

Assessing university student perceptions and comprehension of climate change (Portugal, Mexico and Mozambique)

Fernando Morgado, Paula Bacelar-Nicolau, Jaime Rendon von Osten, Paulo Santos, Leonor Bacelar-Nicolau, Harith Farooq, Fátima Alves, Amadeu M.V.M. Soares and Ulisses M. Azeiteiro
(*Author affiliations can be found at the end of the article*)

Abstract

Purpose – Higher education system has a critical role to play in educating environmentally aware and participant citizens about global climate change (CC). And, as shown by the 21st Conference of the Parties of the UN Convention on Climate Change – COP 21, held in Paris in December 2015, there is still a path to be followed regarding the role played by universities in the negotiations and in influencing decision-making on a matter of such global importance. The purpose of this first study conducted within Portuguese (Europe), Mexican (Spanish-speaking North America University) and Mozambican (Africa) universities is to investigate higher education system students' perceptions on CC.

Design/methodology/approach – The data were collected through a questionnaire aiming at characterising students from the socio-demography, and from their perceptions, motivations, attitudes and knowledge relating to the topic of CC. Statistical analysis was used to compare and characterise the three national groups under study.

Findings – This study did not show significant perception differences among the analysed subsamples, although there was a tendency for Mexican students to express lesser belief that CC was happening, and for Mozambicans to show a greater belief in CC issues and motivation to mitigate its effects which may be related to the specifics contexts. The results show that relevant differences among nationalities mostly concerned the magnitude of choices (e.g. most respondents of each nationality expressed interest in CC issues, but the magnitude of this expression differed according to nationality). The principal component analysis (second and third components) clearly embodied nationality profiles (discussed in the context of different cultures, educational structures and CC impacts).

Research limitations/implications – Further research is warranted to understand the integration of CC into higher education curriculum to improve and target educational efforts to suit students' needs.

Practical implications – How CC perceptions vary cross-nationally and how research studies that examine the integration of CC into higher education curriculum are areas for which more research is needed.

Originality/value – The results highlight the importance of socio-cultural dimensions of each country in relation to the understanding or perception of CC issues, namely, in what concerns aspects related with gender roles, age, active learning and citizenship. This study's data evidenced that despite the surveyed students being familiarized with CC phenomena, this knowledge does not translate necessarily into concrete mitigation practices and behaviours.

Keywords Perceptions, Mexico, Climate change, Portugal, Attitudes and behaviours, Mozambique

Paper type Research paper



1. Introduction

Climate change (CC) is a major issue of our time that has vast environmental, cultural and social-economic impacts. Over the past two decades, many studies have focused on the science behind climate systems. There is also a growing body of lived experiences associated with CC s, such as rising ocean level and surface temperatures and increasing variability in extreme climate episodes. Humanity is called to become aware of the urgent need to understand the causes of CC and deal with its consequences, requiring profound changes in lifestyles, production and consumption (Giddens, 2009).

There is still much public debate and uncertainty regarding the reality of CC and the degree to which human activities are responsible, but CC is a global problem and we are educating a “climate change generation” (Feldman *et al.*, 2010). Thus, higher education has a critical role to play in educating university students (Wachholz *et al.*, 2014; Santos *et al.*, 2016) and in educating environmentally aware and participant citizens about global CC. Many universities across the world perform state-of-the-art research on CC matters (e.g. mitigation and adaptation). Yet, as shown by the latest 21st Conference of the Parties of the UN Convention on Climate Change (COP 21), held in Paris in December 2015, there is a path to be followed regarding the role played by universities in the negotiations and in influencing decision-making on a matter of such a global importance. So far, few studies have focused on higher education students’ knowledge and attitudes about this issue (Santos *et al.*, 2016). CC is a matter of global concern, being a significant challenge facing society today and becoming a central issue to the society (Leal Filho *et al.*, 2016), and specific sectors such as universities need to engage and be active in the search for regional and local solutions for what is a global problem (Leal Filho, 2010).

As stated by Adger *et al.* (2013), society’s response to every dimension of global CC is mediated by culture. Most individuals relate to CC through personal experience, highlighting what people know, think and believe (Lorenzoni and Pidgeon, 2006). The study of CC perceptions across cultural, political, economic, social, educational and geographical areas (demographic and regional differences) should offer more detailed insights into the effectiveness of different educational and communication strategies.

Higher education institutions (HEIs) must be called to adapt curricula, general teaching and evaluation approaches to foster a desirable growing of the willingness-to-change behaviour related to CC and its impacts on the environment and socio-environmental and climate governance (Santos *et al.*, 2016). Universities must be able to integrate the need of this interdisciplinary vision and develop a critical role to prepare society to adapt to the impacts of climate disruption by providing intercultural research and education on adaptation strategies.

The purpose of this study was to investigate HEI students’ perceptions of CC and global warming (GW). This is the first study conducted within Portuguese (Europe), Mexican (Spanish-speaking North American University) and Mozambican (Africa) universities, and the results in this context should have meaningful implications for both national and international future CC policies, as well as university curricula adaptation to students’ perceptions (Jamelske *et al.*, 2013; Santos *et al.*, 2016).

Africa is the continent most vulnerable to the impacts of CC, because of increases in both droughts and floods, the epidemic potential of many infectious diseases and low capacity of nations and communities to adapt to CC (Boko *et al.*, 2007; Patt *et al.*, 2010). Regular, predictable rainfall is particularly critical in Africa because many countries are highly dependent on rain-fed agriculture. In the African continent, farmers’ perceptions about CC have been largely studied (Hameso, 2014; Osbahr *et al.*, 2011; Deressa

et al., 2009), and the same for Southern, Central America and Spanish-speaking North America-Mexico (Valdivia *et al.*, 2010; Márdero *et al.*, 2014), where CC impacts and adaptation (Peterson *et al.*, 2002; Aparicio-Effen *et al.*, 2016a, 2016b; Nagy *et al.*, 2016) and mitigation issues are known. Few studies focused on university student perceptions (e.g. health students from Ethiopia; Nigatu *et al.*, 2014).

Regarding the herein studied nationalities, Patt and Schroter (2008) reported on Mozambican CC perceptions and Sánchez-Cortés and Chavero (2011) and Márdero *et al.* (2014) analysed Mexico's CC perceptions. No references were found about HEI student perceptions and comprehension of CC science in those countries. In Portugal, the first study was published by Santos *et al.* (2016).

2. Research methodology

2.1 Surveyed institutions and courses

Research was conducted at two European Public Universities (Portuguese Universities of Porto and Aberta), one Spanish-speaking North American University (from the Institute EPOMEX of the Autonomous University of Campeche, Mexico) and one African university (Lúrio University, Pemba, Mozambique). The survey was applied to students of four Master degrees in the areas of Ecology, Coastal and Marine Management, Biodiversity and Natural Resources, Environmental Citizenship and Participation and Sustainability.

The Master in Ecology, Environment and Territory, at Porto University, is aimed at acquisition of knowledge to understand the biological aspects that are essential to the applied fields of ecology and biodiversity, landscape ecology and planning, environmental education and nature tourism, technology of environmental management and environmental characterisation, monitoring and recovery. Also at Porto University, the Master in Biological Aquatic Resources is a post-graduation designed for the management, sustainable exploitation and preservation of the aquatic ecosystem. The two programmes are full-time, daytime attendance degrees with 120 ECTS (European Credit Transfer System) and the duration of two years.

The multidisciplinary Master in Coastal and Marine Management, from the Institute EPOMEX of the Autonomous University of Campeche, Mexico, aims to develop manpower with high scientific and analytical capacity about concept, methodologies and tools for the analysis and management of coastal and marine problems with emphasis on local, regional and national views. It is intended also that the student knows the essentials of the coastal management, to be able to study and develop sustainable activities related to fisheries, aquaculture and human activities and problems on coastal and marine pollution using broad techniques including GIS (geographic information system). The manpower formed is trained to apply their skills in the academic and government areas. The programme is full-time, daytime attendance degree with 120 ECTS and of two years' duration: the first year is dedicated to the curricular units (60 ECTS), and the second year is dedicated to the planning, developing, writing and defending of the dissertation/project (60 ECTS).

The Master Program in Ecology of the Lúrio University, Pemba, Mozambique, aims to provide a thorough and specialized understanding of key ecological processes, issues and management of biodiversity loss, as well as its importance, including the interactions between the different components, both biotic and abiotic, and terrestrial and tropical ecosystems. It is intended also that the student knows the essentials of the proper functioning of individuals' physiological mechanisms and feedback mechanisms involved, to be able to recognize and interpret the biodiversity present in different types of ecosystems, the major adaptations of organisms to life in these ecosystems and the main threats to the maintenance of biodiversity. These programmes are full-time, daytime

attendance degrees with 120 ECTS and of two years' duration: the first year is dedicated to the curricular units (60 ECTS) and the second year is dedicated to the planning, developing, writing and defending of the dissertation/project (60 ECTS).

Finally, Master in Environmental Citizenship and Participation, offered at the Portuguese Distance Learning University, is designed to prepare individuals to work in environmental policy-making, as well as to improve their environmental citizenship, participation and planning abilities (e.g. individuals working within government, environmental advisors, members of environmental NGOs, teachers, researchers and individuals involved in environmental practices, policies, planning, training, participation and citizenship). It is taught in an e-learning regime, and the pedagogical model underlying the learning process was developed specifically for e-learning second-cycle degrees at the Universidade Aberta (UAb) ([Azeiteiro et al. 2015](#); [Bacelar-Nicolau et al., 2009](#)): the first year is dedicated to the curricular units (60 ECTS) and the second year is dedicated to the planning, developing, writing and defending of the dissertation/project (40 ECTS) (a total of 100 ECTS and three semesters).

2.2 Sample

The convenience samples including 40 Mexican, 40 Mozambican and 124 Portuguese students were recruited online through email invitation. The invitation to participate in the study included a short presentation of the study, its aims, responsible researchers and universities to assure an informed consent from participants, followed by a link to the questionnaire itself. Response rates were 98, 85 and 57 per cent for Mexico, Mozambique and Portugal, respectively, corresponding to subsample sizes of 39, 34 and 71 respondents.

2.3 Questionnaire

The questionnaire was composed of 30 closed-ended questions and two open questions aiming at characterising students from the socio-demography and their perceptions, motivations, attitudes and knowledge relating to CC. The questionnaire was pre-tested among faculty students, not enrolled in its application, and the results were used to refine it. The time required for filling in the questionnaire was 10 min. The questionnaire was adapted from [Wachholz et al. \(2014\)](#) and [Manolas et al. \(2010\)](#). Google Drive was used to host the questionnaire and allow for the online survey. Students were assured that their responses will remain anonymous and they willingly participated in the survey.

The questionnaire was translated into Spanish by the Mexican co-author and adapted to Mozambican Portuguese language local specificities by the Mozambican co-author.

2.4 Statistical analysis

Three subsamples, corresponding to the three student groups of different nationalities (Portuguese, Mexican and Mozambican), were analysed and compared. Crosstabs by nationality were built for all survey questions, with observed counts, column percentages, adjusted residuals and pairwise comparisons of column percentages (with Bonferroni correction). Additionally, homogeneity chi-square tests or Fisher exact tests, were computed (the latter whenever more than 20 per cent of all cells presented expected values under 5). This analysis was complemented with chi-square measures of association contingency coefficient, Phi and Cramer's V (not presented here, as the results were coherent with the homogeneity chi-square tests and Fisher exact tests applied). A similar analysis, with results split by nationality, was used to analyse crosstabs by sex and by age, to check eventual biases from different sex and age distributions within each nationality. These results are mentioned in the results section, when characterising sub-samples.

Principal component analysis (PCA) was applied to variables where nationalities differed significantly according to the chi-square and Fisher exact tests. The use of this exploratory multivariate methodology aimed to attain a global view of the main characteristics that differentiated among the three nationalities under study.

Data were analysed using the IBM SPSS Statistics 21[®] software. A significance level of 5 per cent was used whenever statistical tests were applied.

3. Findings

3.1 Respondents characterisation

Sex. The majority of the Portuguese respondents were mostly male (61 per cent), while the opposite was observed for the Mozambique respondents (32 per cent male), and the Mexican respondents were nearly equally divided for sex (54 per cent male). Because Mozambicans had significantly different sex distribution than other nationalities, results were split by nationality and crossed by sex variable to identify the distinctive aspects. Only three issues raised significant sex differences among Mozambicans (one barely, with a borderline *p*-value of 0.047; see below).

Age. Regarding age, although the majority of the respondents were aged between 21 and 30 years, the magnitude of this proportion differed with respondents' nationality. Almost all Mozambican respondents fell into the younger age group (<21 years; 91 per cent). Mexican respondents were mostly, 62 per cent, aged 21 to 30 years, but 33 per cent were younger (<21 years). Inversely, most Portuguese respondents (79 per cent) were aged from 21 to 30 years, and 21 per cent were above 30 years.

Because Mexicans had a significantly different age distribution than other nationalities, the results were split by nationality and crossed by age groups to identify issues where responses were age-related, within Mexican respondents. Only two queried issues were significantly related to the age groups, among Mexican respondents: one concerning the study regime (i.e. working students or full-time students; see below) and the other the belief that "humankind may successfully mitigate CC effects" (see below). As for all other survey questions, age differences were not significant among Mexican respondents; this bias sample was not considered relevant for our study.

Study regime. Concerning the study regime "full-time students" vs "working-students", there were no clear significant differences among nationalities ($p = 0.05$), indicating a strong tendency for non-similitude): the wide majority of Mexican students were full-time students (85 per cent), while for Mozambicans and Portuguese students, the numbers were lower (59 and 69 per cent, respectively). The age distribution may have contributed to the observed differences.

3.2 Perceptions relating to CC and their impacts

Most respondents of all nationalities believed that CC was happening. Nevertheless, Mexican respondents were significantly less certain of its existence (82 per cent) compared with the Portuguese (98 per cent) and Mozambicans (100 per cent) (Table I).

In what concerns their interest in the topic, Mozambicans were significantly much more interested in CC (88 per cent answering "very much interest") than Mexican or Portuguese students (64 and 56 per cent, respectively). The perceived importance of the topic was also significantly different among the three nationalities: 66 per cent of Portuguese answered that they "perceived CC as a very important issue", while 82 per cent of Mozambican and 100 per cent of Mexican students expressed the same opinion. Regarding the level of concern with the topic of CC, although globally all students shared a similar degree of high concern with CC issues (45-59 per cent were "very much concerned"), Mexican respondents

Inquired topic	Answer alternatives	Mexican (%)	Mozambican (%)	Portuguese (%)
CC is happening?	Yes	82 (**)	100	99 (**)
	Not sure	18 (**)	0	1 (**)
The topic of CC has ...	Interest	64	88 (*)	56 (**)
	Some	31	12 (*)	44 (**)
	Little	5 (**)	0	0
	Importance	100 (**)	82	66 (**)
	Some	0 (**)	18	34 (**)
	Concern	59	56	45
	Some	31 (**)	44	54 (**)
	Little	10	0	1
Perception of CC impacts on ...	Human communities in one's country	72	82	76
	In 10 years	26	15	11
	Human communities in other's countries	74 (**)	88	92 (*)
	In 10 years	26 (**)	9	3 (**)
	Biotic communities in one's country	90	91	94
	In 10 years	5	9	3
	Biotic communities in other's countries	90	91	96
	In 10 years	10	6	1
Belief on human ability to mitigate CC	We can and we will	3 (*)	27 (**)	4 (**)
	We can but it's not clear if we'll succeed	49	38 (*)	59 (*)
	We can but people do not have the will	49 (*)	35	34
	We will not succeed	0	0	3

Notes: (**) statistically significant, see section Research Methodology; (*) statistically nearly significant, see section Research Methodology

Table I.
Climate change
perception and their
impact, by
nationality

expressed significantly less “somewhat concerned” (31 per cent) than Mozambican and Portuguese (44 and 54 per cent, respectively), and they also expressed significantly greater “little concern” (10 per cent) compared to others (0-1 per cent).

There was a generalised, and similar, perception that biotic communities were already being impacted by CC (90-96 per cent), irrespective of its location in the world. A considerable number of respondents also, similarly, perceived that CC impacts were already being felt in human communities in their own country (72-83 per cent), and much less perceived that CC would be felt in the next decade (1-10 per cent). The perception of CC impacts on human communities was greater concerning foreign countries than in one's country, being significantly higher among the Portuguese respondents (92 per cent) than Mozambican or Mexican respondents (88 and 74 per cent, respectively); in accord with these result, Mexican students perceived to a significantly greater extent that CC impacts would be felt in 10 years from now (26 per cent), compared to Mozambican (9 per cent) or Portuguese respondents (3 per cent).

Most students (72-85 per cent), similarly, expressed that “the scientific community assumed that CC was happening”, although a considerable proportion expressed that “there was much disagreement amongst the scientists relating to the subject” (12-24 per cent). Nearly all students (95 -100 per cent), regardless of nationality, also perceived that human activities were an important cause of CC.

When inquired on the capacity of humanity to mitigate CC, the vast majority of the respondents expressed that humans could mitigate effects of CC (97-100 per cent), although

only Mozambican were significantly more positive, 27 per cent expressing that “humans would manage successfully to mitigate the effect of CC” opposed to 4 per cent of Portuguese and 3 per cent of Mexican. Most respondents irrespective of their nationality expressed that “people did not have the will to change their behaviour to achieve mitigation” (34-48 per cent) or that “it was not clear if they would do what was necessary to achieve it” (38-59 per cent).

The collected perception data did not show significant differences among the analysed subsamples, although there was a tendency for Mexican students to express lesser belief in CC and a tendency for Mozambicans to show a greater positivism, hinting that Mexican respondents were less certain that CC was happening. However, this was not statistically significant and further studies are needed to confirm this trend.

Students’ sex did not significantly influence their perceptions of:

- time scale of CC impact (both on human and biotic communities);
- anthropogenic activities as a main cause of CC; or
- the will or possibility of humans to alter the course of CC.

Only one queried CC issue was significantly related to sex in the Mozambican subsample: almost all Mozambican women defended that scientists believed CC were happening (96 per cent), while this opinion was lower among Mozambican men (64 per cent).

As for the age factor, this only significantly influenced the perception relating to the capacity of humankind to successfully mitigate CC effects (although p -value = 0.045). The majority of the younger Mexican respondents (aged <21 years) expressed that humankind could successfully mitigate CC effects, but people are not willing to change their behaviour (77 per cent), while lesser respondents shared this opinion in the older age groups (38 per cent aged between 21 and 30 years and no one over 30 years).

3.3 Training and knowledge of CC

Regarding student’s academic training and their perception of its focus on CC issues, their opinions were not significantly different for the three nationalities. Most respondents (61-74 per cent), shared the opinion that their training “had focused enough on CC issues”, and some (21-31 per cent) felt that “it had not focused enough”. Still, a few Portuguese and Mexican respondents were not aware of having studied it during training (6-8 per cent), or they had not studied the topic in training “but had obtained their knowledge informally” (3-8 per cent). This aspect was also significantly influenced by gender in the Mozambican subsample, where the majority of Mozambican women declared their training focused enough on CC issues (87 per cent), while only 46 per cent of men expressed the same (Table II).

The self-perceived technical knowledge on CC, significantly differed among the respondents of different nationality. Most respondents (53-78 per cent) expressed they had a “moderate technical knowledge”, although Mozambicans perceived a significantly lower “moderate technical knowledge” (53 per cent) than Mexican or Portuguese (69 and 78 per cent, respectively), and a significantly greater “technical knowledge at professional level” (21 per cent), compared to Mexican or Portuguese students (5 and 1 per cent, respectively). “Minimum technical knowledge on CC” was perceived by few (3-5 per cent) and extended knowledge by some (17 - 24 per cent), regardless of nationality.

Concerning the “knowledge of how one’s actions/behaviours influence CC”, a greater proportion of respondents, from each subsample (38-80 per cent), also expressed having a moderate knowledge was significantly less for Mozambicans (38 per cent) than Portuguese

Dimension inquired	Inquired topic	Answer alternatives	Mexican (%)	Mozambican (%)	Portuguese (%)
Academic training and knowledge of CC	Technical knowledge on CC . . .	Minimum	5	3	4
		Moderate	69	53 (**)	78 (**)
		Extensive	21	24	17
	Knowledge of how one's actions influence CC	Professional-level	5	21 (**)	1 (**)
		Minimum	5	27 (**)	4 (**)
		Moderate	80 (**)	38 (**)	68
	Ever calculated your ecological footprint?	Extensive	0 (**)	29 (*)	27 (**)
		Professional-level	15 (**)	6	1 (**)
		No	80 (**)	53	49 (**)
	Need more information on CC?	Yes, in-training	0 (**)	41 (**)	17
		Yes, informally	18	0 (**)	27 (**)
		A lot more information	31 (**)	12	7 (**)
	“Hole in the ozone layer is a main cause of CC” . . .	More information	44	65 (**)	41
		A little more information	26	24	47 (**)
		No	0	0	6 (**)
Governance and actions to mitigate CC	Who should take main mitigation actions?	Is a true sentence	77 (**)	50	56
		Is a false sentence	23	50 (*)	37
		Do not know	0	0	7
	I would support measures to reduce greenhouse gas effect . . .	Governments	26 (**)	62	73 (**)
		Private companies	8	0	9
		Individuals	64 (**)	38	18 (**)
	Actions to mitigate CC	Yes	56	80 (**)	56
		No	13	18	13
		Not sure	31	3 (**)	31 (*)
	My contribution towards mitigating CC would . . .	I believe CC, but one's actions are not enough	39	50 (**)	13 (**)
		I believe CC, but haven't decided on the best actions	8	6 (*)	20 (**)
		I have decided, but not acted	10	18	13
		I took action, but they're difficult	18	12	23
		I took action	26	15	32
		Increase a lot my quality of life	44	80 (**)	25 (**)
		Increase a little my quality of life	41	12 (**)	39
		Have no impact in my quality of life	3 (**)	0 (**)	21 (**)
		decrease life quality	13	9	14

Notes: (**) statistically significant, see section Research Methodology; (*) statistically nearly significant, see section Research Methodology

Table II.
Academic training and knowledge of CC, and governance and actions to mitigate CC, by nationality

(68 per cent) or Mexican (80 per cent). “Extended knowledge of one’s behaviour effect on CC” was significantly higher for Portuguese and Mozambican respondents (27 and 29 per cent, respectively) than Mexican (0 per cent). Nevertheless, a significantly greater “knowledge at professional level” was reported by the Mexicans (15 per cent), than by Portuguese and Mozambicans (1 and 6 per cent). A “minimum knowledge on the effect of one’s behaviour on CC” was expressed to significantly higher level by Mozambican respondents (27 per cent) compared to others (4 and 5 per cent, respectively for Portuguese and Mexican).

Different opinions were found relating to the perceived need for more information on CC. Globally, the vast majority (95-100 per cent) felt they needed more information relating to CC. Among these, and in line with other results, Mexican students felt more information was needed (31, 44 and 26 per cent, respectively needed “much more”, “more” and a “little more information”), than Mozambican (12, 65 and 24 per cent, respectively, needed “much more”, “more” and a “little more information”) or than Portuguese (7, 41 and 6 per cent, respectively, needed “much more”, “more” and a “little more information”). Only among Portuguese, a small number (6 per cent) felt “no need for further information” on the subject.

Also, in what concerns their ecological footprint, most students (49-80 per cent) had not estimated it, and among these, Mexican had estimated it significantly less (80 per cent) than Mozambican or Portuguese (53 and 49 per cent). Among the students who declared having calculated their ecological footprint, a significantly greater proportion of Mozambicans (41 per cent) had calculated it during training, opposed to Mexicans and Portuguese (0 and 17 per cent, respectively). On the other hand, no Mozambican had calculated the ecological footprint outside training (0 per cent), opposed to a significantly greater proportion of Portuguese (27 per cent) and Mexican respondents (18 per cent). A low proportion, regardless of nationality (3-7 per cent) was not aware of having, or not, calculated it.

When asked about the effect of the hole in the ozone layer on CC, a significantly lower proportion (23 per cent) of Mexican respondents correctly acknowledged that this was not a main cause of CC, compared to Mozambican (50 per cent) and Portuguese (37 per cent). Only among the Portuguese subsample, 7 per cent individuals (significantly) expressed not knowing whether the hole in the ozone layer was a cause of CC, opposed to other nationalities (0 per cent).

3.4 Governance and actions to mitigate CC

Opinions on who should take the main actions in mitigating CC were strongly, and significantly, dependent on the respondents’ nationality, with most Portuguese and Mozambicans (73 and 62 per cent, respectively) sharing the opinion that this responsibility should lay upon governments, opposed to only 26 per cent of Mexican respondents who expressed the same opinion. On the other hand, significantly most Mexican (64 per cent) expressed that the responsibility to mitigate CC should lay upon individual’s, opposed to Portuguese and Mozambicans (18 and 38 per cent, respectively) (Table II).

Also, without an international agreement, e.g. Kyoto’s protocol successor, most students (52-69 per cent), regardless of nationality, felt there would be still a way to mitigate CC, although many felt that such an international agreement was essential (23-40 per cent) or they “did not have an opinion on the matter” (7-8 per cent).

Regarding the behaviour of the respondents’ relational communities, this was similarly perceived regardless of their nationality: most respondents (49-59 per cent) expressed that their relational communities acted partially to mitigate CC, and a considerable proportion (31-42 per cent) expressed that their relational community did not act to mitigate CC, and only a small number (6-9 per cent) perceived that they did so.

As individuals, even though they believed CC was happening, only 27 to 55 per cent had taken some action to mitigate CC (among these, 12-23 per cent considered the measures taken were difficult to implement); nationality of the respondents did not significantly affect these results. Hence, a considerable proportion of the respondents (45-74 per cent) had taken no action to mitigate CC. Among these, a significantly greater number (50 per cent) of Mozambicans expressed that the “they believed in CC, but the actions of a single individual would not change anything”, opposed to 13 per cent Portuguese who expressed the same opinion (and 39 per cent Mexican).

When inquired if they were to reduce their contribution to CC, Mozambicans expressed a significantly greater confidence (79 per cent) that their actions to mitigate CC would increase their life quality by a lot, opposed to Portuguese and Mexican respondents (25 and 44 per cent, respectively). On the other hand, a significantly greater proportion of Portuguese respondents (21 per cent) expressed that “their actions would not have any impact in their life quality”, opposed to Mexican (3 per cent) and Mozambican respondents (0 per cent).

As individuals, most of the respondents also expressed that they would support actions to reduce greenhouse gas emissions, including measures that implied, e.g., paying more for fuel and electric energy. Among these, Mozambicans expressed a significantly greater will to support these mitigation actions (79 per cent) than Portuguese or Mexican (56 per cent). Also, a significantly lower proportion of Mozambicans expressed less uncertainty in acting, i.e. only 3 per cent “were not sure/had no opinion on the matter”, opposed to 31 per cent of Portuguese or Mexican respondents.

Again, as in most other issues assessed in the questionnaire, the respondents’ gender did not significantly affect the responses in governance aspects, actions or perception of actions, except what related to the importance of an international agreement to combat CC. In this issue, (with borderline statistical significance), 27 per cent of Mozambican men “had no opinion on the importance of an international agreement to combat CC”, and all women clearly stated their opinion, either affirmably or negatively (39 and 61 per cent, respectively).

3.5 Exploratory multivariate data analysis

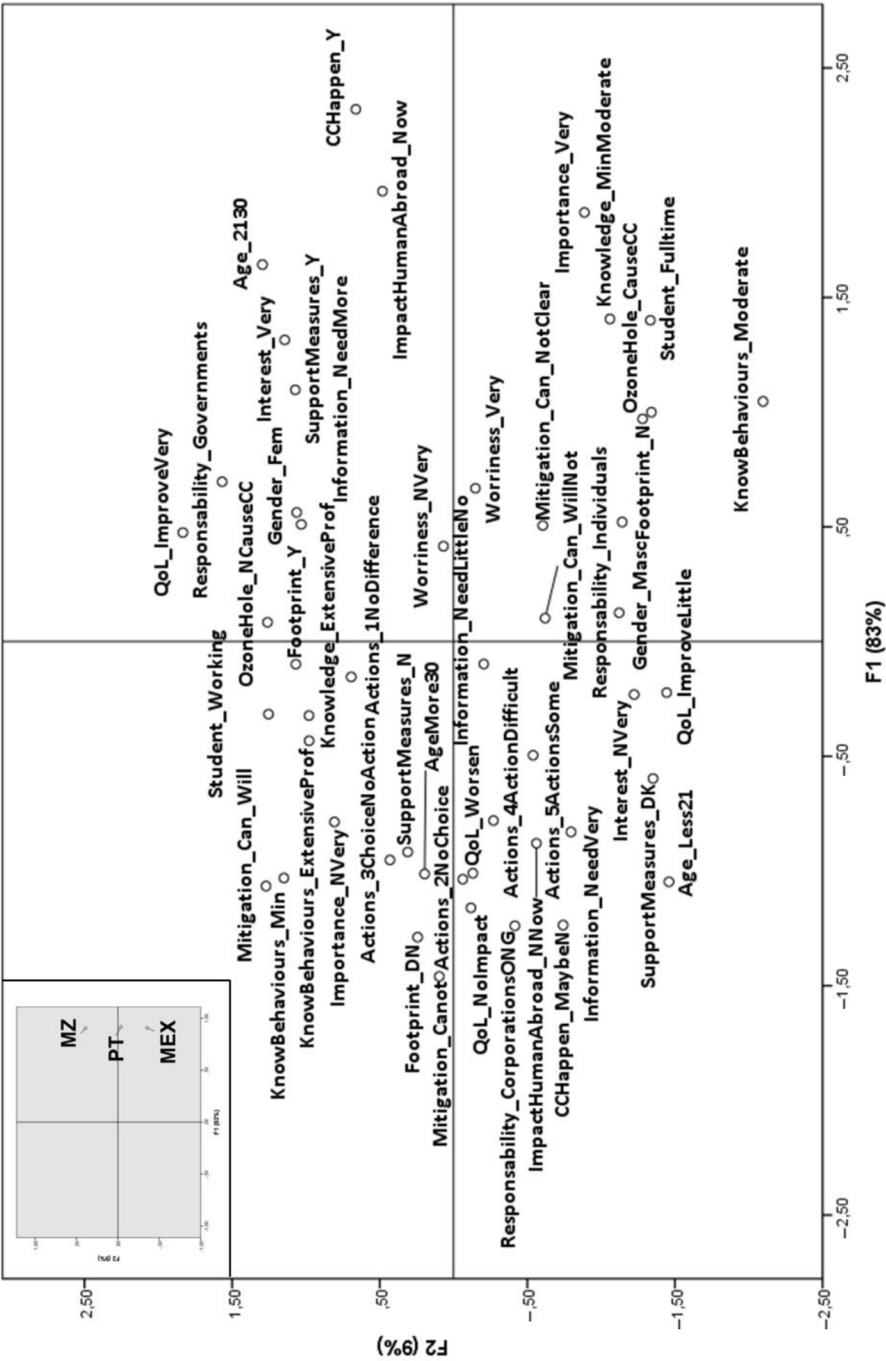
The PCA results showed that individuals did not differ greatly among the three nationality groups. Hence, the first component (F1) (Figure 1) indicates that the three groups had a similar profile (83 per cent of all data variability), with the main contributing aspects to all being the perceptions that:

- (1) CC was happening;
- (2) CC was a very important subject to them; and
- (3) human impact in human communities was being felt abroad now.

F1 embodies a size effect: answers with high response rates appear on the far-right side and further to the left, answer categories appear, and the lower their response rates tend to be. This result is coherent with that of the previous analysis, where for each question, the majority of all three nationalities tended to give the same answer, and relevant differences among nationalities mostly concerned the magnitude of that choice. For example, most respondents of each nationality considered themselves interested on CC issues, but the magnitude of that interest was different: 88 per cent of Mozambican, 64 per cent of Mexican and 56 per cent of Portuguese respondents.

The second and third components (respectively, responsible for 9 and 8 per cent of data variability) however, did reveal profile differences associated with the distinct nationality

Figure 1.
PCA factorial plans
for Principal
Components 1 and 2
regarding
nationalities
and variable categories,
differentiated by
most respondents



groups (Figure 2). The second component (F2) showed an opposition between Mozambican (on the right side) and Mexican students (on the left side). The third component (F3) showed an opposition between Portuguese (towards the bottom) and the other two nationalities, Mozambican and Mexican (towards the top).

The use of this exploratory multivariate methodology allows for a global view of the main characteristics that differentiated among the three nationalities under study. Hence, Portuguese students were characterised for having – to a greater extent than other students:

- perceived that CC was less important, and of lesser interest;
- perceived they needed little more information on CC;
- perceived their life quality would not change with their actions to mitigate CC;
- attributed to governments the main responsibility in CC mitigation actions;
- calculated their ecological footprint; and
- were aware that ozone was not a main cause of CC.

On the other hand, Mexican students were characterised for – to a greater extent than other students:

- being younger (<21 years);
- perceiving that CC was very important;
- perceiving they needed much more information on CC;
- attributing to individuals the main responsibility in CC mitigation actions; and
- not having calculated their ecological footprint.

Lastly, Mexican also shared with Mozambican students, to a greater extent than Portuguese students:

- the believe that individuals' actions were not enough to mitigate CC; and (but)
- that their contribution to mitigate would improve a lot their life quality.

Besides these, Mozambican students were also characterized by attributing both to governments and to individuals the main responsibility in CC mitigation actions.

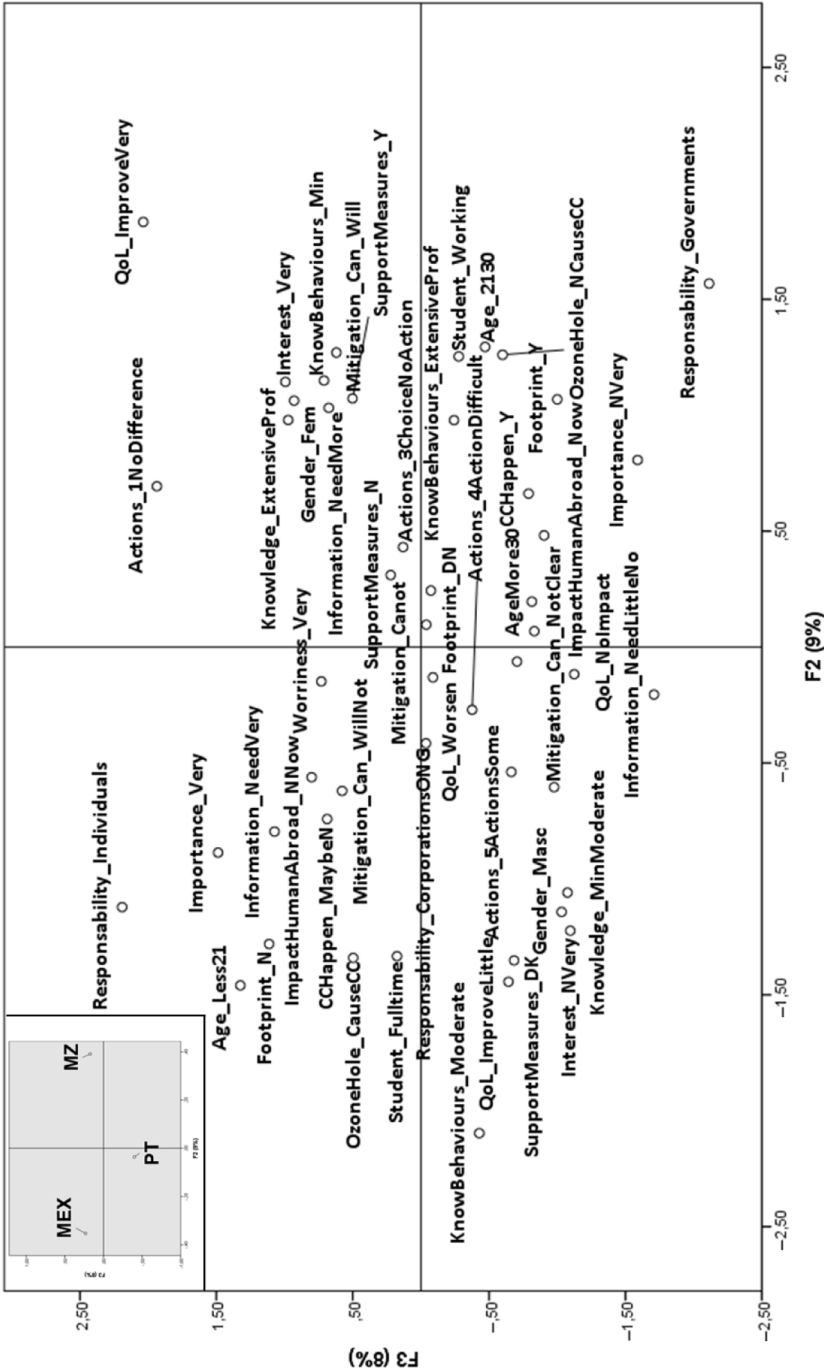
4. Discussion

Individuals' perceptions about CC are complex and multidimensional. This paper provides the first results obtained from a second cycle among Portuguese, Mozambican and Mexican university students in the fields of ecology and environmental sciences. Towards a deeper understanding of these perceptions, which should be considered in university curricula, national policies and adaptation strategies, future studies should bring to the analysis more inquiries (e.g. the sample size) to improve representativeness: students' gender did not significantly influence their perceptions of:

- time scale of CC impact (both on human and biotic communities);
- anthropogenic activities as a main cause of CC; or
- the will or possibility of humans to alter the course of CC.

As in most other issues assessed in the questionnaire, the respondents' gender did not significantly affect the responses in governance aspects, actions or perception of actions, except in what concerns the importance of an international agreement to combat CC. In this

Figure 2.
PCA factorial plans
for Principal
Components 2 and 3
regarding
nationalities and
variable categories
differentiated by
most respondents



issue, 27 per cent of Mozambican men have no opinion on the importance of an international agreement to combat CC, and all women clearly stated their opinion, either affirmably or negatively (39 and 61 per cent, respectively). This is a very interesting information but also hard to explain based on the available data (e.g. socio-cultural indicators used to understand gender inequalities), in the absence of similar studies on other African countries. Previous studies highlighted that gender was a factor affecting CC views, and that women were more willing to acknowledge the need for more information on CC, as well as were more positive about increasing their life quality because of actions taken to mitigate CC, demonstrating always greater levels of concern with CC issues (Wachholz *et al.*, 2014; Santos *et al.*, 2016). Our data show that although Mozambican women occupy an unequal and subordinate place in the Mozambican society structure, being poorer, less educated, performing unpaid (or not formally paid) work, having a residual participation in the structure of power and decision, among other situations (Ribeiro and Chaúque, 2010; Wamukonya and Skutch, 2002), they have opinions towards the need to have (or not) international agreements to deal with CC, while men do not reveal any opinion. In this sense, the available data from other studies about gender (referred above) show the social, material and cultural conditions, justifying the disadvantaged position of women in society (Tvedten *et al.*, 2008), filtered by “Western” indicators (that are essentialist). In this context, our research draws attention to the need for indicators adjusted to the socio-cultural contexts that we are studying. Our data also underlines the importance of taking into account the role of women in development and in the need for a changing behavior, developing mitigation and adaptation instruments and policies to cope with CC, as recognized by various international organizations, such as UN, WHO.

As for the age factor, this only significantly influenced the perception relating to the capacity of humankind to successfully mitigate CC effects. The majority of the younger Mexican respondents (aged <21 years) expressed that humankind could successfully mitigate CC effects, but people are not willing to change their behaviour (77 per cent), while fewer respondents shared this opinion in the older age groups (38 per cent aged between 21 and 30 years and no one aged >30 years). This is a thematic that does not gather consensual answering patterns, but some studies (Hibberd and Nguyen, 2013) suggest that CC scepticism is less likely to be found among younger age groups.

Future studies of CC perceptions, knowledge and attitudes should use larger samples to further analyse the gender and age distributions, both within national groups and also between nationalities.

Most respondents of all nationalities believed that CC was happening. Nevertheless, Mexican respondents were significantly less certain of their existence and in what concerns their interest of the topic, Mozambican students were significantly more interested in the topic than either Mexican or Portuguese students. The perceived importance of the topic was also significantly different among the three nationalities: 66 per cent of Portuguese answering that they “perceived CC as a very important issue”, while 82 per cent of Mozambican and 100 per cent of Mexican expressed the same opinion. These results (namely, students’ interest) may reflect the CC and Extreme Events meteorological patterns in different geographies, with African students living under more severe climatic conditions. This can also be seen in the perception of CC impacts on human communities (greater, concerning foreign countries than in one’s country), being significantly higher among the Portuguese respondents (92 per cent) than either Mozambican or Mexican respondents (88 and 74 per cent, respectively). In line with these result, Mexican students perceived to a greater extent that CC impacts would be felt in 10 years from now (26 per cent), compared to

Mozambican (9 per cent) or Portuguese respondents (3 per cent). More affected geographies also seem to be more optimistic about solutions. When inquired on the capacity of humanity to mitigate CC, the vast majority of the respondents expressed that humans could mitigate effects of CC (97-100 per cent), but only Mozambican were more positive, with 27 per cent expressing that “humans would manage successfully to mitigate the effect of CC”, as opposed to 4 per cent of Portuguese and 3 per cent of Mexican students. This could be also in line with the fact that the vast majority of inquired students (95-100 per cent) felt they needed more information relating to CC. Among these, and also in line with other results, Mexican respondents felt the need for more information than Mozambican or than Portuguese students. Only among Portuguese students, a small number (6 per cent) felt no need for further information on the subject. In fact, when asked about the effect of the hole in the ozone layer on CC, a significantly lower proportion (23 per cent) of Mexican respondents acknowledged that this was not a main cause of CC, compared to Mozambican (50 per cent) and Portuguese (37 per cent) respondents. Hence, students believe that CC is happening, that their main causes are anthropogenic and they feel well informed on the topic of CC. However, when asked about particular concepts and processes of CC, their answers do not reflect their self-perceived knowledge. Similar results were reported in other studies (Löfstedt, 1991), where the greenhouse gas effect was confused with the issue of ozone depletion and other misconceptions that can be found among other European (Manolas *et al.*, 2010; Santos *et al.*, 2016) and American (Wachholz *et al.*, 2014) university students. The erroneous beliefs held by university students about this environmental and socio-environmental and political problem is a concern, however, and like in other reports (Wachholz *et al.*, 2014), students believe that CC is real and largely human-induced, and most expressed concerns about CC. For this purpose, it is interesting to note that as Stoutenborough and Vedlitz (2014) state that perceived knowledge and assessed knowledge of CC are distinct parameters, and those with more perceived knowledge tend to report less concern for CC, and – we add – that they also tend to dismiss the need to change their actions and thus, their individual responsibility in either mitigation or adaptation. Those with more assessed knowledge tend to report more concern for CC.

Opinions on who should take the main actions in mitigating CC were strongly dependent on the respondents’ nationality, with most Portuguese and Mozambicans (73 and 62 per cent, respectively) sharing the opinion that this responsibility should lay upon governments, opposed to only 26 per cent of Mexican students who expressed the same opinion. On the other hand, most Mexican (64 per cent) students expressed that the responsibility to mitigate CC should lie upon individuals, opposed to Portuguese and Mozambicans (18 and 38 per cent, respectively), which may be related to the social organization and political system of each country. In this context, Portugal has redistributive policies and the state plays a central role in welfare; Mozambique closely follows this trend in their legislation in several areas. Mexico deviates from this trend and presents a residual public supply system in all areas (Diaz-Cayeros *et al.*, 2016), which may result in the importance of individual responsibility instead of state responsibility. Also, without an international agreement, e.g. Kyoto’s protocol successor, most students (52-69 per cent), regardless of nationality, felt there would still be a way to mitigate CC, although many felt that such an international agreement was essential (23-40 per cent) or they “did not have an opinion on the matter” (7-8 per cent). Opposition between an individual’s approach to seek solution (e.g. Mexican students) and institutional approaches (e.g. Portuguese and Mozambican students) is suggested by the results

When inquired if they were to reduce their contribution to CC, Mozambicans (79 per cent) expressed a greater confidence that their actions to mitigate CC would increase their life

quality, as opposed to Portuguese and Mexican respondents (25 and 44 per cent, respectively). On the other hand, a greater proportion of Portuguese respondents (21 per cent) expressed that “their actions would not have any impact in their life quality”, as opposed to Mexican (3 per cent) and Mozambican respondents (0 per cent). As individuals, most respondents also expressed that they would support actions to reduce greenhouse gases, with Mozambicans expressing a greater will to support these mitigation actions (79 per cent) than Portuguese or Mexican (56 per cent). This optimism among more impacted and poor geographies (e.g. Mozambique) is somehow surprising, and qualitative studies are required for deepening this issue (e.g. cultural factors may enlighten senses and meanings of the data).

Data analysis revealed that most students recognized human responsibility in CC but demonstrated gaps in their understanding of the phenomenon and in the need to adopt behaviours to tackle CC. The results show that more specialized university education in natural and technological sciences did not translate into more accurate representation and action, which are affected by social and cultural factors. One interesting contribution of this study is that despite our surveyed students being familiarized with CC phenomenon, through their curricula, this knowledge does not translate necessarily into concrete practices and behaviours that mitigate CC, which is in accordance with Giddens (2009). This observation shows the complexity and multidimensionality of CC phenomena that defy us all, individuals, collectivities and governments in the needed action to change the situation.

5. Conclusions

More research (using mixed methods) into how CC mitigation measures, adaptation strategies and policies in developing countries, as well as more cross-country comparisons, would make a valuable contribution to our knowledge on how sociocultural factors affect public engagement in CC. The next step on this research project is conduct an in-depth qualitative analysis (semi structured interviews) in these three continental regions for a holistic comprehension about attitudes and willingness to take part in this climate global citizenship.

CC relates to sustainable development, and the “Transforming our World: the 2030 Agenda for Sustainable Development” clearly states “Take urgent action to combat climate change and its impacts”. In this context “Strengthen the means of implementation and revitalize the global partnership for sustainable development” includes certainly a transdisciplinary and intercultural approach to CC that goes beyond national borders and country policies (namely, educational).

Curriculum “globalization” is fundamental in today’s globalized world and the multidimensional and interdisciplinary nature of global environmental problems, such as CC. Students’ competencies must incorporate critical thinking and think beyond their disciplinary and cultural boundaries. Such intercultural studies are a tentative approach towards this objective of integrating CC in university curricula in an international perspective.

References

- Adger, W.N., Barnett, J., Brown, K., Marshall, N. and O’Brien, K. (2013), “Cultural dimensions of climate change impacts and adaptation”, *Nature Climate Change*, Vol. 3 No. 2, pp. 112-117, doi: [10.1038/NCLIMATE1666](https://doi.org/10.1038/NCLIMATE1666).
- Aparicio-Effen, M., Arana, I., Aparicio, J., Cortez, P., Coronel, G., Pasten, M., Nagy, G.J., Rojas, A.G., Flores, L., Bidegain, M., (2016b), “Introducing hydro-climatic extremes and human impacts in

- Bolivia, Paraguay and Uruguay”, in Leal Filho, W., Azeiteiro, U.M. and Alves, F. (Eds), *Climate Change and Health: Improving Resilience and Reducing Risks*, Springer, Berlin, pp. 449-474, ISBN: 978-3-319-24660-4
- Aparicio-Effen, M., Arana, I., Aparicio, J., Ramallo, C., Bernal, N., Ocampo, M. and Nagy, G.J. (2016a), “Climate change and health vulnerability in Bolivian Chaco Ecosystems”, in Leal Filho, W., Azeiteiro, U.M. and Alves, F. (Eds), *Climate Change and Health: Improving Resilience and Reducing Risks*, Springer, Berlin, pp. 231-262, ISBN: 978-3-319-24660-4
- Azeiteiro, U.M., Bacelar-Nicolau, P., Caetano, F. and Caeiro, S. (2015), “Education for sustainable development through e-learning in higher education: experiences from Portugal”, *Journal of Cleaner Production*, Vol. 106, pp. 308-319, doi: [10.1016/j.jclepro.2014.11.056](https://doi.org/10.1016/j.jclepro.2014.11.056).
- Bacelar-Nicolau, P., Caeiro, S., Martinho, A., Azeiteiro, U.M. and Amador, F. (2009), “E-learning for the environment: the Universidade Aberta (Portuguese Open Distance University) experience in the Environmental Sciences Post-Graduate Courses”, *International Journal of Sustainability in Higher Education*, Vol. 10 No. 4, pp. 354-367, doi: [10.1108/14676370910990701](https://doi.org/10.1108/14676370910990701).
- Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, R., Osman-Elasha, B., Tabo, R. and Yanda, P. (2007), “Africa: in impacts, adaptation and vulnerability”, in Parry, M.L., Canziani, O. F., Palutikof, J.P., Van der Linden, P.J. and Hanson, C.E. (Eds), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, MA, pp. 433-467.
- Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. (2009), “Determinants of farmers’ choice of adaptation methods to climate change in the Nile Basin of Ethiopia”, *Global Environmental Change*, Vol. 19 No. 2, pp. 248-255.
- Diaz-Cayeros, A., Estévez, F. and Magaloni, B. (2016), *The Political Logic of Poverty Relief: Electoral Strategies and Social Policy in Mexico*, Cambridge University Press, Cambridge, MA, ISBN: 9781107140288.
- Feldman, L. Nisbet, M.C. Leiserowitz, A. and Maibach, E. (2010), “The Climate Change Generation? Survey analysis of the perceptions and beliefs of young Americans”, Yale Project on Climate Change Communication, Yale University and George Mason University, available at: <http://environment.yale.edu/climate-communication-OFF/files/YouthJan2010.pdf>
- Giddens, A. (2009), *The Politics of Climate Change*, Polity Press, Cambridge, MA, p. 264, ISBN-13: 978-0-7456-4692-3.
- Hameso, S. (2014), “Perceptions about climate change in Sidama, Ethiopia”, in Leal Filho, W., Alves, F., Caeiro, S. and Azeiteiro, U.M. (Eds), *International Perspectives on Climate Change: Latin America and Beyond*, Springer, New York, NY, p. 316, ISBN 978-3-319-04488-0, doi: [10.1007/978-3-319-04489-7](https://doi.org/10.1007/978-3-319-04489-7).
- Hibberd, M. and Nguyen, A. (2013), “Climate change communications and young people in the Kingdom: a reception study”, *International Journal of Media and Cultural Politics*, Vol. 9 No. 1, pp. 27-46, doi: [10.1386/macp.9.1.27_1](https://doi.org/10.1386/macp.9.1.27_1).
- Jamelske, E., Barrett, J. and Boulter, J. (2013), “Comparing climate change awareness, perceptions, and beliefs of college students in the United States and China”, *Journal of Environmental Studies and Sciences*, Vol. 3 No. 3, pp. 269-278, doi: [10.1007/s13412-013-0144](https://doi.org/10.1007/s13412-013-0144).
- Leal Filho, W. (Ed) (2010), *Universities and Climate Change – Introducing Climate Change at University Programmes*, Springer, Berlin, ISBN: 978-3-642-10750-4.
- Leal Filho, W., Adamson, K., Dunk, R., Illingworth, S., Azeiteiro, U.M. and Alves, F. (Eds) (2016), *Implementing Climate Change Adaptation in Cities and Communities Integrating Strategies and Educational Approaches*, Springer, New York, NY, ISBN: 978-3-319-24660-4.
- Löfstedt, R.E. (1991), “Climate change perceptions and energy-use: decisions in Northern Sweden”, *Global Environmental Change*, Vol. 1, pp. 321-324.
- Lorenzoni, I. and Pidgeon, N.F. (2006), “Public views on climate change: European and USA perspectives”, *Climatic Change*, Vol. 77 No. 1, pp. 73-95.

- Manolas, E.I., Tampakis, S.A. and Karanikola, P.P. (2010), "Climate change: the views of forestry students in a Greek University", *International Journal of Environmental Studies*, Vol. 67 No. 4, pp. 599-609, doi: [10.1080/00207233.2010.499208](https://doi.org/10.1080/00207233.2010.499208).
- Márdero, S., Schmook, B., Christman, Z., Nickl, E., Schneider, L., Rogan, J. and Lawrence, D. (2014), "Precipitation variability and adaptation strategies in the Southern Yucatán Peninsula, Mexico: integrating local knowledge with quantitative analysis" in Leal Filho, W., Alves, F., Caeiro, S. and Azeiteiro, U.M. (Eds), *International Perspectives on Climate Change: Latin America and Beyond*, Springer, p. 316, ISBN: 978-3-319-04488-0, doi: [10.1007/978-3-319-04489-7](https://doi.org/10.1007/978-3-319-04489-7).
- Nagy, G.J., Coronel, G., Pasten, M., Baez, J., Monte-Domecq, R., Galeano-Rojas, A., Flores, L., Ciganda, C., Bidegain, M., Aparicio-Effen, M. and Arana, I. (2016), "Impacts on well-being and health by excessive rainfall and floods in Paraguay, Uruguay and Bolivia", in Leal Filho, W., Azeiteiro, U. M. and Alves, F. (Eds), *Climate Change and Health: Improving Resilience and Reducing Risks*, Springer, New York, NY, pp. 475-514, ISBN: 978-3-319-24660-4.
- Nigatu, A.S., Asamoah, B.O. and Kloos, H. (2014), "Knowledge and perceptions about the health impact of climate change among health sciences students in Ethiopia: a cross-sectional study", *BMC Public Health*, Vol. 14 No. 1, p. 587, doi: [10.1186/1471-2458-14-587](https://doi.org/10.1186/1471-2458-14-587).
- Osbahr, H., Dorward, P., Stern, R. and Cooper, S. (2011), "Supporting agricultural innovation in Uganda to respond to climate risk: linking climate change and variability with farmer perceptions", *Experimental Agriculture*, Vol. 47, pp. 293-316.
- Patt, A.G. and Schroter, D. (2008), "Perceptions of climate risk in Mozambique: implications for the success of adaptation strategies", *Global Environmental Change*, Vol. 18 No. 3, pp. 458-467.
- Patt, A.G., Tadross, M., Nussbaumer, P., Asante, K., Metzger, M., Rafael, J., Goujon, A. and Brundrit, G. (2010), "Estimating least-developed countries' vulnerability to climate-related extreme events over the next 50 years", *Proceedings of the National Academy of Sciences*, Vol. 107 No. 4, pp. 1333-1337, doi: [10.1073/pnas.0910253107](https://doi.org/10.1073/pnas.0910253107).
- Peterson, T., Ortega-Huerta, M.A., Bartley, J., Sánchez-Cordero, V., Soberón, J., Buddemeier, R.H. and Stockwell, D.R.B. (2002), "Future projections for Mexican faunas under global climate change scenarios", *Nature*, Vol. 416, pp. 626-629, doi: [10.1038/416626a](https://doi.org/10.1038/416626a).
- Ribeiro, N. and Chaúque, A. (2010), *Gender and Climate Change: Mozambique Case Study*, Heinrich Boell Foundation Southern Africa, Cape Town.
- Sánchez-Cortés, M.S. and Chavero, E.L. (2011), "Indigenous perception of changes in climate variability and its relationship with agriculture in a Zoque community of Chiapas", *Mexico Climatic Change*, Vol. 107, pp. 363-389.
- Santos, P.T., Bacelar-Nicolau, P., Pardal, M.A., Bacelar-Nicolau, L. and Azeiteiro, U.M. (2016), "Assessing student perceptions and comprehension of climate change in Portuguese higher education institutions", in Leal Filho, W., Adamson, K., Dunk, R., Illingworth, S., Azeiteiro, U.M. and Alves, F. (Eds), *Implementing Climate Change Adaptation in Cities and Communities Integrating Strategies and Educational Approaches*, 1st ed., Springer, pp. 221-236, ISBN: 978-3-319-28591-7, ISBN: 978-3-319-28589-4, doi: [10.1007/978-3-319-28591-7_12](https://doi.org/10.1007/978-3-319-28591-7_12).
- Stoutenborough, J.W. and Vedlitz, A. (2014), "The effect of perceived and assessed knowledge of climate change on public policy concerns: an empirical comparison", *Environmental Science and Policy*, Vol. 37, pp. 23-33.
- Tvedten, I., Paulo, M. and Montserrat, G. (2008), *Políticas de Género e Feminização da Pobreza em Moçambique*, CMI Chr. Michelsen Institute, Scandinavia.
- Valdivia, C., Seth, A., Gilles, J.L., García, M., Jiménez, E., Cusicanqui, J., Navia, F. and Yucra, E. (2010), "Adapting to climate change in Andean ecosystems: landscapes, capitals, and perceptions shaping rural livelihood strategies and linking knowledge systems", *Annals of the Association of American Geographers*, Vol. 100 No. 4, pp. 818-834.

- Wachholz, S., Artz, N. and Chene, D. (2014), "Warming to the idea: university students' knowledge and attitudes about climate change", *International Journal of Sustainability in Higher Education*, Vol. 15 No. 2, pp. 128-141, doi: [10.1108/IJSHE-03-2012-0025](https://doi.org/10.1108/IJSHE-03-2012-0025).
- Wamukonya, N. and Skutch, M. (2002), "Is there a gender angle to the climate change negotiations?", *Energy and Environment*, Vol. 13 No. 1, pp. 115-124.

Further reading

- Ford, J.D., Berrang-Ford, L., Bunce, A., McKay, C., Irwin, M. and Pearce, T. (2015), "The status of climate change adaptation in Africa and Asia", *Regional Environmental Change*, Vol. 15 No. 5, pp. 801-814, doi: [10.1007/s10113-014-0648-2](https://doi.org/10.1007/s10113-014-0648-2).
- McGregor, H.V., O'Shea, B., Brewer, C., Abuodha, A. and Pharo, E.J. (2014), "Internationalization of the curriculum through student-led climate change teaching activity", *Journal of Geosciences Education*, Vol. 62 No. 3, pp. 353-363, doi: [10.5408/13-033.1](https://doi.org/10.5408/13-033.1).

Author Affiliations

Fernando Morgado, Department of Biology, Centre for Environmental and Marine Studies, Universidade de Aveiro, Aveiro, Portugal

Paula Bacelar-Nicolau, Department of Sciences and Technology, Universidade Aberta, Lisbon, Portugal, and Centre for Functional Ecology, Universidade de Coimbra, Coimbra, Portugal

Jaime Rendon von Osten, Universidad Autonoma de Campeche, Campeche, Mexico

Paulo Santos, Department of Biology, Faculty of Sciences, Universidade do Porto, Porto, Portugal

Leonor Bacelar-Nicolau, Institute of Preventive Medicine and Public Health and Institute of Environmental Health, Faculty of Medicine, Universidade de Lisboa, Portugal

Harith Farooq, Faculty of Natural Sciences, Universidade Lúrio, Pemba, Mozambique

Fátima Alves, Department of Social Sciences and Management, Universidade Aberta, Lisbon, Portugal, and Centre for Functional Ecology, Universidade de Coimbra, Coimbra, Portugal

Amadeu M.V.M. Soares, Department of Biology, Centre for Environmental and Marine Studies, Universidade de Aveiro, Aveiro, Portugal

Ulisses M. Azeiteiro, Department of Biology, Centre for Environmental and Marine Studies, Universidade de Aveiro, Aveiro, Portugal

About the authors

Fernando Morgado has a PhD in Biology and is a Full Professor at the University of Aveiro, Portugal. He is a Senior Researcher at Centre for Environment and Marine Sciences at University of Aveiro, Portugal. He was a member of several evaluation panels from research projects and grants (international and national). His main research areas include Biology and Ecology, Aquatic Ecotoxicology, Tropical ecology and ecotoxicology, Environmental Education, Education for Sustainable Development, Communication and Dissemination of Science. He has written, co-written, edited or co-edited about 150 publications, including books, book chapters, special issues of scientific journals and papers in refereed journals (ISI and peer-reviewed). He has been a supervisor of 3 post doc researchers, 11 PhD Students, 40 MSc students. He is a member of more than 100 exam panels for viva voce examinations (for PhD and MSc) and career assessment. He is a member of the organizing and scientific committees of more than 100 international and national congresses and workshops. He has participated in several research and development projects.

Paula Bacelar-Nicolau has a PhD in Environmental Microbiology from the University of North Wales, Bangor, UK. She is an Assistant Professor at Universidade Aberta, Portugal, and a Senior Researcher at the Centre for Functional Ecology at Universidade de Coimbra, Portugal. Her main research areas include e-learning in biological and environmental sciences, education for sustainable development and environmental microbiology. She has mentored several post-graduate students, published papers in peer-reviewed ISI journals, chapter books and international conference proceedings, and has participated in several research and development projects.

Jaime Rendón von Osten has a PhD in Biology from the Universidade de Aveiro, Portugal. He is a Professor at EPOMEX Institute of Universidad Autónoma de Campeche, Mexico. His main research areas are Ecotoxicology, Environmental Monitoring, Water Pollution and Impacts of Climate Change in wildlife. He has supervised over 50 graduate and post-graduate students. He has published several papers in peer-reviewed ISI journals, chapter books and international conference proceedings. As a researcher, he also a leader and collaborates in several research projects.

Paulo Santos has a PhD in Biology (Animal Ecology) and is an Assistant Professor at the University of Porto where he teaches Marine Ecology, Conservation Biology, Management and Conservation of Natural Resources, Biodiversity and also Environmental Education. He is a member of CIIMAR, Interdisciplinary Center for Marine and Environmental Research, and he carries out research in the areas of characterization and ecosystem management for biodiversity and quality, especially in marine and estuarine areas and also fisheries biology and spatial planning. He has written papers on aquatic ecology, fisheries biology and land management. He was responsible for and/or collaborated in several research projects in ichthyology, marine and estuarine ecology, environmental impact assessments, strategic plans and coastal zone management plans. He was a former member of the Steering Committee of the College of the Environment of the Portuguese Society of Biologists and is the President of FAPAS, Fund for the Protection of Wild Animals.

Leonor Bacelar Nicolau holds a BSc in Economics from the NOVA School of Business and Economics and an MSc in Statistics and Information Management from NOVA IMS Information Management School, Portugal. She is an invited Assistant Professor and Researcher at the Faculty of Medicine of Universidade de Lisboa, respectively, at the Institute of Preventive Medicine & Public Health and at ISAMB-Institute of Environmental Health, since 2004. She is a founding partner at DataScience Cons., since 2000, and is currently pursuing a joint PhD degree from Universidade de Lisboa, Portugal and CNAM-Conservatoire des Arts et Métiers, France, on Health Management and Health Economics. Her areas of research focus on health economics, multivariate statistics, environmental and preventive medicine and health impact assessment. Her international experience includes being: WHO Temporary Adviser at the high-level meeting on Health in Times of Global Economic Crisis: Implications for the WHO European Region (2009); she is Adviser of the High Commissioner for Health regarding the evaluation of the National Health Plan (2011); is a WHO Country Expert for “Health policy responses to the financial crisis in Europe” study (2012-2015); is a focal point in the Faculty of Medicine of ULisboa of CuteHeart Project (Comparative use of technologies for coronary heart disease), an international partnership between the Harvard Medical School and the Faculties of Medicine from ULisboa and the University of Porto in Portugal, funded by the Harvard Medical School – Portugal Program in Translational Research and Information [<http://cuteheart.med.up.pt/>] (since 2014); Adviser for Mental Well-being Impact Assessment regarding the Healthy Employment Project (since 2015): an international partnership including Portugal, Norway and Iceland, for the promotion of mental health and well-being of the unemployed active population and the professionals that give them support [www.empregosaudavel.org/en/].

Harith Farooq is a PhD Student at the University of Aveiro, Portugal, and Guest Student at University of Gothenburg, Sweden, in the areas of Biology and Ecology of Global Change and with the topic: The biodiversity value of Northern Mozambique montane forests. His main interests are Biodiversity, Biogeography, Evolution and Ecology. Before starting his PhD, he has been working for six years in Mozambique as a lecturer and as the head of the Faculty of Natural sciences at Lúrio University. He has been inventorying biodiversity in Central and Northern Mozambique and has published checklists and new distribution ranges from areas not previously sampled, contributing to fill in the gaps of knowledge of biodiversity in remote areas. He has also published books on science communication on the subject of biodiversity in Northern Mozambique and award-winning Environmental Education Books for Children. He did his Bachelor in Biology and his Masters Marine Biology from the University of Aveiro.

Fátima Alves has a PhD in Sociology; is an Assistant Professor at the Department of Social Sciences and Management at Universidade Aberta; and is a Coordinator of the Centre for Functional Ecology (CFE/UC) Extension at Universidade Aberta. She also coordinates the Research Group Socio-environmental Governance and Sustainability at CFE/UC. This is a multidisciplinary group of researchers that integrates post-graduate students and researchers from natural sciences and social

sciences: its scientific production and relation with society is concerned with the need to articulate different disciplinary perspectives that emphasize complementary dimensions of socio-environmental phenomena and sustainability. As a researcher, she also collaborates at the Centre for Migrations and Intercultural Relations (CEMRI). Her research work has focused on the Sociology of Health and Illness and Mental Illness; Social Policy; Gender and Health; Interculturalities; Environment and Society; Lay Rationalities and Climate Change; Governance of Social and Environmental Systems, Participation and Citizenship; Qualitative Methodologies. She has mentored several post-graduate students, published several books, book chapters, papers in peer-review journals, international conference proceedings and coordinated several national and international research projects.

Amadeu M.V.M. Soares is a Full Professor and Head of the Department of Biology at University of Aveiro in Portugal, and Chair of the PhD Program in Biology and Ecology of Global Change (BEGC). Former President of SETAC-Europe, member of several international advisory committees, received some national and international prizes for his scientific career and supervised over 50 PhD students. Professor Amadeu Soares has written, co-written, edited or co-edited more than 400 publications, including books, book chapters and papers in refereed journals and has an H index of 42.

Ulisses M. Azeiteiro is a Senior Professor (Associate Professor with Habilitation and Tenure) and Coordinator of the Climate Change and Biodiversity Assets Unit from the Biology Department and Integrated Member/Senior Researcher of the Centre for Environmental and Marine Studies (CESAM) at University of Aveiro in Portugal. His main interests are the Impacts of Climate Change in the Marine Environment (Biology and Ecology of Global Change) and Adaptation to Climate Change in the Context of Sustainable Development (Social and Environmental Sustainability and Climate Change). He is a Research Coordinator since 2008 (Research Line Long-Term Ecological Response to Global Changes at IMAR-CMA – Marine and Environmental Research from 2008 to 2010 and Research Group Social-Economic Governance and Sustainability from the Centre for Functional Ecology, hosted by the Faculty of Sciences and Technology at University of Coimbra from 2010 to 2016) and was a member of several evaluation panels from research projects and grants (International, European and National – Portuguese and outside Portugal), member of the organizing and scientific committees of more than 100 international and national congresses, member of more than 150 exam panels for viva voce examinations (for PhD and MSc) and career assessment and supervised over 50 postgraduate students (MSc and PhD students). Professor Ulisses M Azeiteiro has written, co-written, edited or co-edited more than 200 publications, including books (>20), book chapters (>50), special issues of scientific journals and papers in refereed journals (>75 ISI and >50 peer-reviewed). Ulisses M. Azeiteiro is the corresponding author and can be contacted at: ulisses@ua.pt

For instructions on how to order reprints of this article, please visit our website:

www.emeraldgrouppublishing.com/licensing/reprints.htm

Or contact us for further details: permissions@emeraldinsight.com