,39% | 5,08% | 26,24 % | 37,66 % | 25,62 % | 3,73 | F | 2304 | 3% | 5% | 23% | 37% | 33% | 3,92 |
| | M | 1192 | 6,04% | 5,87% | 29,70 % | 35,82 % | 22,48 % | 3,63 | M | 2315 | 5% | 7% | 27% | 35% | 26% | 3,69 |

Note: F=Female, M=Male, SD= Strongly Disagree, D=Disagree, N= Neutral, A= Agree SA= Strongly Agree

5

6

7 Appendix C. Frequency and mean distribution of trust in informational resources in Nicaragua and Colombia

| Statements | Nicaragua | | | | | | | Colombia | | | | | | | | |
|---|-----------|------|---------|---------|---------|---------|---------|----------|--------|------|--------|-------|-------|-------|--------|------|
| | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom | Gender | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom |
| I trust the information the government provides on climate change | F | 988 | 14,37 % | 21,05 % | 33,91 % | 23,18 % | 7,49% | 2,88 | F | 2323 | 20% | 27% | 36% | 14% | 3% | 2,53 |
| | M | 1221 | 17,20 % | 20,15 % | 29,98 % | 22,85 % | 9,83% | 2,88 | M | 2333 | 23% | 25% | 31% | 17% | 5% | 2,56 |
| I trust the information the non-governmental agencies provide on climate change | F | 988 | 5,36% | 9,62% | 32,49 % | 35,73 % | 16,80 % | 3,49 | F | 2325 | 6% | 10% | 29% | 38% | 16% | 3,47 |
| | M | 1221 | 7,86% | 9,66% | 30,30 % | 35,05 % | 17,12 % | 3,44 | M | 2320 | 7% | 11% | 27% | 37% | 19% | 3,49 |
| I trust the information provided for scientific community on climate change | F | 998 | 3,71% | 6,91% | 22,14 % | 41,28 % | 25,95 % | 3,79 | F | 2336 | 3% | 4% | 13% | 39% | 41% | 4,13 |
| | M | 1220 | 5,25% | 5,66% | 20,08 % | 41,39 % | 27,62 % | 3,80 | M | 2345 | 3% | 4% | 13% | 38% | 42% | 4,13 |
| I trust information provided for Nicaraguan/Colombian educational institutions on climate change | F | 993 | 5,04% | 8,86% | 31,52 % | 38,77 % | 15,81 % | 3,51 | F | 2332 | 5% | 10% | 32% | 38% | 14% | 3,46 |
| | M | 1230 | 7,80% | 8,70% | 28,37 % | 36,26 % | 18,86 % | 3,50 | M | 2345 | 6% | 10% | 29% | 38% | 18% | 3,52 |
| In my opinion, the average Nicaraguan/Colombian is aware of causes and effects of global warming and climate change | F | 995 | 12,56 % | 20,50 % | 21,71 % | 27,24 % | 17,99 % | 3,18 | F | 2303 | 21% | 35% | 21% | 17% | 6% | 2,52 |
| | M | 1218 | 16,01 % | 21,76 % | 20,44 % | 24,96 % | 16,83 % | 3,05 | M | 2309 | 22% | 34% | 20% | 17% | 8% | 2,54 |
| In my opinion, the groups of defense of the environment have correct information on global warming and climate change | F | 971 | 4,63% | 8,65% | 32,44 % | 36,77 % | 17,51 % | 3,54 | F | 2218 | 3% | 8% | 34% | 40% | 15% | 3,55 |
| | M | 1193 | 6,71% | 9,22% | 28,67 % | 36,55 % | 18,86 % | 3,52 | M | 2232 | 4% | 9% | 32% | 38% | 18% | 3,57 |

Note: F=Female, M=Male, SD= Strongly Disagree, D=Disagree, N= Neutral, A= Agree SA= Strongly Agree

9 Appendix D. Frequency and mean distribution of perceived pro-environmental behaviors in Nicaragua and Colombia

| Statements | Gender | Nicaragua | | | | | | Colombia | | | | | | | | |
|--|--------|-----------|--------|--------|--------|--------|--------|----------|---|--------|-------|-------|-------|--------|------|------|
| | | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom | n | SD (1) | D (2) | N (3) | A (4) | SA (5) | Prom | |
| While I brush my teeth's I do not let the water run | F | 1023 | 4,11% | 3,23% | 4,69% | 27,37% | 60,61% | 4,37 | F | 2347 | 2% | 1% | 3% | 15% | 79% | 4,69 |
| | M | 1243 | 5,39% | 5,07% | 7,16% | 23,73% | 58,57% | 4,25 | M | 2351 | 2% | 2% | 5% | 18% | 73% | 4,57 |
| When I leave a room I turn off the lights | F | 1027 | 3,60% | 3,80% | 9,54% | 28,53% | 54,53% | 4,27 | F | 2351 | 1% | 2% | 6% | 24% | 66% | 4,51 |
| | M | 1241 | 4,75% | 4,67% | 9,19% | 28,04% | 53,26% | 4,21 | M | 2357 | 2% | 2% | 9% | 25% | 61% | 4,41 |
| When I leave the house I turn off the fan and/or the air conditioner | F | 984 | 4,47% | 2,74% | 5,79% | 24,90% | 62,09% | 4,37 | F | 2090 | 2% | 1% | 2% | 10% | 85% | 4,76 |
| | M | 1191 | 3,86% | 3,36% | 8,31% | 24,35% | 60,03% | 4,34 | M | 2135 | 3% | 1% | 4% | 14% | 78% | 4,63 |
| My fan/air conditioner is on every day for a long time | F | 941 | 32,73% | 19,77% | 19,34% | 14,35% | 13,82% | 2,57 | F | 2041 | 70% | 12% | 7% | 5% | 7% | 1,67 |
| | M | 1162 | 31,33% | 21,43% | 18,67% | 15,23% | 13,34% | 2,58 | M | 2084 | 60% | 17% | 9% | 7% | 8% | 1,87 |
| I take short showers to reduce water consumption in my home | F | 1011 | 10,19% | 12,46% | 23,05% | 27,79% | 26,51% | 3,48 | F | 2345 | 5% | 10% | 25% | 25% | 35% | 3,76 |
| | M | 1224 | 11,85% | 11,60% | 21,73% | 26,14% | 28,59% | 3,48 | M | 2355 | 7% | 10% | 22% | 27% | 33% | 3,69 |
| I do not waste food | F | 1012 | 7,11% | 9,09% | 21,64% | 28,36% | 33,79% | 3,73 | F | 2346 | 3% | 7% | 20% | 33% | 37% | 3,94 |
| | M | 1237 | 6,95% | 7,44% | 16,25% | 26,84% | 42,44% | 3,91 | M | 2347 | 4% | 5% | 16% | 27% | 48% | 4,09 |
| If I see someone throwing garbage in the street I tell him he should not do it | F | 995 | 8,74% | 11,26% | 27,94% | 23,12% | 28,94% | 3,52 | F | 2304 | 8% | 12% | 29% | 26% | 25% | 3,48 |
| | M | 1214 | 12,60% | 14,66% | 26,85% | 22,82% | 23,06% | 3,29 | M | 2321 | 13% | 14% | 33% | 22% | 18% | 3,19 |
| I turn off the TV or computer when I'm not using them | F | 1015 | 6,21% | 5,62% | 11,03% | 26,60% | 50,54% | 4,10 | F | 2345 | 3% | 6% | 12% | 26% | 53% | 4,21 |
| | M | 1227 | 7,74% | 6,36% | 13,20% | 26,41% | 46,21% | 3,97 | M | 2348 | 5% | 8% | 15% | 28% | 44% | 3,98 |
| I use the same item of clothing more than once week before washing it to reduce water consumption in my home | F | 1014 | 17,16% | 13,71% | 16,86% | 23,77% | 28,50% | 3,33 | F | 2346 | 9% | 8% | 14% | 26% | 44% | 3,89 |
| | M | 1234 | 14,75% | 12,32% | 15,15% | 26,18% | 31,60% | 3,48 | M | 2359 | 9% | 8% | 15% | 31% | 38% | 3,80 |
| I separate the garbage in my home | F | 1013 | 21,03% | 22,21% | 20,93% | 19,55% | 16,19% | 2,90 | F | 2329 | 19% | 19% | 20% | 19% | 22% | 3,05 |
| | M | 1229 | 21,48% | 20,34% | 20,91% | 20,18% | 17,01% | 2,91 | M | 2341 | 21% | 20% | 23% | 18% | 18% | 2,91 |
| I avoid using private transportation to reduce pollution | F | 915 | 20,00% | 15,96% | 23,61% | 18,47% | 21,97% | 3,06 | F | 2002 | 17% | 14% | 19% | 18% | 32% | 3,35 |
| | M | 1135 | 19,91% | 14,19% | 24,85% | 17,09% | 23,96% | 3,11 | M | 2080 | 19% | 14% | 19% | 18% | 30% | 3,24 |

| | | | | | | | | | | | | | | | | |
|--|---|------|---------|---------|---------|---------|---------|------|---|------|-----|-----|-----|-----|-----|------|
| I use bicycle and/or road to avoid contamination when transporting | F | 945 | 20,74 % | 14,71 % | 22,86 % | 18,84 % | 22,86 % | 3,08 | F | 2242 | 21% | 16% | 21% | 18% | 25% | 3,11 |
| | M | 1200 | 19,08 % | 12,83 % | 20,83 % | 19,75 % | 27,50 % | 3,24 | M | 2281 | 17% | 13% | 20% | 19% | 31% | 3,34 |
| I'm willing to travel less frequently to reduce my impact on the environment | F | 962 | 12,68 % | 11,85 % | 32,22 % | 23,28 % | 19,96 % | 3,26 | F | 2243 | 13% | 16% | 33% | 19% | 19% | 3,14 |
| | M | 1201 | 14,57 % | 13,57 % | 28,23 % | 23,06 % | 20,57 % | 3,21 | M | 2299 | 15% | 13% | 31% | 21% | 21% | 3,18 |
| I'm willing to change my diet to reduce my impact on the environment | F | 976 | 13,22 % | 9,02% | 25,82 % | 26,95 % | 25,00 % | 3,41 | F | 2308 | 9% | 10% | 25% | 28% | 28% | 3,57 |
| | M | 1203 | 15,30 % | 12,80 % | 29,59 % | 21,95 % | 20,37 % | 3,19 | M | 2303 | 14% | 13% | 27% | 24% | 22% | 3,26 |

Note: F=Female, M=Male, SD= Strongly Disagree, D=Disagree, N= Neutral, A= Agree SA= Strongly Agree

11 Appendix E. Frequency and mean distribution of the NEP scale in Nicaragua and Colombia

| Statements | Nicaragua | | | | | | | Colombia | | | | | | | | |
|---|-----------|------|---------|---------|---------|---------|---------|----------|--------|------|---------|--------|-------|--------|---------|------|
| | Género | n | TED (1) | ED (2) | N (3) | DA (4) | TDA (5) | Prom | Género | n | TED (1) | ED (2) | N (3) | DA (4) | TDA (5) | Prom |
| In order to survive, humans must live in harmony with nature | F | 1029 | 3,50% | 2,04% | 5,64% | 21,28 % | 67,54 % | 4,47 | F | 2345 | 1% | 2% | 6% | 24% | 67% | 4,53 |
| | M | 1243 | 4,51% | 2,09% | 6,19% | 22,04 % | 65,08 % | 4,41 | M | 2351 | 2% | 2% | 7% | 26% | 62% | 4,43 |
| Human intervention in nature often produces disastrous results | F | 1011 | 3,36% | 1,48% | 6,82% | 30,07 % | 58,26 % | 4,38 | F | 2343 | 2% | 2% | 7% | 27% | 63% | 4,47 |
| | M | 1234 | 4,21% | 3,00% | 10,29 % | 28,61 % | 53,81 % | 4,25 | M | 2353 | 2% | 2% | 11% | 31% | 54% | 4,32 |
| To maintain a healthy economy, it requires a developing economy where industrial growth is controlled | F | 1001 | 2,90% | 2,30% | 12,59 % | 32,57 % | 49,65 % | 4,24 | F | 2319 | 2% | 2% | 15% | 32% | 49% | 4,25 |
| | M | 1217 | 4,60% | 4,11% | 15,28 % | 34,02 % | 41,91 % | 4,05 | M | 2321 | 3% | 4% | 15% | 35% | 43% | 4,10 |
| Humans are severely abusing the environment | F | 1024 | 3,32% | 1,56% | 4,69% | 20,61 % | 69,82 % | 4,52 | F | 2340 | 2% | 1% | 2% | 15% | 80% | 4,73 |
| | M | 1229 | 3,58% | 3,01% | 4,31% | 19,77 % | 69,32 % | 4,48 | M | 2352 | 1% | 1% | 4% | 22% | 72% | 4,62 |
| The earth is like a spaceship with very limited room and resources | F | 988 | 5,87% | 5,67% | 16,50 % | 29,05 % | 42,91 % | 3,97 | F | 2319 | 4% | 5% | 11% | 25% | 54% | 4,19 |
| | M | 1203 | 6,23% | 6,15% | 14,46 % | 26,10 % | 47,05 % | 4,02 | M | 2324 | 4% | 4% | 12% | 29% | 50% | 4,16 |
| The primary purpose of the creation of plants and animals is to satisfy human needs | F | 979 | 21,76 % | 19,00 % | 24,92 % | 18,79 % | 15,53 % | 2,87 | F | 2321 | 43% | 24% | 17% | 10% | 8% | 2,16 |
| | M | 1199 | 22,35 % | 17,18 % | 23,69 % | 19,68 % | 17,10 % | 2,92 | M | 2335 | 36% | 22% | 21% | 12% | 9% | 2,38 |
| We are reaching the stage where the earth cannot meet the needs of the population anymore | F | 1005 | 3,58% | 1,99% | 9,25% | 29,45 % | 55,72 % | 4,32 | F | 2340 | 3% | 3% | 7% | 27% | 61% | 4,42 |
| | M | 1230 | 6,10% | 3,74% | 9,67% | 27,32 % | 53,17 % | 4,18 | M | 2337 | 3% | 4% | 9% | 31% | 53% | 4,28 |
| The growth of societies is limited by the natural characteristics of the environment | F | 958 | 6,05% | 6,78% | 24,84 % | 29,02 % | 33,30 % | 3,77 | F | 2251 | 10% | 11% | 23% | 24% | 33% | 3,60 |
| | M | 1195 | 9,37% | 7,70% | 23,51 % | 28,12 % | 31,30 % | 3,64 | M | 2285 | 8% | 10% | 19% | 30% | 33% | 3,70 |

Note: F=Female, M=Male, SD= Strongly Disagree, D=Disagree, N= Neutral, A= Agree SA= Strongly Agree

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