

Latent profiles of climate change perceptions, responsibility, and value orientations: Evidence from ESS round 11

İklim değişikliği algıları, sorumluluk ve değer yönelimlerinin gizli profilleri: ESS 11. turundan bulgular

Uğur Arcagök¹ 

¹Assist. Prof. Dr., Muş Alparslan University, Faculty of Economics and Administrative Sciences, Department of Business Administration, Muş, Türkiye



Abstract

Existing literature extensively explores the relationship between climate change perceptions and environmental values; however, these studies predominantly use variable-centered approaches, which often overlook unobservable individual differences. This study addresses this gap by identifying latent classes among respondents from participating countries based on their climate change perceptions, perceived personal responsibility, and environmental value orientations. We analyzed data from the European Social Survey (ESS) Round 11 integrated file, Edition 4.2, with a final complete-case analytic sample of 44,338 respondents from 30 countries (29 European countries and Israel). Using Latent Class Analysis (LCA), we applied five indicator variables representing concern about climate change, perceived personal responsibility, beliefs about climate change causes, and environmental values. We also employed the R3STEP approach to assess the associations of age, gender, and educational attainment with latent class membership. Our findings identified three latent profiles among respondents from participating countries, characterized by varying levels of climate change concern, environmental value orientations, and perceived personal responsibility. These profiles exhibited graded differences, particularly in climate change concern and perceived personal responsibility, reflecting heterogeneity in climate-related attitudes and value orientations. Moreover, the automatic R3STEP procedure indicated that gender, age group, and educational attainment were each significantly associated with latent profile membership after adjustment for the other demographic covariates. Overall, these results indicate substantial heterogeneity in climate change perceptions and environmental values within the pooled ESS Round 11 analytic sample and demonstrate the usefulness of a person-centered approach for characterizing this heterogeneity.

Keywords: Climate change concern, environmental responsibility, environmental values, latent class analysis, european social survey, person-centered approach

Öz

Mevcut literatürde iklim değişikliği algıları ile çevresel değerler arasındaki ilişki kapsamlı biçimde incelenmiş olmakla birlikte, bu çalışmalar ağırlıklı olarak değişken merkezli yaklaşımlara dayanmakta ve bu nedenle bireyler arasındaki gözlemlenemeyen farklılıkları çoğu zaman yeterince dikkate almamaktadır. Bu çalışma, katılımcı ülkelerdeki bireylerin iklim değişikliğine ilişkin algıları, algılanan kişisel sorumlulukları ve çevresel değer yönelimleri temelinde örtük sınıfları belirleyerek literatürdeki bu boşluğu ele almayı amaçlamaktadır. Çalışmada, Avrupa Sosyal Araştırması'nın (European Social Survey [ESS]) 11. Tur bütünlüklü veri dosyasının 4.2 sürümü kullanılmış ve 30 ülkeden (29 Avrupa ülkesi ve İsrail) 44.338 katılımcıdan oluşan eksiksiz gözlemlere dayalı nihai analitik örneklem analiz edilmiştir. Örtük Sınıf Analizi (Latent Class Analysis [LCA]) kapsamında; iklim değişikliğine ilişkin kaygı, algılanan kişisel sorumluluk, iklim değişikliğinin nedenlerine ilişkin inançlar ve çevresel değerleri temsil eden beş gösterge değişkeni kullanılmıştır. Ayrıca yaş, cinsiyet ve eğitim düzeyinin örtük sınıf üyeliğiyle ilişkilerini değerlendirmek amacıyla R3STEP yaklaşımından yararlanılmıştır. Bulgular, katılımcı ülkelerdeki bireyler arasında iklim değişikliğine ilişkin kaygı, çevresel değer yönelimleri ve algılanan kişisel sorumluluk düzeyleri bakımından farklılaşan üç örtük profil ortaya koymuştur. Bu profiller, özellikle iklim değişikliğine ilişkin kaygı ve algılanan kişisel sorumluluk bakımından kademeli farklılıklar sergilemiş ve iklimle ilişkili tutumlar ile değer yönelimlerindeki heterojenliği ortaya koymuştur. Ayrıca, otomatik R3STEP prosedürü, diğer demografik ortak değişkenler kontrol edildiğinde, cinsiyet, yaş grubu ve eğitim düzeyinin her birinin örtük profil üyeliğiyle anlamlı düzeyde ilişkili olduğunu göstermiştir. Genel olarak bulgular, birleştirilmiş ESS 11. Tur analitik örnekleminde iklim değişikliği algıları ve çevresel değerler açısından önemli bir heterojenlik bulunduğunu ortaya koymakta ve bu heterojenliğin karakterize edilmesinde birey merkezli yaklaşımın yararlılığını göstermektedir.

Anahtar Kelimeler: İklim değişikliği endişesi, çevresel sorumluluk, çevresel değerler, gizli sınıf analizi, avrupa sosyal araştırması, kişi merkezli yaklaşım

Citation:

Arcagök, U. (2026). Latent profiles of climate change perceptions, responsibility, and value orientations: Evidence from ESS round 11. *OPUS-Journal of Society Research*, 23, e1977255. <https://doi.org/10.26466/opusjsr.1977255>

Open Access Statement:

This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). This license permits unrestricted use, distribution, and reproduction in any medium, provided that the original author(s) and the source are properly credited. The original publication in *OPUS Journal of Society Research* must be cited in accordance with accepted academic practice.

Review Note:

Evaluated by Double-Blind Peer Review

Ethics Reporting:

To report potential ethical concerns, contact: editorialoffice@opusjournal.net

Similarity screening was conducted via intihal.net.



Introduction

Climate change, recognized as one of the most significant global challenges of the 21st century, has garnered substantial attention from the public and scientific communities. Europe is experiencing increasing climate-related impacts, including extreme heat, drought, wildfires, declining snow and ice cover, and biodiversity loss, affecting regions from the Arctic to the Mediterranean (WMO & C3S/ECMWF, 2026).

Recent research confirms considerable cross-national variation in climate change perceptions across Europe. Using ESS data from 22 European countries and Israel, Poortinga et al. (2019) showed that both levels of climate change perceptions and the strength of their individual-level correlates vary across national contexts.

Furthermore, Eurobarometer surveys indicate that most European citizens consider climate change a serious problem and support stronger climate action (European Commission, 2023).

Recent assessments indicate that Europe is the fastest-warming continent, warming at around twice the global average rate (WMO & C3S/ECMWF, 2026). Although climate change is fundamentally a physical phenomenon, responses to environmental issues are shaped by social, psychological, and cultural factors (Stoll-Kleemann et al., 2001). Scholars increasingly argue that environmental risks are filtered through underlying belief and value systems. Consequently, understanding environmental attitudes requires going beyond objective indicators to examine the motivational foundations guiding people's judgments and behaviors.

Schwartz's theory of fundamental human values is among the most widely adopted frameworks for understanding motivation. The theory delineates ten universal value types organized into four higher-order dimensions: openness to change, self-transcendence, self-enhancement, and conservation (Schwartz, 1992). From the perspective of environmental attitudes, universalism and stimulation are particularly salient. Universalism en-

compasses nature protection, environmental sustainability, social justice, and concern for the well-being of all living beings. Individuals endorsing high levels of universalism perceive environmental risks more acutely, support environmental protection policies more strongly, and are more likely to engage in pro-environmental behaviors (Schultz et al., 2005; Steg et al., 2014). Accordingly, IMPENVA was treated as a single value-related item reflecting the importance attached to caring for nature and the environment. Although this item is theoretically related to the universalism value domain in Schwartz's framework, it was not treated as a comprehensive measure of universalism.

Within Schwartz's value framework, stimulation is associated with novelty, variety, curiosity, and excitement (Schwartz, 1992). The ESS item IMPDIFFA ("Important to try new and different things in life") captures one specific aspect related to this value domain. Accordingly, in the present study, IMPDIFFA was treated as a single value-related item reflecting the importance attached to novelty, variety, and trying new things, rather than as a comprehensive measure of stimulation or the broader higher-order openness-to-change dimension. Therefore, theoretical interpretations based on this item are made cautiously and are restricted to the specific value content assessed by the item.

The relationship between values and environmental attitudes is central to environmental sociology and psychology. Dunlap and Van Liere (1978) introduced the New Environmental Paradigm (NEP), emphasizing ecological limits and the reciprocal relationship between humans and nature. The revised NEP scale (Dunlap et al., 2000) remains the standard instrument for assessing ecological worldviews.

Building on this perspective, Stern and Dietz (1994) argued that environmental sensitivity is shaped by egoistic, altruistic, and biospheric value orientations. Stern (2000) further developed the Values-Beliefs-Norms (VBN) theory, proposing that values influence environmental behavior indirectly through beliefs and personal norms.

Karp (1996) similarly found that self-transcendence/openness-to-change and universalism/biospheric values were positively associated with pro-environmental behavior, whereas self-enhancement/conservation values showed negative associations. Individuals who recognize the consequences of environmental problems and perceive personal responsibility are more likely to engage in pro-environmental behavior. Accordingly, *ccrdprs* was evaluated as an indicator of perceived personal responsibility.

Climate change concern represents another important dimension of environmental attitudes. Previous research has documented associations between climate change risk perception and pro-environmental behavior, while also indicating that these relationships may operate through intervening psychological processes (Bradley et al., 2020). Accordingly, *WRCLMCH* was treated as an indicator of climate concern.

Beliefs about the causes of climate change constitute an important dimension of climate change perceptions. Cross-European evidence indicates that beliefs about the reality and anthropogenic causes of climate change vary across individuals and national contexts (Poortinga et al., 2019). Accordingly, *ccnthum* served as an indicator of beliefs regarding the anthropogenic causes of climate change.

Recent scholarly inquiry has focused on the relationships among climate change perceptions, environmental values, and attitudes toward climate policies. The literature has documented significant associations among climate change concern, personal responsibility, and biospheric values, as well as their relationships with support for climate policies and pro-environmental behaviors (Bouman et al., 2020; Verschoor et al., 2020). Attitudes toward climate change are also associated with ideological and political orientations. Previous research has linked nationalism, nativism, and right-wing populist orientations to greater climate change skepticism and opposition to climate policies, although the strength of these associations varies across countries (Kulin et al., 2021; Kim et al., 2024; Kulin

& Johansson Sevä, 2024). Regional economic conditions and the perceived economic burden of climate policies further influence environmental attitudes (Arndt et al., 2023).

Recent research also indicates that the relationship between environmental values and climate policy support is not uniform across individuals or countries. Yao et al. (2026) reported significant cross-country differences in the effects of values on climate policy support, while Kácha et al. (2022) identified distinct latent classes based on climate change attitudes and beliefs. These findings highlight substantial heterogeneity in climate change perceptions and environmental values, indicating the need to move beyond average variable relationships toward identifying groups of individuals with similar characteristics. In this study, beliefs about the anthropogenic causes of climate change, climate concern, perceived personal responsibility, the importance attached to caring for nature and the environment, and the importance attached to trying new and different things represent complementary dimensions of individuals' environmental orientations. Despite these findings, most previous studies have relied on variable-centered approaches, including regression analysis, multilevel modeling, and structural equation modeling. Although these methods have substantially advanced understanding of environmental attitudes, they primarily focus on average associations among variables and may not directly identify subgroups of individuals characterized by distinct configurations of beliefs, climate concern, perceived personal responsibility, and environmental value orientations. Consequently, person-centered approaches provide an important alternative by addressing unobserved heterogeneity. Latent Class Analysis (LCA) identifies subgroups of individuals with similar response patterns, offering a more nuanced understanding of environmental orientations. Despite its growing use in the social sciences, LCA remains underutilized in studies examining climate change perceptions and environmental values in Europe.

Significant gaps remain in the literature. Most individual-level classifications of climate change

attitudes rely on older datasets, such as ESS Round 8, despite considerable changes in public awareness of climate change, climate policy debates, and environmental sustainability across Europe. Moreover, previous studies have largely focused on attitudes, concerns, or policy preferences, while giving limited attention to how environmental values and climate change perceptions interact to form distinct individual profiles. In particular, few person-centered studies have examined environment-related and stimulation-related single-item value indicators, together with beliefs about the causes of climate change, climate concern, and perceived personal responsibility. This highlights the need to reassess the environmental orientations of respondents from participating European countries and Israel using current data.

Individual climate change perceptions and environmental value orientations are important not only for explaining environmental attitudes but also for evaluating corporate sustainability strategies. Businesses increasingly engage with carbon reduction programs, sustainable consumption initiatives, green marketing, and corporate social responsibility. Although the present study does not directly assess consumer behavior or organizational outcomes, the identified heterogeneity in climate-related profiles may provide contextual insights for future research examining how sustainability and green marketing strategies relate to different stakeholder groups.

This study classifies respondents from countries participating in the 11th round of the European Social Survey (ESS) based on their climate change perceptions, perceived personal responsibility, and environmental value orientations. It examines how beliefs about the anthropogenic causes of climate change, climate concern, perceived personal responsibility, the importance attached to caring for nature and the environment, and the importance attached to trying new and different things are integrated within individuals. Latent Class Analysis (LCA) is employed to identify latent profiles and characterize unobserved heterogeneity in climate change perceptions, perceived personal responsibility, and environmental value orientations within

the pooled ESS Round 11 analytic sample. The study contributes primarily to research on climate-related perceptions and environmental orientations by providing a person-centered account of how these indicators co-occur. The identified heterogeneity may also provide a basis for future research on environmental communication, sustainability policy, and stakeholder responses, although business and organizational outcomes are not directly examined in the present study.

Accordingly, this study addresses the following research questions:

RQ1. What latent profiles can be identified among respondents from participating countries based on their beliefs about the causes of climate change, climate concern, perceived personal responsibility, and environment-related and novelty-related value indicators?

RQ2. How are age, gender, and educational attainment associated with membership in the identified latent profiles?

RQ3. To what extent does the prevalence of the identified latent profiles vary across participating countries?

1. Methods

1.1. Data and Sample

This study utilizes data from Round 11 of the European Social Survey (ESS), an international research program conducted biennially to comparatively examine attitudes, values, and behaviors across European countries. ESS Round 11 includes items assessing beliefs about the causes of climate change, climate concern, perceived personal responsibility, and value-related orientations, providing a valuable data source for examining heterogeneity in environmental orientations across participating countries.

Data for this study were obtained from Round 11 of the European Social Survey (ESS), using the ESS11 integrated file, Edition 4.2 (European Social Survey European Research Infrastructure [ESS ERIC], 2026), accessed through the official ESS Data Portal in 2026. The ESS is a cross-national

survey conducted across participating countries using standardized methodological procedures designed to enhance comparability across national contexts. The initial dataset comprised 50,116 respondents from 30 countries. Following the sample-selection and complete-case procedures described below, the final analytic sample comprised 44,338 respondents from 30 countries (29 European countries and Israel). The participating countries, country-specific analytic sample sizes, and distributions of the three latent classes across countries are presented in Table 7.

The initial sample comprised 50,116 respondents from the ESS Round 11 integrated dataset. Before conducting the latent class analysis, the completeness of all latent class indicators and covariates was evaluated. Missing observations were identified for age group ($n = 393$), WRCLMCH ($n = 985$), IMPENVA ($n = 1,177$), CCRDPRS ($n = 1,686$), and IMPDIFFA ($n = 2,722$), whereas no missing observations were identified for gender or educational attainment (EISCED). Because missingness overlapped across variables, these variable-specific counts are not mutually exclusive and therefore should not be summed to obtain the total number of excluded cases. For CCNTHUM, 1,280 respondents had non-substantive missing responses, comprising refusal ($n = 46$), “don’t know” ($n = 1,227$), and no answer ($n = 7$). These responses were treated as missing. Missing data were handled using a complete-case approach. Complete-case selection was implemented during data preprocessing prior to Mplus estimation; therefore, the dataset submitted to Mplus contained only respondents with complete data on all indicators and covariates required for the analysis. Mplus did not independently determine the complete-case analytic sample.

Importantly, an additional 599 respondents (1.2% of the initial unweighted sample; ANWEIGHT-weighted proportion = 0.7%) selected the substantive response “I don’t think climate change is happening” (CCNTHUM = 55). This substantive response was distinguished from refusal, “don’t know,” and no-answer codes and was not

treated as ordinary item nonresponse. In accordance with the ESS questionnaire routing, these respondents were not administered the subsequent climate concern (WRCLMCH) and perceived personal responsibility (CCRDPRS) items and were therefore recorded as “not applicable” for these items. Consequently, they did not have complete data on the indicators required for the latent class analysis and were excluded from the complete-case analytic sample. The resulting latent classes therefore characterize respondents with complete information on the selected climate-related and value-related indicators and should not be interpreted as representing respondents who explicitly indicated that they did not think climate change was happening.

After applying the complete-case criterion, the final analytic sample comprised 44,338 respondents from 30 countries (29 European countries and Israel). The study employed five indicator variables representing climate change perceptions and value-related orientations, three covariate variables (age group, gender, and educational attainment), and the analysis weight (anweight) recommended by the ESS. Descriptions and measurement scales of all study variables are presented in Table 1.

Before conducting the latent class analysis, the selected ESS indicators were reviewed to ensure a consistent coding direction and facilitate the interpretation of the latent class profiles. The ESS value items *impenva* (“Important to care for nature and environment”) and *impdiffa* (“Important to try new and different things in life”) were originally coded from 1 = “Very much like me” to 5 = “Not like me.” Both variables were reverse-coded so that higher scores consistently represented stronger endorsement of the respective value-related item; specifically, greater importance attached to caring for nature and the environment (IMPENVA) and to seeking novelty, variety, and trying new things (IMPDIFFA). This transformation did not alter the substantive meaning of the variables but standardized their coding direction for interpretation. Both variables were treated as individual value-related items rather than as complete measures of

broader Schwartz value constructs. In particular, IMPDIFFA was interpreted as reflecting the importance attached to novelty, variety, and trying new things and was not treated as synonymous with the broader higher-order openness-to-change dimension. The ESS variable *ccrdprs* (“To what extent feel personal responsibility to reduce climate change”) was originally measured on an 11-point scale ranging from 0 (“Not at all”) to 10 (“A great deal”). For the primary latent class analysis, the variable was recoded into three ordered categories representing low (0–3), moderate (4–7), and high (8–10) levels of perceived personal responsibility. These cut-offs were analytically defined for the purposes of the present study to provide a more parsimonious and interpretable ordered representation of perceived personal responsibility; they were not based on established ESS thresholds or validated substantive cut-points. Although the recoding retained the ordinal ordering of the original responses, collapsing the 11-point scale into three categories necessarily reduced information and may have affected the observed distribution and the resulting latent class solution. The categories should therefore be interpreted as study-specific analytical groupings rather than as validated levels of perceived personal responsibility. Age was originally available as a continuous measure in the ESS dataset and was categorized for the present study into seven groups: 15–24, 25–34, 35–44, 45–54, 55–64, 65–74, and 75 years or older. This categorization was used to facilitate the interpretation of age-related differences in latent class membership across broad age ranges rather than assuming a uniform association for each one-year increase in age across the entire age range. The resulting age-group variable was treated as an ordinal covariate, with higher values representing older age groups; accordingly, its coefficient represents the average change in the log-odds of latent class membership associated with a one-category increase in age group. Educational attainment (EISCED) was also treated as an ordinal covariate because its seven categories represent an ordered progression from lower to higher levels of educational attainment. This specification was

used to provide a parsimonious estimate of the overall directional association between increasing educational attainment and latent class membership. Accordingly, the estimated coefficient for education represents the average change in the log-odds of class membership associated with a one-category increase in educational attainment and should not be interpreted as implying that adjacent EISCED categories are strictly equidistant in substantive terms. Gender was coded as 1 = male and 2 = female and entered as a binary covariate; therefore, its coefficient represents the change in the log-odds of latent class membership associated with moving from male to female. In the multinomial logistic regression component of the R3STEP analysis, Class 2 (Moderate Concern/Responsibility Profile) served as the reference latent class. Respondents with missing information on any of the indicators or covariates required for the analysis were excluded through complete-case analysis, as described above. Consequently, higher categories across the latent class indicators represent stronger endorsement of the specific construct represented by each indicator rather than a single common dimension of environmental orientation.

1.2. Research Model

The research model identifies unobserved subgroups among respondents from participating countries using five indicator variables representing climate change perceptions, perceived personal responsibility, and environmental value orientations.

Latent class analysis was employed to classify individuals into distinct environmental profiles. Subsequently, the R3STEP approach was used to examine the associations of age, gender, and education level with latent class membership. All analyses incorporated the analysis weight (*anweight*) recommended for ESS Round 11 data.

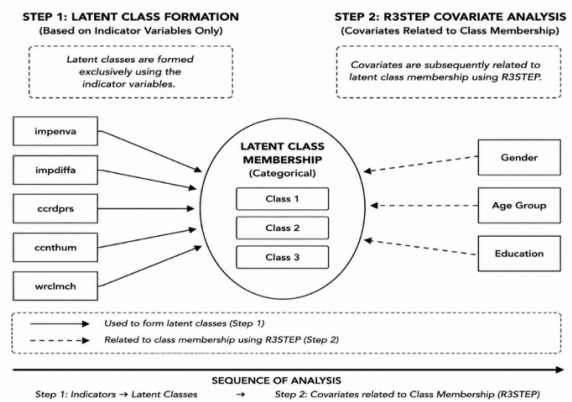
The figure 1 distinguishes the two analytical stages. Solid arrows represent the latent-class measurement stage, in which the five observed indicators are used to estimate latent class membership.

Table 1. Definitions and Measurement of Variables

Variable Type	Variable Name	Original Question / Definition	Scale / Category Structure
Indicator Variables	Impenva	Important to care for nature and environment	Reverse-coded for analysis 1: Not like me 2: A little like me 3: Somewhat like me 4: Like me 5: Very much like me
	Impdiffa	Important to try new and different things in life	Reverse-coded for analysis 1: Not like me 2: A little like me 3: Somewhat like me 4: Like me 5: Very much like me
	Ccrdprs	To what extent feel personal responsibility to reduce climate change?	0-3: Low Responsibility (1) 4-7: Moderate Responsibility (2) 8-10: High Responsibility (3)
	Ccnthum	Do you think that climate change is caused by natural processes, human activity, or both?	1: Entirely by natural processes 2: Mainly by natural processes 3: About equally by natural and human activity 4: Mainly by human activity 5: Entirely by human activity
	Wrclmch	How worried about climate change?	1: Not at all worried 2: Not very worried 3: Somewhat worried 4: Very worried 5: Extremely worried
Covariates	Gender	Gender of respondent	1: Male 2: Female
	Age Group	Age group	1: 15-24 2: 25-34 3: 35-44 4: 45-54 5: 55-64 6: 65-74 7: 75+
	Eisced	Highest level of education	1: Less than lower secondary 2: Lower secondary 3: Lower tier upper secondary 4: Upper tier secondary 5: Advanced vocational, sub-degree 6: Lower tertiary education, BA degree 7: Higher tertiary education, >= MA level
Weight	Anweight	Analysis weight	Continuous

Note: IMPENVA and IMPDIFFA were reverse-coded from their original ESS coding so that higher scores indicate stronger endorsement of the respective value-related item. The categories shown in the table represent the recoded variables used in the analyses. For the remaining indicators, higher categories represent greater attribution of climate change to human activity (CCNTHUM), greater climate concern (WRCLMCH), and stronger perceived personal responsibility (CCRDPRS). Accordingly, higher categories should be interpreted in relation to the specific construct represented by each indicator rather than as a uniform measure of environmental orientation.

Dashed arrows represent the subsequent automatic R3STEP covariate stage, in which gender, age group, and educational attainment are related to latent class membership while accounting for classification uncertainty. The direction of the arrows indicates the direction of estimation in each stage.

**Figure 1. Research Model**

1.3. Weighting

In this study, the ESS analysis weight (ANWEIGHT) was applied to improve the comparability of pooled cross-national estimates by accounting for unequal selection probabilities and differences in country sample sizes. However, weighting does not establish measurement equivalence of the latent class indicators across countries; this issue is considered separately when interpreting the pooled latent class solution. The analysis weight variable ensures more reliable parameter estimates by accounting for differences in selection probabilities arising from the sampling design, non-response, and differences in population size across countries (Kaminska, 2020). Therefore, all analyses were conducted in accordance with the weighting procedure recommended by the ESS.

The ESS analysis weight (anweight) was applied in the analyses. This weight is designed for analyses of pooled cross-national ESS data and incorporates adjustments for unequal selection probabilities while also accounting for differences in country sample sizes. Its use therefore improves the representation of individuals within countries and prevents countries with larger achieved samples from contributing disproportionately to pooled estimates solely because of differences in sample size. Accordingly, anweight was used to enhance the comparability of pooled estimates across the participating countries rather than to make the pooled sample representative of a single European population. However, the use of ANWEIGHT addresses weighting and representation issues and does not establish measurement equivalence of the latent class indicators across countries. Accordingly, potential cross-national differences in class-specific item-response probabilities cannot be resolved through weighting alone and are considered separately as a limitation of the pooled latent class analysis. The pooled LCA assumes a common measurement structure across the participating countries, and the weighting procedure does not establish equality of class-specific item-response probabilities across national con-

texts. Therefore, potential cross-national differences in the latent class measurement model were considered separately from survey weighting when interpreting the pooled solution.

The ESS analysis weight (anweight) was applied throughout the Mplus estimation. Accordingly, model-based latent class proportions, class-specific response probabilities, and R3STEP regression estimates are weighted. Country-specific latent class distributions reported in Table 7 were also calculated using anweight. In contrast, all reported sample sizes (N) represent unweighted respondent counts. The weighting status of the reported statistics is indicated in the notes to the relevant tables.

1.4. R3STEP

The automated R3STEP approach (Asparouhov & Muthén, 2013) implemented in Mplus was used to examine the associations between demographic covariates and latent class membership. In this three-step procedure, latent classes are first estimated exclusively from the indicator variables, after which covariates are related to class membership while accounting for classification uncertainty. This approach preserves the latent class measurement model when incorporating covariates and provides adjusted estimates of the associations between gender, age group, educational attainment, and latent class membership without allowing these covariates to influence class formation. In Mplus, gender, age group, and educational attainment were specified using the AUXILIARY = (R3STEP) option.

Educational attainment (EISCED) was entered as an ordered seven-category covariate, with a single coefficient used to estimate the overall linear trend across successive educational categories. This parsimonious specification assumes a constant change in the log-odds of latent class membership for each one-category increase in educational attainment and does not estimate separate contrasts between individual education categories. Accordingly, the resulting odds ratios were in-

terpreted as changes in the odds of class membership associated with a one-category increase in educational attainment, rather than as changes in the probability of class membership.

In the final analysis, only the five latent class indicators were included in the USEVARIABLES statement, whereas gender, age group, and educational attainment were specified as auxiliary covariates using the automatic R3STEP procedure. The three demographic covariates were evaluated jointly in the R3STEP analysis. Class 2 (Moderate Concern/Responsibility Profile) served as the reference class for the reported multinomial contrasts.

1.5. Latent Class Model

Latent Class Analysis (LCA) is a finite mixture modeling approach that identifies unobserved subgroups of individuals based on patterns of responses to categorical indicators (Goodman, 1974; McCutcheon, 1985; Vermunt, 2010). In the present study, the five climate- and value-related indicator variables (CCNTHUM, WRCLMCH, CCRDPRS, IMPENVA, and IMPDIFFA) were treated as categorical indicators, and models with one to five latent classes were estimated using maximum likelihood with robust standard errors (MLR).

Model selection was based on multiple statistical and substantive criteria, including the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Sample-Size Adjusted BIC (SSA-BIC), entropy, the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR-LRT), and class interpretability. Following latent class estimation, demographic covariates (gender, age group, and educational attainment) were incorporated using the R3STEP procedure to evaluate their associations with latent class membership while accounting for classification uncertainty. Local independence was additionally evaluated using the TECH10 output in Mplus. Standardized bivariate residuals were examined for each pair of latent class indicators in the competing two-, three-, and four-class solutions.

TECH10 was treated as a diagnostic of residual association rather than as a stand-alone criterion for determining the number of latent classes.

2. Analysis

2.1. Model

Analyses were conducted using Mplus Version 9.1 Muthén & Muthén, 2026. As the primary objective was to identify latent subgroups of individuals based on climate change perceptions and environmental value orientations, models were estimated within the finite mixture modeling framework (TYPE = MIXTURE). Models were estimated using robust maximum likelihood (MLR). In the categorical latent class framework, the indicators were modeled through class-specific categorical response probabilities rather than under an assumption of multivariate normality. MLR was used to obtain maximum-likelihood parameter estimates with robust standard errors, providing inference that is less sensitive to model-based distributional misspecification. The ESS analysis weight (anweight) was incorporated using the WEIGHT option. The complex sampling design was not additionally modeled through clustering and stratification variables; accordingly, TYPE = COMPLEX MIXTURE was not used. Thus, while the analyses incorporated the ESS analysis weight, additional design-based adjustments for clustering and stratification were not applied. This distinction should be considered when interpreting the precision of the parameter estimates.

All five latent class indicators (CCNTHUM, WRCLMCH, CCRDPRS, IMPENVA, and IMPDIFFA) were specified as categorical variables in Mplus. Missing responses were coded as -999 and declared using the MISSING option, and the ESS analysis weight (anweight) was incorporated through the WEIGHT option. The three-class model was estimated using TYPE = MIXTURE with MLR estimation and 5000 initial-stage random starts, of which 1000 were retained for final-stage optimization. Gender, age group, and educational attainment

were subsequently related to latent class membership using the automated Mplus R3STEP procedure through the AUXILIARY = (R3STEP) option. The complete Mplus syntax is provided in the Supplementary Material to facilitate reproducibility. The best log-likelihood value for the final three-class solution was successfully replicated, indicating that the selected solution was not attributable to a nonoptimal local maximum. No convergence problems or local-maximum warnings were observed for the final solution based on the TECH8 output.

To reduce local maxima and increase the likelihood of reaching the global maximum log-likelihood value, 5,000 random starting values were specified for each model, with the 1,000 best solutions advanced to the final optimization stage (STARTS = 5,000 1,000). Fifty iterations were used to evaluate the initial solutions (STITERATIONS = 50). Alternative class solutions were compared using information criteria, entropy, and the Vuong-Lo-Mendell-Rubin likelihood ratio test (TECH11). The Bootstrap Likelihood Ratio Test (TECH14) was not applicable because analysis weights were used.

2.2. Model Estimation Procedure

2.3. Results

Table 2 presents the fit indices for alternative latent class models, evaluated using the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Sample-Size-Adjusted BIC (SABIC), entropy, and the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (VLMR-LRT). Because no single fit index is sufficient for determining the optimal number of latent classes, information criteria, classification quality, model parsimony, and theoretical interpretability should be considered jointly (Masyn, 2013; Nylund et al., 2007).

The AIC, BIC, and SABIC values decreased consistently from the two- through the four-class solutions, indicating progressively improved relative statistical fit. In particular, the four-class solution yielded substantially lower information criteria

than the three-class solution: BIC decreased from 547,068.584 to 545,935.886 ($\Delta\text{BIC} = 1,132.698$), AIC decreased by 1,297.990 points, and SABIC decreased by 1,193.079 points. These sizeable reductions were explicitly considered as evidence favoring the four-class solution in terms of relative statistical fit rather than being treated as secondary criteria. However, information criteria were considered jointly with likelihood-ratio tests, classification precision, class sizes, local independence, model parsimony, and substantive interpretability (Nylund et al., 2007; Tein et al., 2013). A five-class solution was also estimated. Despite 10,000 initial-stage random starts and 2,000 final-stage optimizations, the model did not terminate normally, and Mplus indicated that the parameter estimates could not be trusted. Accordingly, the five-class solution was excluded from substantive interpretation and model comparison.

Among the successfully estimated two-, three-, and four-class solutions, the three-class model showed the highest entropy (.627), compared with .616 for the two-class model and .555 for the four-class model. This value indicates moderate rather than high class separation and suggests some uncertainty in individual class assignments (Clark & Muthén, 2009). Accordingly, entropy was interpreted as an indicator of classification precision rather than as a stand-alone measure of global model fit and was considered jointly with the information criteria, likelihood-ratio tests, class sizes, model parsimony, local independence diagnostics, and substantive interpretability when selecting the final model.

The VLMR-LRT indicated that the three-class model provided a statistically significant improvement over the two-class model (VLMR-LRT = 5,317.201, $p < .001$). In contrast, the comparison of the four-class solution with the three-class solution was not statistically significant (VLMR-LRT = 1,335.990, $p = .781$). Thus, although the information criteria clearly favored the four-class solution, the VLMR-LRT did not provide corresponding evidence that the addition of a fourth class significantly improved fit relative to the three-class solu-

tion. Entropy also decreased from .627 to .555, indicating poorer classification precision rather than poorer global model fit in the four-class solution. These results were therefore treated as complementary rather than competing criteria in the class-enumeration decision (Nylund et al., 2007).

Examination of the four-class response profiles further indicated that the additional class primarily subdivided an existing response pattern rather than identifying a clearly distinct substantive profile (Table 2). By comparison, the three-class solution yielded three sufficiently large classes (36.9%, 48.0%, and 15.2%) that could be interpreted consistently in terms of the observed response patterns. Thus, the choice between the three- and four-class solutions involved an explicit trade-off: the four-class solution was favored by AIC, BIC, SABIC, and the reduction in residual associations, whereas the three-class solution was favored by classification precision, parsimony, and substantive distinctiveness. The decision to retain three classes therefore does not imply that the four-class model provided poorer statistical fit; rather, the additional statistical fit obtained by introducing a fourth class was not accompanied by a correspondingly distinct and substantively useful profile. The Bootstrap Likelihood Ratio Test (BLRT) could not be estimated for the weighted latent class models because sampling weights were incorporated into the analysis. Consequently, model selection relied on multiple complementary criteria, including AIC, BIC, SABIC, VLMR-LRT, entropy, class sizes, local-independence diagnostics, model

parsimony, and substantive interpretability. The unavailability of the BLRT is acknowledged as a limitation of the model-selection procedure.

The local independence assumption was assessed for the competing latent class solutions using TECH10 diagnostics. Examination of the standardized bivariate residuals indicated that residual associations decreased as additional latent classes were introduced. The two-class solution yielded 102 significant standardized bivariate residuals, compared with 71 for the three-class solution and 49 for the four-class solution (Supplementary Table S4). Thus, the three-class solution substantially reduced residual associations relative to the two-class model, although the four-class solution produced a further reduction.

These findings indicate that the three-class solution improved the representation of associations among the observed indicators relative to the two-class solution but did not completely satisfy the local independence assumption. Moreover, TECH10 did not uniquely favor the three-class solution because the four-class solution showed fewer significant standardized residuals.

Accordingly, the TECH10 results were treated as a complementary diagnostic rather than as a stand-alone criterion for class enumeration. Detailed indicator-pair diagnostics are reported in Supplementary Table S4. Considering the evidence jointly, the three-class solution was retained for subsequent analyses because it provided the most defensible balance among classification precision, likelihood-ratio evidence, model parsimony, and

Table 2. Model Fit Indices for Competing Latent Class Models

Model Fit Criterion	C = 1	C = 2	C = 3	C = 4	C = 5
Log-Likelihood	-285,229.623	-275,893.303	-273,234.703	-272,566.708	—
Free Parameters	18	37	56	75	—
AIC	570,495.247	551,860.607	546,581.406	545,283.416	—
BIC	570,651.840	552,182.492	547,068.584	545,935.886	—
SABIC	570,594.636	552,064.906	546,890.615	545,697.536	—
Entropy	—	.616	.627	.555	—
VLMR-LRT	—	18,672.640	5,317.201	1,335.990	—
VLMR-LRT p	—	< .001	< .001	.781	—
Class Sizes (%)	100	45.8 / 54.2	36.9 / 48.0 / 15.2	12.4 / 21.2 / 37.2 / 29.3	—
Best LL Replicated	—	—	Yes	Yes	Not established

Note: AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; SABIC = Sample-Size-Adjusted Bayesian Information Criterion; VLMR-LRT = Vuong-Lo-Mendell-Rubin Likelihood Ratio Test; LL = log-likelihood. Class sizes are based on estimated model proportions. Boldface indicates the retained three-class solution. The five-class solution was estimated but did not terminate normally despite 10,000 initial-stage random starts and 2,000 final-stage optimizations. Mplus indicated that the parameter estimates could not be trusted; therefore, fit indices, class proportions, and classification diagnostics for the five-class solution are not reported. A dash (—) indicates that a statistic was not available or not reported because a trustworthy solution was not obtained.

substantive interpretability. Although the four-class solution yielded lower information criteria and fewer significant standardized bivariate residuals, its entropy was lower (.555 vs. .627), the VLMR-LRT did not indicate a statistically significant improvement over the three-class solution ($p = .781$), and the additional class did not yield a clearly distinct substantive response profile.

2.3.1. Distribution of Indicator Response Categories

Table 3 presents the distribution of response categories for the five indicator variables used in the latent class analysis. Overall, within the analytic sample, the distributions indicate substantial endorsement of human involvement in climate change, concern about climate change, perceived personal responsibility for mitigating climate change, and the importance of environmental protection. These patterns should be interpreted with reference to the composition of the analytic sample.

Perceptions of the Causes of Climate Change (CCNTHUM): Within the analytic sample, 42.1% of respondents attributed climate change approximately equally to natural processes and human activity, while 39.8% attributed it mainly to human activity. A further 2.4% attributed climate change entirely to natural processes. These proportions describe the distribution among respondents included in the analytic sample and should not be interpreted as population-wide estimates of agreement regarding the human causes of climate change.

Level of Concern About Climate Change (WRCLMCH): Concern about climate change is widespread. Overall, 42.3% of participants reported being somewhat concerned and 31.7% very concerned, whereas only 4.0% reported no concern.

Perceived Personal Responsibility for Mitigating Climate Change (CCRDPRS): A majority of participants (53.1%) reported a high level of personal responsibility, 32.3% a moderate level, and 14.5% a low level.

Importance Placed on Protecting Nature and the Environment (IMPENVA): Following reverse coding, higher categories indicate stronger endorsement of the importance of caring for nature and the environment. Within the analytic sample, 39.6% of respondents were in Category 4 and 31.6% in Category 5, corresponding to 71.2% in the two highest endorsement categories.

Importance of Trying New and Different Things in Life (IMPDIFFA): Following reverse coding, higher categories indicate stronger endorsement of trying new and different things in life. The distribution was relatively dispersed, with the largest proportions observed in Categories 3 (24.9%) and 4 (27.6%), indicating variation in endorsement of this value-related item.

Overall, the indicator distributions reveal differences in climate change perceptions, personal responsibility, and environmental values, suggesting the presence of unobserved subgroups within the sample and supporting the use of latent class analysis.

Table 3. Observed Weighted Response Proportions for the Indicator Variables (N = 44,338)

Variable	Category 1	Category 2	Category 3	Category 4	Category 5
Ccnthum	.024	.066	.421	.398	.092
Wrclmch	.040	.129	.423	.317	.090
Ccrdprs	.145	.323	.531	-	-
Impenva	.023	.070	.195	.396	.316
Impdiffa	.141	.187	.249	.276	.147

Note: Proportions are weighted using the ESS Round 11 analysis weight (anweight).

2.3.2. Class Counts and Proportions

Table 4 presents the weighted model-estimated class proportions together with the unweighted counts and proportions based on most-likely class assignment. The weighted model-estimated proportions were 36.9% for Class 1, 48.0% for Class 2, and 15.2% for Class 3. Based on most-likely class assignment, the unweighted counts were 16,238 respondents (36.6%) in Class 1, 22,480 respondents (50.7%) in Class 2, and 5,620 respondents (12.7%) in Class 3.

The model-based class proportions and most-likely classification proportions were broadly similar; however, this similarity should not be interpreted as evidence of model stability. All three classes were sufficiently represented in the sample, with the smallest model-based class comprising approximately 15% of respondents. Nevertheless, the moderate entropy and the observed classification overlap, particularly between Classes 2 and 3, indicate meaningful uncertainty in individual class assignment. Accordingly, the three-class solution is interpreted as a probabilistic representation of heterogeneity in the selected indicators rather than as evidence of sharply separated or formally stable respondent subgroups.

Table 4. Weighted Model-Estimated Class Sizes and Unweighted Most-Likely Class Assignments for the Three-Class Solution

Latent Class	Weighted Model-Based Proportion	Unweighted Most-Likely Count (n)	Unweighted Most-Likely Proportion
Class 1	.369	16,238	.366
Class 2	.480	22,480	.507
Class 3	.152	5,620	.127

Note: Model-based class sizes and proportions are weighted using the ESS analysis weight (anweight). Most-likely class counts and proportions are unweighted and represent respondents assigned to each class according to their highest posterior class-membership probability.

2.3.3. Classification Quality

To evaluate the classification quality of the three-class solution, two complementary measures were examined: average posterior class-membership probabilities and classification probabilities (Table 5). Average posterior class-membership probabilities summarize, among respondents assigned to a given class on the basis of their most-likely classification, their average posterior probabilities of belonging to each latent class. In contrast, classification probabilities represent the probabilities of most-likely class assignment conditional on latent class membership and therefore provide information about the direction and magnitude of classification error across classes. The average posterior probabilities on the diagonal were .845 for Class 1, .808 for Class 2, and .862 for Class 3, indicating that respondents assigned to each class

generally had their highest average posterior probability for that class. However, these values should be interpreted together with the overall entropy and classification probabilities rather than as evidence of uniformly high classification accuracy (Masyn, 2013; Nylund et al., 2007).

The classification probabilities showed diagonal values of .839 for Class 1, .854 for Class 2, and .721 for Class 3. Classification was stronger for Classes 1 and 2, whereas the probability of Class 3 being classified as Class 2 was .260, indicating meaningful overlap between these two classes and greater classification uncertainty for Class 3. In contrast, classification overlap between Classes 1 and 3 was relatively limited. Taken together with the entropy value of .627, these results indicate moderate overall classification quality rather than clear or uniformly high-class separation. Accordingly, the three-class solution should be interpreted as providing substantively distinguishable profiles while retaining some classification uncertainty, particularly between Classes 2 and 3.

Table 5. Classification Quality of the Three-Class Latent Class Solution

Latent Class	Average Latent Class Probabilities			Classification Probabilities		
	1	2	3	1	2	3
C=1	0.845	0.148	0.008	0.839	0.157	0.005
C=2	0.114	0.808	0.078	0.113	0.854	0.033
C=3	0.014	0.124	0.862	0.019	0.260	0.721

2.3.4. Class Profiles (Conditional Probabilities)

To interpret the three-class solution, the conditional response probabilities for each class were examined. Table 6 shows that the three classes differ in climate change perceptions, levels of concern, perceptions of personal responsibility, and environmental value orientations.

Latent Class 1: This class represents individuals with the highest environmental sensitivity toward climate change. Most individuals believe climate change is primarily human-caused (CCNTHUM, Category 4: 53.9%). A substantial proportion also expresses high concern about climate change (WRCLMCH, Category 4: 59.8%) and a strong sense of personal responsibility for mitigating it

(CCRDPRS, Category 3: 84.0%). This class is also notable for its environmental value orientations, with 55.5% indicating that "protecting the environment and caring for nature" describes them "very well" (IMPENVA, Category 5). In contrast, IMPDIFFA showed a comparatively diffuse response pattern, with no single category strongly dominating the class distribution, suggesting that openness to trying new and different things contributed relatively little to the differentiation of this class. Overall, this class is characterized by high environmental sensitivity, strong personal responsibility, and a strong emphasis on caring for nature and the environment.

Latent Class 2: This class comprises individuals with more moderate attitudes toward climate change. Most believe climate change results from the combined effects of natural processes and human activities (CCNTHUM, Category 3: 53.3%). Concern about climate change is predominantly moderate (WRCLMCH, Category 3: 69.3%), as is the sense of personal responsibility (CCRDPRS, Category 2: 48.1%). In terms of environmental values, a substantial proportion views environmental protection as consistent with their values (IMPENVA, Category 4: 43.9%). For IMPDIFFA, response probabilities were relatively dispersed across the middle categories, again indicating weaker class differentiation on this indicator than on climate concern, perceived personal responsibility, and environmental protection. These findings indicate that Class 2 exhibits a more Moderate Concern/Responsibility Profile of environmental sensitivity and responsibility.

Latent Class 3: Lower Concern/Responsibility Profile: This class is characterized by relatively lower climate concern and lower perceived personal responsibility compared with the other two classes. A substantial proportion believes climate change results from the combined effects of natural processes and human activities (CCNTHUM, Category 3: 45.0%). However, over half reported a low level of concern about climate change (WRCLMCH, Category 2: 50.3%). Similarly, personal responsibility is predominantly low (CCRDPRS, Category 1: 57.0%). Although environmental

value orientations are not entirely absent, lower levels were observed for environmental protection and care for nature than in the other classes. Therefore, Class 3 is characterized more specifically by relatively lower climate concern and lower perceived personal responsibility, rather than by broadly lower environmental sensitivity. IMPDIFFA again showed only modest differentiation, with probabilities distributed relatively evenly across response categories compared with the clearer contrasts observed for WRCLMCH, CCRDPRS, and IMPENVA.

The three-class solution should not be interpreted as representing entirely discrete or qualitatively unrelated environmental types. Taken together, these patterns suggest that the latent structure is primarily ordinal in nature, with the classes reflecting graded levels of environmental engagement rather than three fundamentally different respondent types. Rather, the conditional response probabilities indicate a substantial ordinal gradient, particularly in climate concern and perceived personal responsibility, ranging from relatively higher levels in Class 1 through intermediate levels in Class 2 to lower levels in Class 3. At the same time, differences in perceived causes of climate change and endorsement of the environmental value item contribute additional variation to the profiles. Thus, the classes are best understood as probabilistic profiles that primarily differ in the degree of climate concern and personal responsibility, while also exhibiting some differences in the configuration of the other indicators, rather than as completely distinct environmental orientations.

The strongest differentiation among the three classes was observed for climate concern, perceived personal responsibility, and environmental protection, whereas IMPDIFFA contributed comparatively little to class separation. These findings suggest that the identified classes primarily represent graded configurations of environmental engagement rather than wholly distinct environmental orientations.

Table 6. Conditional Response Probabilities by Latent Class

	Latent Class		
	1	2	3
CCNTHUM			
Category 1	0.01	0.01	0.12
Category 2	0.01	0.05	0.26
Category 3	0.26	0.53	0.45
Category 4	0.54	0.37	0.14
Category 5	0.18	0.05	0.03
WRCLMCH			
Category 1	0.01	0.00	0.26
Category 2	0.00	0.11	0.50
Category 3	0.17	0.69	0.19
Category 4	0.60	0.19	0.04
Category 5	0.23	0.01	0.01
CCRDPRS			
Category 1	0.05	0.09	0.57
Category 2	0.11	0.48	0.34
Category 3	0.84	0.43	0.09
IMPENVA			
Category 1	0.00	0.02	0.09
Category 2	0.01	0.08	0.17
Category 3	0.05	0.29	0.26
Category 4	0.38	0.44	0.29
Category 5	0.56	0.17	0.19
IMPDIFFA			
Category 1	0.12	0.15	0.17
Category 2	0.15	0.21	0.19
Category 3	0.24	0.27	0.22
Category 4	0.30	0.27	0.26
Category 5	0.20	0.11	0.16

2.3.5. Country-Specific Sample Sizes and Latent-Class Distributions

Table 7 presents the country-specific sample sizes and weighted distributions of the three latent classes identified in the final latent class analysis. The analysis includes 44,338 respondents from 30 participating countries, with national sample sizes ranging from 575 respondents in Cyprus to 2,241 respondents in Germany. This broad coverage permits a descriptive examination of how the classes derived from the pooled LCA are distributed across the participating countries.

All three classes derived from the pooled latent class model were represented in every participating country, although their relative prevalence varied substantially across national samples. This pattern indicates that the pooled solution was not characterized by classes occurring exclusively in only a small subset of countries. At the same time, the marked variation in class prevalence across countries indicates meaningful cross-national heterogeneity. Importantly, the presence of all three classes across countries should not be interpreted

as evidence of measurement invariance or equivalence of the class-specific item-response probabilities across national contexts.

Among the three latent classes, Class 2 constituted the largest group in most participating countries. Its weighted proportion generally remained close to one-half of the national sample, varying from approximately 41.2% in Serbia to 64.2% in Montenegro. Compared with the other latent classes, Class 2 displayed the smallest degree of variation across countries, suggesting that this was the most prevalent of the three pooled response patterns across most participating national samples.

In contrast, Class 1 exhibited considerably greater between-country variability. The proportion of respondents assigned to this class ranged from 16.1% in Bulgaria to 44.8% in Germany, representing almost a threefold difference between the lowest and highest observed values. Relatively high proportions of Class 1 were also observed in Spain (44.2%), Austria (43.8%), and Switzerland (39.4%), whereas substantially lower proportions characterized Bulgaria (16.1%) and Estonia (17.4%). Most of the remaining countries displayed intermediate values between approximately 30% and 40%, indicating marked cross-national variation in the prevalence of this class within the analytic sample.

A similar pattern emerged for Class 3, although with a lower overall prevalence. The proportion of respondents assigned to this class varied from 5.7% in Portugal to 30.8% in Israel, corresponding to more than a fivefold difference across countries. Elevated proportions were also observed in Bulgaria (28.5%), Estonia (27.3%), Latvia (27.2%), Slovakia (25.0%), and Montenegro (24.3%). Overall, Class 3 was the smallest latent class in most participating countries, although its prevalence varied considerably across national samples.

Taken together, the country-specific distributions reveal substantial cross-national variation in the prevalence of the three classes derived from the pooled LCA. Although all three classes were represented in every participating country, their relative sizes differed considerably across national contexts. These descriptive findings suggest that

the pooled solution is not attributable to classes occurring exclusively in a small number of countries; however, they do not establish cross-national measurement invariance or demonstrate that the class-specific item-response probabilities are equivalent across countries. Country context may therefore contribute to variation in latent class membership and should be considered when interpreting the pooled solution. This cross-national heterogeneity is also relevant to the interpretation of the covariate results. In particular, because the pooled R3STEP model did not explicitly adjust for country-level differences, the observed associations between the demographic covariates and latent class membership may partly reflect cross-national differences in demographic composition and climate-related attitudes.

Table 7. Country-Specific Sample Sizes and Latent-Class Distributions

Country	N	Class 1 (%)	Class 2 (%)	Class 3 (%)
Austria	2,114	43.85	44.99	11.17
Belgium	1,485	36.60	50.20	13.20
Bulgaria	1,879	16.13	55.34	28.52
Switzerland	1,301	39.44	52.68	7.88
Cyprus	575	36.81	51.40	11.79
Germany	2,241	44.79	45.20	10.01
Estonia	1,205	17.38	55.34	27.28
Spain	1,646	44.17	46.06	9.77
Finland	1,458	37.23	52.29	10.48
France	1,643	38.84	51.64	9.52
United Kingdom	1,329	39.41	47.84	12.75
Greece	2,463	33.38	51.95	14.66
Croatia	1,369	33.02	51.62	15.36
Hungary	1,985	31.23	56.95	11.81
Ireland	1,738	31.42	53.34	15.24
Israel	741	22.66	46.59	30.75
Iceland	795	29.86	54.34	15.81
Italy	2,565	35.19	53.27	11.53
Lithuania	1,201	19.77	60.54	19.69
Latvia	1,074	16.62	56.17	27.21
Montenegro	1,242	11.51	64.20	24.29
Netherlands	1,612	32.81	54.92	12.27
Norway	1,262	29.79	57.31	12.90
Poland	1,273	26.87	58.59	14.54
Portugal	1,273	40.53	53.74	5.73
Serbia	1,275	36.30	41.18	22.52
Sweden	1,128	32.89	56.13	10.98
Slovenia	1,157	39.35	53.75	6.90
Slovakia	1,238	17.78	57.22	25.00
Ukraine	2,071	26.71	52.36	20.93
Pooled sample	44,338	36.62	50.70	12.67

Note: N represents the unweighted number of respondents, whereas country-specific and pooled latent class percentages are weighted using the ESS analysis weight (anweight).

2.3.6. Covariate Effects

Gender, age group, and educational attainment were evaluated jointly using the automatic R3STEP procedure. The estimated coefficients therefore represent the association of each covariate with latent class membership after adjustment for the other demographic covariates included in the analysis. The Moderate Concern/Responsibility Profile (Class 2) served as the reference category for the reported multinomial contrasts.

Compared with the Moderate Concern/Responsibility Profile, membership in the High Concern/Responsibility Profile (Class 1) was significantly associated with all three demographic variables. Gender showed a significant negative association with Class 1 membership ($\beta = -0.721$, $SE = 0.065$, $z = -11.06$, $p < .001$, $OR = 0.486$, 95% CI [0.428, 0.553]). Given that gender was coded as 1 = male and 2 = female, women had significantly lower odds than men of belonging to the High Concern/Responsibility Profile rather than the Moderate Concern/Responsibility Profile, after adjustment for age group and educational attainment.

Age group was also negatively associated with membership in the High Concern/Responsibility Profile ($\beta = -0.087$, $SE = 0.018$, $z = -4.96$, $p < .001$, $OR = 0.916$, 95% CI [0.885, 0.948]). Each one-category increase in age group was associated with approximately 8.4% lower odds of belonging to the High Concern/Responsibility Profile relative to the Moderate Concern/Responsibility Profile, after adjustment for gender and educational attainment.

Educational attainment likewise showed a significant negative association with membership in the High Concern/Responsibility Profile ($\beta = -0.249$, $SE = 0.017$, $z = -14.30$, $p < .001$, $OR = 0.780$, 95% CI [0.754, 0.807]). Educational attainment was entered as an ordinal covariate in the R3STEP model. Accordingly, the coefficient represents an overall linear trend across ordered educational categories rather than separate contrasts between individual education levels. Higher values of educational attainment were associated with lower odds of membership in the High Concern/Responsibility

Table 8. Associations of Gender, Age Group, and Educational Attainment with Latent Class Membership (R3STEP Results)

Comparison	Covariate	β	SE	Wald z	p	OR	95% CI for OR
Class 1 vs Class 2	Gender	-0.721	0.065	-11.06	<.001	0.486	0.428–0.553
	Age	-0.087	0.018	-4.96	<.001	0.916	0.885–0.948
	Education	-0.249	0.017	-14.30	<.001	0.780	0.754–0.807
Class 3 vs Class 2	Gender	-0.300	0.054	-5.51	<.001	0.741	0.666–0.824
	Age	-0.077	0.015	-5.08	<.001	0.926	0.899–0.954
	Education	-0.185	0.015	-12.35	<.001	0.831	0.807–0.856

Note: R3STEP regression estimates are weighted using the ESS analysis weight (anweight). Class 2 (Moderate Concern/Responsibility Profile) is the reference class. β denotes the multinomial logistic regression coefficient; SE denotes the standard error; OR denotes the odds ratio; and CI denotes the confidence interval. Mplus reports parameter-specific Wald z tests (Estimate/SE) for the automatic R3STEP procedure; separate covariate-level omnibus Wald χ^2 tests are not provided in this output.

Profile relative to the Moderate Concern/Responsibility Profile (OR = 0.780, 95% CI [0.754, 0.807]).

When the Lower Concern/Responsibility Profile (Class 3) was compared with the Moderate Concern/Responsibility Profile, all three demographic variables were again significantly associated with class membership. Gender showed a significant negative association with membership in the Lower Concern/Responsibility Profile ($\beta = -0.300$, SE = 0.054, $z = -5.51$, $p < .001$, OR = 0.741, 95% CI [0.666, 0.824]), indicating that women had lower odds than men of belonging to the Lower Concern/Responsibility Profile rather than the Moderate Concern/Responsibility Profile, after adjustment for age group and educational attainment.

Age group was also significantly and negatively associated with Class 3 membership ($\beta = -0.077$, SE = 0.015, $z = -5.08$, $p < .001$, OR = 0.926, 95% CI [0.899, 0.954]). Each one-category increase in age group was associated with approximately 7.4% lower odds of belonging to the Lower Concern/Responsibility Profile relative to the Moderate Concern/Responsibility Profile, after adjustment for gender and educational attainment.

Educational attainment similarly showed a significant negative association with membership in the Lower Concern/Responsibility Profile ($\beta = -0.185$, SE = 0.015, $z = -12.35$, $p < .001$, OR = 0.831, 95% CI [0.807, 0.856]). Higher values of educational attainment were associated with lower odds of membership in the Lower Concern/Responsibility Profile relative to the Moderate Concern/Responsibility Profile (OR = 0.831, 95% CI [0.807, 0.856]) under the ordinal linear-trend specification used in the R3STEP model.

Educational attainment was treated as an ordered covariate in the R3STEP analysis. This specification assumes a linear trend across successive education categories; therefore, the resulting coefficient was interpreted as an overall ordinal association rather than as category-specific contrasts. Overall, the R3STEP multinomial logistic regression results indicate that gender, age group, and educational attainment were independently associated with latent class membership after mutual adjustment. These findings demonstrate systematic demographic differences in membership across the three concern/responsibility profiles.

3. Discussion

A key finding of this study is that, despite a general tendency within the analytic sample to attribute climate change at least partly to human activity, the identified latent classes differ primarily in the degree of climate concern, perceived personal responsibility, and environmental value orientation. Latent Class Analysis indicates that individuals vary not only in their beliefs about the causes of climate change but also in the extent to which they perceive it as a matter of personal and moral responsibility. This suggests that environmental attitudes do not constitute a homogeneous structure and that individual-centered approaches can advance climate change research. Importantly, the findings suggest that attributing climate change at least partly to human activity does not necessarily correspond to uniformly high levels of climate concern or perceived personal responsibility. The overall pattern is predominantly ordinal, suggesting graded levels of environmental engagement

rather than three fundamentally distinct environmental types.

Within the analytic sample, relatively few respondents attributed climate change entirely to natural processes, while most attributed it at least partly to human activity. However, the latent class structure indicates that similar causal attributions can coexist with different levels of climate concern, perceived personal responsibility, and value-related orientations. Thus, causal attribution alone does not fully characterize the heterogeneity observed across the selected climate-related and value-related indicators. Rather, the identified profiles reflect graded configurations across causal attribution, climate concern, perceived personal responsibility, and the two value-related items included in the analysis, with the clearest differentiation occurring for climate concern and perceived personal responsibility.

These findings show some broad parallels with the “engaged,” “pessimistic,” “indifferent,” and “doubtful” classifications identified by Kácha et al. (2022) using ESS Round 8 data, particularly in demonstrating heterogeneity in climate-related attitudes across European populations. However, direct correspondence between the profiles identified in the two studies should not be assumed, given differences in the indicators, datasets, number and composition of latent classes, and analytical contexts. Accordingly, the present findings should be viewed as complementary evidence of heterogeneity in climate-related perceptions and environmental orientations rather than as a replication of the class structure reported by Kácha et al. (2022).

The pattern observed in the first group, designated the “High Concern/Responsibility Profile,” is broadly consistent with theoretical perspectives derived from Schwartz’s Theory of Values and Stern’s Value-Belief-Norm (VBN) theory. This group showed the highest endorsement of environmental protection values, stronger attribution of climate change to human activities, higher climate concern, and greater perceived personal responsibility. These patterns are broadly consistent

with previous research reporting associations between environmental values and individuals’ interpretations of environmental issues (Schultz et al., 2005; Steg et al., 2014). VBN theory proposes that values are related to pro-environmental attitudes and behaviors through beliefs about environmental consequences and perceived personal responsibility (Stern, 2000). Although the cross-sectional design and the use of single-item value indicators in the present study do not permit a direct test or confirmation of these theoretical mechanisms, the observed clustering of environmental values, climate concern, and perceived personal responsibility is broadly consistent with these theoretical expectations. Similarly, the associations among biospheric values, climate concern, and climate action reported by Bouman et al. (2020) provide relevant comparative evidence for interpreting the present pattern.

Moderate Concern/Responsibility Profile (Class 2) and Lower Concern/Responsibility Profile (Class 3). In both classes, the prevailing perception is that climate change results from a combination of human activities and natural processes. At the same time, the ordered progression from higher to moderate to lower concern and responsibility across the three classes indicates that these profiles are differentiated primarily by degree rather than by qualitatively opposing response configurations. Nevertheless, the two classes differ markedly in their levels of climate concern and personal responsibility. Moderate levels of concern and responsibility characterize Class 2, whereas low levels predominate in Class 3. This pattern is theoretically relevant because similar cognitive assessments of the causes of climate change co-occurred with different levels of climate concern and perceived personal responsibility across the identified profiles. In other words, acknowledging climate change is not synonymous with viewing it as a matter of personal responsibility. Thus, within the identified profiles, similar beliefs about the causes of climate change were not necessarily accompanied by similar levels of perceived personal responsibility.

The country-specific distributions provide a descriptive perspective on the cross-national presence of the classes derived from the pooled latent class model. All three classes were represented in each of the 30 participating countries, although their relative prevalence varied considerably across national samples. This pattern indicates that the pooled classes were not confined exclusively to a small subset of countries. However, the presence of all three classes across countries should not be interpreted as evidence of formal measurement invariance or equivalence of class-specific item-response probabilities across national contexts.

At the same time, the considerable variation in class prevalence demonstrates that the pooled profiles are not distributed uniformly across participating countries. Some national samples contained relatively larger proportions of respondents assigned to the higher concern/responsibility profile, whereas others contained larger proportions assigned to the lower concern/responsibility profile. These differences indicate that national context may be associated with the prevalence of the pooled latent profiles. Accordingly, the pooled solution should be interpreted as an overall cross-national summary of the analytic sample rather than as evidence that an identical latent class measurement structure operates in every participating country.

These findings have important methodological implications. Reporting country-specific class distributions provides useful descriptive information about how the classes derived from the pooled model are represented across national samples and reveals substantial cross-national variation in their prevalence. However, country-specific class prevalence alone cannot establish cross-national measurement equivalence because the present analysis did not test whether class-specific item-response probabilities were invariant across countries. Thus, the country-level distributions should be regarded as a descriptive robustness assessment of the pooled solution rather than as evidence of an invariant latent class structure. Future research using multigroup or known-class LCA,

partial measurement-invariance approaches, or replication across theoretically meaningful country groupings would be needed to evaluate the cross-national equivalence of the latent measurement model more directly.

This result highlights the association between value-related orientations and climate-related attitudes within the identified profiles. The lower importance attached to protecting the environment in the Lower Concern/Responsibility Profile co-occurred with lower climate concern and perceived personal responsibility. This pattern is consistent with aspects of Value-Belief-Norm (VBN) theory, which proposes theoretical relationships among values, environmental beliefs, and personal norms. However, the present cross-sectional latent class analysis does not test the causal sequence proposed by VBN or establish the direction of these relationships. Accordingly, the observed patterns should be interpreted as theory-consistent associations among the selected indicators rather than as evidence that environmental values causally determine climate concern or perceived personal responsibility.

The findings also underscore the relevance of climate concern within the identified profiles. Previous research has documented associations between climate change risk perception and pro-environmental behavior, although these relationships may involve intervening psychological processes (Bradley et al., 2020). This study reveals that high climate concern co-occurs with a strong sense of responsibility and robust environmental values. Conversely, the third group, characterized by low climate concern, exhibited lower levels of responsibility. Within the identified profiles, climate concern co-occurs with perceived personal responsibility and the importance attached to caring for nature and the environment, although these associations should not be interpreted as evidence that climate concern itself represents a broader psychological construct. Thus, climate concern emerges as an important dimension of environmental orientation that is associated with perceived personal responsibility.

Another noteworthy finding concerns differences in the discriminatory contribution of the two value-related indicators. While the item assessing the importance of caring for nature and the environment showed clearer differentiation across the latent classes, the novelty-related item assessing the importance of trying new and different things exhibited relatively limited class discrimination. Accordingly, the contribution of the novelty-related item to the latent class solution should be interpreted cautiously. Although some variation in this item was observed across the profiles, its comparatively weak discriminatory contribution does not support strong conclusions regarding its relationship with climate-related orientations. In contrast, the clearer differentiation observed for the environmental protection item is broadly consistent with previous research reporting associations between environmental values and climate-related attitudes (Steg et al., 2014). Accordingly, the contribution of the person-centered approach in the present study should not be understood as the identification of three fundamentally discrete environmental types. Rather, the latent class solution demonstrates how climate-related causal attribution, concern, perceived personal responsibility, and value-related orientations co-occur at different levels of environmental engagement. Although the profiles are predominantly ordered in degree, the extent of differentiation varies across indicators, with climate concern, perceived personal responsibility, and environmental protection contributing more clearly to class separation than openness to trying new and different things. Thus, the person-centered perspective complements a purely dimensional interpretation by describing how these indicators jointly configure across respondents, while acknowledging the predominantly graded nature of the resulting latent structure.

The association between educational attainment and latent class membership is also noteworthy. Higher educational attainment was associated with lower odds of membership in both the High Concern/Responsibility Profile and the Lower Con-

cern/Responsibility Profile relative to the Moderate Concern/Responsibility Profile. These findings should be interpreted as associations rather than causal effects. One possible explanation is that educational attainment may be related to differences in knowledge, the consideration of long-term social consequences, the understanding of complex environmental processes, or environmental value orientations. However, these potential mechanisms were not directly measured in the present study and therefore remain possible explanations rather than demonstrated mechanisms. Accordingly, the present findings do not establish that education itself produces changes in climate-related awareness, perceived personal responsibility, or environmental values.

The study's findings may also have implications for the business and sustainability literature, although these implications should be interpreted cautiously. The identification of three graded climate concern/responsibility profiles indicates heterogeneity in climate-related perceptions, environmental values, and perceived personal responsibility within the analytic sample. Such heterogeneity may be relevant to future research on stakeholder segmentation, sustainability communication, corporate social responsibility, and green marketing. However, the present study did not directly measure consumer behavior, behavioral intentions, responses to marketing practices, or organizational outcomes; therefore, the findings do not demonstrate that profile-based business or communication strategies would produce more effective outcomes. Rather, the identified profiles provide a potential framework for future studies to examine whether differences in climate concern, environmental values, and perceived personal responsibility are associated with stakeholder responses to sustainability initiatives and green marketing strategies.

4. Conclusion

This study used a person-centered approach to examine heterogeneity in climate-related perceptions, perceived personal responsibility, and value-

related orientations among respondents from countries participating in ESS Round 11. The latent class analysis identified three profiles characterized by predominantly graded differences, particularly in climate concern and perceived personal responsibility. The findings further showed that similar beliefs about the causes of climate change can coexist with different levels of concern and perceived personal responsibility. Gender, age group, and educational attainment were also significantly associated with latent profile membership in the R3STEP analysis after adjustment for the other demographic covariates.

These findings should be interpreted considering the study's principal methodological limitations. In particular, the pooled latent class model did not formally test cross-national measurement invariance, and the moderate classification quality indicates some uncertainty in individual class assignment, especially between the Moderate and Lower Concern/Responsibility Profiles. Accordingly, the identified classes should be understood as probabilistic and predominantly graded response configurations within the pooled ESS Round 11 analytic sample rather than as measurement-invariant or fundamentally distinct respondent types across countries.

Within these boundaries, the findings demonstrate the usefulness of a person-centered approach for characterizing heterogeneity in climate-related orientations and may inform the development and evaluation of differentiated environmental communication, public engagement, and policy messaging. Because behavioral and organizational outcomes were not examined, potential applications to sustainability management, corporate social responsibility, green marketing, and stakeholder behavior remain questions for future research rather than direct empirical implications of the present study.

4.1. Practical Implications

The findings may have practical relevance for the design of climate communication and public engagement strategies. The identification of distinct

latent profiles highlights heterogeneity in climate-related perceptions, environmental values, and perceived personal responsibility, which may be relevant when considering how communication and educational initiatives address different population segments. Policymakers and organizations involved in environmental communication may therefore consider this heterogeneity when developing and evaluating communication approaches. However, because this study did not examine consumer behavior, employee attitudes, purchase intentions, or organizational outcomes, the implications for green marketing, sustainability management, and corporate strategy should be interpreted with caution. Future research should directly investigate whether the identified latent profiles are associated with behavioral and organizational outcomes.

4.2. Limitations

This study is subject to several limitations that should be considered when interpreting the findings. First, the cross-sectional nature of the ESS Round 11 data precludes causal inference; therefore, the observed relationships should be interpreted as statistical associations rather than causal effects. Second, all measures relied on self-reported responses, which may introduce response bias. Third, the two value-related indicators (IMPENVA and IMPDIFFA) were individual items drawn from the broader ESS Human Values battery and therefore should not be interpreted as comprehensive measures of the corresponding Schwartz value constructs. IMPENVA captures the specific importance attached to caring for nature and the environment, whereas IMPDIFFA captures the importance attached to trying new and different things. Although these items are theoretically related to broader value domains in Schwartz's framework, single-item representation does not capture the full conceptual breadth of universalism, stimulation, or the higher-order openness-to-change dimension. Future research could use multi-item value scores derived from the broader ESS Human Values battery to examine whether the

identified patterns are robust to more comprehensive operationalizations of these value domains. Fourth, the recoding and categorization of several variables may have resulted in information loss. In particular, the original 0–10 personal responsibility item (CCRDPRS) was collapsed into three study-specific categories (0–3 = low, 4–7 = moderate, and 8–10 = high). Because these cut-offs were analytically defined rather than based on established ESS thresholds or validated substantive cut-points, the categorization may have affected the observed distribution, class separation, and potentially the resulting latent class solution. The findings involving perceived personal responsibility should therefore be interpreted with this limitation in mind. In addition, the use of complete-case analysis may have introduced selection bias if missingness was not random. Importantly, respondents who indicated that they did not think climate change was happening ($n = 599$; 1.2% of the initial unweighted sample; ANWEIGHT-weighted proportion = 0.7%) were not administered the subsequent climate concern and perceived personal responsibility items because of ESS questionnaire routing and were therefore excluded from the complete-case analytic sample. Consequently, the identified profiles do not represent respondents who explicitly indicated that they did not think climate change was happening, and the findings should be interpreted as applying to respondents with complete information on the selected climate-related and value-related indicators. Fifth, although respondents from 30 countries were included and country-specific class distributions were examined descriptively, cross-national heterogeneity in the latent measurement model was not explicitly modeled, and measurement invariance of the class-specific item-response probabilities across countries was not formally tested. The presence of all three pooled classes across the participating countries and the observed country-specific differences in class prevalence therefore should not be interpreted as evidence that the latent class measurement structure is equivalent across national contexts. Country-specific differences in item-response probabilities may have contributed to the

pooled class solution. Accordingly, the findings should be interpreted as characterizing the pooled ESS Round 11 analytic sample rather than as demonstrating a measurement-invariant latent class structure across the participating countries. Future research could evaluate this issue more directly using multigroup or known-class LCA, partial measurement-invariance approaches, or replication across theoretically meaningful country or regional groupings. Sixth, classification quality was moderate rather than high (entropy = .627), and some overlap was observed between the Moderate and Lower Concern/Responsibility Profiles. Seventh, the study did not examine behavioral outcomes such as pro-environmental behavior, consumer choices, behavioral intentions, or organizational outcomes. Educational attainment was modeled as an ordered linear covariate in the R3STEP analysis, which assumes a constant change in the log-odds across adjacent EISCED categories; this specification may not capture nonlinear or category-specific educational differences in latent class membership. Future research using longitudinal designs, multi-item measures, and behavioral indicators could address these limitations. In addition, although the retained three-class solution reduced residual associations relative to the two-class solution, TECH10 diagnostics indicated that some residual associations among the indicators remained. The local independence assumption should therefore not be regarded as fully satisfied. Accordingly, the identified profiles should be interpreted as a parsimonious representation of the observed response patterns rather than as perfectly locally independent latent subpopulations.

Finally, the three-class solution exhibited a predominantly ordinal structure, particularly for climate concern and perceived personal responsibility, suggesting that the identified classes may partly represent graded positions along a broader environmental engagement continuum rather than fundamentally distinct respondent types. A separate dimensional alternative was not formally tested in the present study. Accordingly, the latent classes should be interpreted cautiously as proba-

bilistic and predominantly ordered response configurations, and future research could directly compare person-centered and dimensional representations of these climate-related orientations.

Declarations

Funding: The author received no financial support for the research, authorship, and / or publication of this article.

Conflicts of Interest: The author declares no conflicts of interest related to this study.

Ethical Approval: Ethical committee approval was not required for this study because This study is based solely on the textual analysis of subtitle transcripts of publicly released films. It does not involve human or animal participants, surveys, interviews, experiments, or the collection of personal data. Therefore, it does not fall within the scope of research requiring ethics committee approval under the relevant regulations on scientific research and publication ethics.

Data Availability: The data that support the findings of this study are openly available in European Social Survey (ESS) Data Portal at https://doi.org/10.21338/ess11e04_2.

AI Disclosure: ChatGPT (GPT-5.6 Sol) was used for An AI-based tool (ChatGPT, OpenAI; GPT-5.6 Sol) was used solely to assist with language editing, proofreading, and improving the clarity and readability of the manuscript. The author reviewed, edited, and verified all AI-assisted outputs and takes full responsibility for the content of the manuscript. AI was not used to generate or analyze the study data or to make substantive research decisions. The author reviewed, edited, and verified all AI-assisted outputs and takes full responsibility for the content of the manuscript.

References

- Arndt, C., Halikiopoulou, D., & Vrakopoulos, C. (2023). The centre-periphery divide and attitudes towards climate change measures among Western Europeans. *Environmental Politics*, 32(3), 381–406.
<https://doi.org/10.1080/09644016.2022.2075155>
- Bouman, T., Verschoor, M., Albers, C. J., Böhm, G., Fisher, S. D., Poortinga, W., Whitmarsh, L., & Steg, L. (2020). When worry about climate change leads to climate action: How values, worry and personal responsibility relate to various climate actions. *Global Environmental Change*, 62, 102061.
<https://doi.org/10.1016/j.gloenvcha.2020.102061>
- Bradley, G. L., Babutsidze, Z., Chai, A., & Reser, J. P. (2020). The role of climate change risk perception, response efficacy, and psychological adaptation in pro-environmental behavior: A two nation study. *Journal of Environmental Psychology*, 68, 101410.
<https://doi.org/10.1016/j.jenvp.2020.101410>
- Clark, S. L., & Muthén, B. (2009). *Relating latent class analysis results to variables not included in the analysis*.
- Dunlap, R. E., & Van Liere, K. D. (1978). The “New Environmental Paradigm.” *The Journal of Environmental Education*, 9(4), 10–19.
<https://doi.org/10.1080/00958964.1978.10801875>
- Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). New Trends in Measuring Environmental Attitudes: Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues*, 56(3), 425–442.
<https://doi.org/10.1111/0022-4537.00176>
- European Commission. (2023). *Special Eurobarometer 538: Climate Change*.
- European Social Survey European Research Infrastructure (ESS ERIC). (2026). ESS11—Integrated file, edition 4.2 [Data set]. Sikt—Norwegian Agency for Shared Services in Education and Research.
https://doi.org/10.21338/ess11e04_2

- Kácha, O., Vintr, J., & Brick, C. (2022). Four Europes: Climate change beliefs and attitudes predict behavior and policy preferences using a latent class analysis on 23 countries. *Journal of Environmental Psychology*, 81, 101815. <https://doi.org/10.1016/j.jenvp.2022.101815>
- Kaminska, O. (2020). *Guide to Using Weights and Sample Design Indicators with ESS Data Contents*. www.europeansocialsurvey.org/sites/default/files/2023-06/ESS_weighting_data_1_1.pdf?
- Karp, D. G. (1996). Values and their Effect on Pro-Environmental Behavior. *Environment and Behavior*, 28(1), 111–133. <https://doi.org/10.1177/0013916596281006>
- Kim, J., Nuhoğlu Soysal, Y., Cebolla Boado, H., & Schimmöller, L. (2024). Inhibiting or Contributing? How Global Liberal Forces Impact Climate Change Skepticism. *International Journal of Sociology*, 54(5–6), 530–564. <https://doi.org/10.1080/00207659.2024.2416279>
- Kulin, J., & Johansson Sevä, I. (2024). Rightwing populist attitudes and public support for climate policies in Western Europe: Widening the scope using the European Social Survey. *PLOS Climate*, 3(10), e0000443. <https://doi.org/10.1371/journal.pclm.0000443>
- Kulin, J., Johansson Sevä, I., & Dunlap, R. E. (2021). Nationalist ideology, rightwing populism, and public views about climate change in Europe. *Environmental Politics*, 30(7), 1111–1134. <https://doi.org/10.1080/09644016.2021.1898879>
- Masyn, K. E. (2013). Latent Class Analysis and Finite Mixture Modeling. In *The Oxford handbook of quantitative methods in psychology* (Vol. 2, pp. 551–611). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199934898.013.0025>
- Muthén, L. K., & Muthén, B. O. (2026). Mplus (Version 9.1) [Computer software]. Muthén & Muthén.
- Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the Number of Classes in Latent Class Analysis and Growth Mixture Modeling: A Monte Carlo Simulation Study. *Structural Equation Modeling: A Multidisciplinary Journal*, 14(4), 535–569. <https://doi.org/10.1080/10705510701575396>
- Poortinga, W., Whitmarsh, L., Steg, L., Böhm, G., & Fisher, S. (2019). Climate change perceptions and their individual-level determinants: A cross-European analysis. *Global Environmental Change*, 55, 25–35. <https://doi.org/10.1016/j.gloenvcha.2019.01.007>
- Schultz, P. W., Gouveia, V. V., Cameron, L. D., Tankha, G., Schmuck, P., & Franěk, M. (2005). Values and their Relationship to Environmental Concern and Conservation Behavior. *Journal of Cross-Cultural Psychology*, 36(4), 457–475. <https://doi.org/10.1177/0022022105275962>
- Schwartz, S. H. (1992). Universals in the Content and Structure of Values: Theoretical Advances and Empirical Tests in 20 Countries. In *Advances in experimental social psychology* (Vol. 25, pp. 1–65). Academic Press. [https://doi.org/10.1016/S0065-2601\(08\)60281-6](https://doi.org/10.1016/S0065-2601(08)60281-6)
- Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An Integrated Framework for Encouraging Pro-environmental Behaviour: The role of values, situational factors and goals. *Journal of Environmental Psychology*, 38, 104–115. <https://doi.org/10.1016/j.jenvp.2014.01.002>
- Stern, P. C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, 56(3), 407–424. <https://doi.org/10.1111/0022-4537.00175>
- Stern, P. C., & Dietz, T. (1994). The Value Basis of Environmental Concern. *Journal of Social Issues*, 50(3), 65–84. <https://doi.org/10.1111/j.1540-4560.1994.tb02420.x>
- Stoll-Kleemann, S., O'Riordan, T., & Jaeger, C. C. (2001). The psychology of denial concerning climate mitigation measures: Evidence from Swiss focus groups. *Global Environmental Change*, 11(2), 107–117. [https://doi.org/10.1016/S0959-3780\(00\)00061-3](https://doi.org/10.1016/S0959-3780(00)00061-3)
- Tein, J.-Y., Cox, S., & Cham, H. (2013). Statistical Power to Detect the Correct Number of Clas-

ses in Latent Profile Analysis. *Structural Equation Modeling: A Multidisciplinary Journal*, 20(4), 640–657.

<https://doi.org/10.1080/10705511.2013.824781>

Verschoor, M., Albers, C., Poortinga, W., Böhm, G., & Steg, L. (2020). Exploring relationships between climate change beliefs and energy preferences: A network analysis of the European Social Survey. *Journal of Environmental Psychology*, 70, 101435.

<https://doi.org/10.1016/j.jenvp.2020.101435>

WMO, & C3S/ECMWF. (2026). *C3S-WMO European State of the Climate 2025*.

<https://doi.org/10.24381/zy93-sb27>

Yao, M., Perez Alonso, A. F., Vermunt, J. K., & De Roo-ver, K. (2026). Revealing cross-national differences and similarities in relations between human values and climate policy support by Mixture Multigroup Structural Equation Modeling: a new tool for comparative research. *Frontiers in Political Science*, 8, 1768359.

<https://doi.org/10.3389/fpos.2026.1768359>

Supplementary

Supplementary Material S1. Mplus Syntax for the Final Three-Class Latent Class Model with Automatic R3STEP Covariates

TITLE: Final 3-Class LCA with Automatic R3STEP Covariates;

DATA:

FILE = "C:\Users\HP\Desktop\data.dat";

VARIABLE:

NAMES =

ccnthum wrclmch ccrdprs impenva impdiffa

gn dr agegroup eisced anweight;

USEVARIABLES =

ccnthum wrclmch ccrdprs impenva impdiffa;

CATEGORICAL =

ccnthum wrclmch ccrdprs impenva impdiffa;

CLASSES = c(3);

MISSING = ALL (-999);

WEIGHT = anweight;

AUXILIARY = (R3STEP) gn dr agegroup eisced;

ANALYSIS:

TYPE = MIXTURE;

ESTIMATOR = MLR;

STARTS = 5000 1000;

STITERATIONS = 50;

OUTPUT:

TECH1 TECH4 TECH7 TECH8;

Supplementary

Material S2. Mplus Syntax for Class Enumeration and Local-Independence Assessment

TITLE: Latent Class Enumeration;

DATA:

FILE = "C:\Users\HP\Desktop\data.dat";

VARIABLE:

NAMES =

ccnthum wrclmch ccrdprs impenva impdiffa

gn dr agegroup eisced anweight;

USEVARIABLES =

ccnthum wrclmch ccrdprs impenva impdiffa;

CATEGORICAL =

ccnthum wrclmch ccrdprs impenva impdiffa;

CLASSES = c(3);

MISSING = ALL (-999);

WEIGHT = anweight;

ANALYSIS:

TYPE = MIXTURE;

ESTIMATOR = MLR;

STARTS = 5000 1000;

STITERATIONS = 50;

OUTPUT:

TECH1 TECH4 TECH7 TECH8 TECH10 TECH11;

Supplementary

Table S3. Class Sizes and Conditional Response Probabilities for the Four-Class Solution

Indicator Class size (%)	Category	Class 1 12.35	Class 2 21.17	Class 3 37.17	Class 4 29.32
CCNTHUM	1	.143	.011	.006	.006
	2	.284	.014	.059	.020
	3	.421	.240	.566	.368
	4	.124	.517	.327	.516
	5	.027	.220	.042	.090
WRCLMCH	1	.308	.004	.000	.005
	2	.484	.005	.185	.000
	3	.149	.141	.715	.371
	4	.050	.506	.090	.581
	5	.008	.343	.010	.043
CCRDPRS	1	.631	.046	.113	.054
	2	.280	.102	.554	.209
	3	.089	.852	.333	.737
IMPENVA	1	.090	.007	.028	.000
	2	.159	.017	.115	.012
	3	.242	.026	.325	.132
	4	.312	.169	.354	.650
	5	.197	.781	.179	.206
IMPDIFFA	1	.178	.115	.146	.139
	2	.188	.133	.219	.185
	3	.212	.209	.264	.275
	4	.261	.269	.249	.320
	5	.161	.273	.121	.081

Note. Values represent model-estimated conditional response probabilities for each indicator category within each latent class. Class sizes are based on the estimated model. CCNTHUM = perceived causes of climate change; WRCLMCH = climate change concern; CCRDPRS = perceived personal responsibility to reduce climate change; IMPENVA = importance attached to caring for nature and the environment; IMPDIFFA = importance attached to trying new and different things.

Supplementary

Table S4. TECH10 Local-Independence Diagnostics Across the Two-, Three-, and Four-Class Solutions

Indicator Pair	C = 2 Max. z	C = 2 n Sig.	C = 3 Max. z	C = 3 n Sig.	C = 4 Max. z	C = 4 n Sig.
CCNTHUM-WRCLMCH	23.412	13	9.931	9	7.069	7
CCNTHUM-CCRDPRS	13.085	10	3.140	3	3.245	1
CCNTHUM-IMPENVA	6.138	11	4.314	8	4.431	8
CCNTHUM-IMPDIFFA	4.399	2	2.232	5	2.926	7
WRCLMCH-CCRDPRS	20.131	11	3.797	5	1.991	1
WRCLMCH-IMPENVA	14.403	19	10.071	13	3.585	3
WRCLMCH-IMPDIFFA	5.557	8	3.621	2	2.913	3
CCRDPRS-IMPENVA	7.243	8	3.022	7	1.954	0
CCRDPRS-IMPDIFFA	2.703	3	2.932	2	3.282	1
IMPENVA-IMPDIFFA	16.660	17	13.723	17	7.410	18
Overall	—	102	—	71	—	49

Note. Max. |z| represents the largest absolute standardized residual across response-category combinations for each indicator pair. n Sig. represents the number of significant standardized residuals reported in the Mplus TECH10 output for the corresponding indicator pair. Lower numbers of significant standardized residuals indicate less residual association after conditioning on latent class membership. TECH10 was treated as a diagnostic of residual association rather than as a stand-alone criterion for class enumeration.