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Social Representations of Environmental Problems and Solutions in Rural Contexts: Comparative Evidence from Three Independent Cohorts

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Environmental problems today represent a growing challenge with profound impacts on rural communities, biodiversity, and traditional livelihoods. In response, local solutions emerge that seek to mitigate or adapt to ecological consequences, which vary over time. The objective of this study was to analyze the social representations of environmental problems and solutions, examining their temporal evolution across three cohorts within a sample of rural population. Methodologically, an exploratory approach to social representations was adopted, using a mixed-method strategy with a repeated cross-sectional trend design. Trends

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were examined among 169 rural participants corresponding to the years 2019, 2020, and 2022, using non-probabilistic convenience sampling through a questionnaire. Additionally, a co-occurrence analysis of codes for open-ended questions regarding environmental problems was used to enhance understanding of the representations. As for the results, the significant and stable problem identified was climate change, understood as a highly abstract issue that is difficult to address. On the other hand, among the solutions, environmental education predominated, showing statistically significant growth in its relevance. In contrast, the absence of changes in rural lifestyles—such as reducing meat consumption or ceasing the use of firewood for heating—reveals difficulties in modifying rural ways of living. In conclusion, the study underscores the need to strengthen environmental education in rural areas, both in formal and non-formal contexts, and to deepen the understanding of climate change at the rural level, considering practical and applied approaches.

KEYWORDS: Social representations, climate change, rural, environmental problems, environmental solutions

INTRODUCTION

Environmental problems and their potential solutions represent a significant and constantly evolving challenge for humanity, with important repercussions for social and economic systems at the global level (Intergovernmental Panel on Climate Change [IPCC], 2021). The era of the Anthropocene and the increasing manipulation of territory through human activities have emerged as the primary drivers of changes in climate and the natural environment (Moore, 2015).

Communities living in rural areas are human groups that experience environmental transformations in close proximity, due to their direct interaction with spaces undergoing ecosystem reconfiguration and their strong dependence on these environments. This situation generates consequences that affect the production of social vulnerability as well as physical, mental, and food-related health (Kipp et al., 2019).

In Latin America, rural territories make up 18% of the region, although they are areas showing a tendency toward reduction (World Bank [WB], 2024). Nevertheless, these zones undergo negative environmental transformations as a result of prevailing extractive and productive

models that directly impact the daily lives of their inhabitants (Gudynas, 2015). Among the most notable changes are the sustained increase in extreme climate events, prolonged droughts, heatwaves, and hydric variability, along with the overexploitation of natural resources linked to agroindustry and the growing pressure on ecosystems (Avila-Diaz et al., 2023; Food and Agriculture Organization [FAO], 2024).

Productive sectors such as forestry, agriculture, and livestock farming are located predominantly in rural areas and are considered a source of economic development for these communities. However, they are also experiencing socio-environmental transformations that generate socioeconomic consequences to the detriment of the actors present in rural settings (Wang et al., 2021; Palacios-Abrantes et al., 2022; Shoko-Kori, 2023).

In response to these scenarios, rural inhabitants have been key actors in the ongoing transformation of practices, adaptation strategies, and other forms of response that reflect the diverse ways in which communities experience and confront environmental problems (Gallardo-Milanés & Hardy-Casado, 2016). For this reason, from the perspective of social representations, we can attend to the emergence and transformation of the relationships that rural inhabitants establish around environmental problems and solutions, thus revealing how these groups construct shared meanings and hierarchize them (Chen, 2019; Piermattéo, 2014; Lo Monaco & Rateau, 2025).

Based on the above, the objective of this study is to analyze the existence of significant variations in the importance assigned to environmental problems and solutions across three rural cohorts (2019, 2021, and 2022), interpreting these differences as indicators of stability or change in social representations, and to complement this analysis with a qualitative description of the contents that participants associate with environmental problems.

Climate change in the rural context

In south-central areas of Chile, climate change presents differentiated and specific impacts at the territorial level, affecting both rural and urban areas (Peña-Garay & Sandoval-Díaz, 2024). In rural environments, environmental problems directly influence subsistence activities that depend on natural resources, such as agriculture, soil, water, and forest ecosystems (FAO, 2024).

These activities are negatively affected due to alterations in climate patterns, fluctuations in precipitation, increases in extreme temperatures, and the intensification of meteorological

phenomena, all of which compromise the stability and sustainability of rural livelihoods (Msimanga & Mukwada, 2022). Moreover, rural communities face additional vulnerabilities due to structural barriers related to access to and use of natural, economic, educational, health, technological, and social resources (Georgilas et al., 2021; Soz & Mankar, 2021; Shoko-Kori, 2023). In addition to these effects, it is important to recognize that environmental dynamics encompass psychosocial dimensions whose impacts go beyond the physical, affecting the mental health and social well-being of communities (Clayton et al., 2020; Shoko-Kori, 2023).

Although research in this area is extensive and efforts have been made to address the rapid proliferation and transformation of environmental problems and solutions over time, these efforts have become insufficient to confront the complex interconnection of psychosocial, economic, political, and environmental challenges affecting rural communities in their context (Kinzig et al., 2013; Herrfahrdt-Pähle, 2020; Nagel & Partelow, 2022). Understanding how rural communities represent these challenges will allow for the development of territorially relevant responses, ensuring their sustainability (Sapiains & Ugarte, 2017a).

In this context, the experiences and ways of life of rural communities are shaped differently according to their sociocultural traditions and customs, expressing particular ways of problematizing environmental issues and proposing solutions to them (Burgos-Ayala et al., 2020). These particularities respond to their knowledge, beliefs, and attitudes, which translate into ways of inhabiting the territory based on a contextualized representation of the environmental problems they experience daily in their setting and, consequently, influence the design and preference for mitigation and adaptation strategies developed at the local level, enabling the creation of contextually relevant solutions (Berkes et al., 2000; Thinh, Mu, & Mul, 2007; Madzivhandila, 2024).

Over time, variations in environmental conditions have become increasingly evident and accelerated, affecting the way this phenomenon is perceived and represented at psychosocial and economic levels. This process was analyzed in the trend study conducted by Kandikuppa and Gray (2022), who argue that environmental problems interact with pre-existing socioeconomic inequalities, amplifying their effects. Thus, as time progresses and climate anomalies intensify, rural households experience heightened multidimensional impacts. Based on these findings, the

need to periodically monitor the effects of environmental problems and alternatives in rural households is emphasized.

Psychosocial dimensions of environmental problems

Amid the urgency and importance of environmental problems, together with the relevance of human behavior both in generating problems and producing solutions for the environment, it becomes necessary to call for an integration of environmental issues with the social sciences in order to deepen and connect changing and pressing social problems. In this regard, socio-environmental studies have increasingly established themselves as a significant field in contemporary society (Ramos-Zincke, 2014).

Along these lines, environmental studies have increasingly focused on the socio-environmental conflicts and crises triggered by neoliberal development models that shape Latin American contexts (Forero et al., 2014; Medina-Arboleda & Páramo, 2024). These conflicts are rooted in environmental controversies, understood as debates and tensions that arise around the impacts of human activities on the environment and that reveal a diversity of perspectives (Correa & Cid-Aguayo, 2021). In this sense, climate change has become one of the main environmental controversies of our time, reflecting a series of consequences that profoundly affect ecological, psychological, social, and economic systems at both global and local levels (Pawson, 2020; Kandikuppa & Gray, 2022; Clayton, 2024).

From the perspective of environmental psychology, particularly in areas related to the environment, ecology, and climate change, it is recognized that rational dimensions constitute key pillars shaping adaptation and mitigation strategies in response to environmental phenomena (Clayton, 2019; Corral-Verdugo, 2021). Although much of the literature on environmental adaptation has focused on technological, institutional, and financial barriers to climate action as proposed by Landauer et al. (2019), Georgilas et al. (2021), and Bergamini & Rasse (2022), there is growing recognition of the role played by cognitive processes in shaping how individuals perceive, process, and represent climate change (Chen, 2019; Clayton et al., 2020).

Rational determinants include individuals' ability to perceive, understand, analyze, and decide which actions to take in response to this phenomenon, while affective determinants are linked to

emotional processes, intuition, and decision-making based on preferences and synthesis capacities. Within the field of environmental psychology, significant efforts have been made to detail and understand the psychological, social, and emotional factors involved in climate change (Clayton, 2019; Valera et al., 2021; Mardones & Berroeta, 2024). In this framework, psychosocial and cognitive dimensions such as education, attitudes, motivation, needs, and perception are considered key elements that shape how people understand and respond to the phenomenon (Corral-Verdugo, 2021; Spence et al., 2011; Biddau et al., 2022).

In this regard, misinformation and limited access to environmental education constitute significant cognitive barriers, as they shape perceptions that may either facilitate or hinder the implementation of adaptation and mitigation strategies (Ranney & Velautham, 2021). These cognitive expressions are key to understanding how individuals and communities develop coping strategies in response to the impacts of climate change and construct adaptive responses at both the local and global levels (Jodelet, 2018; Cianconi et al., 2020).

Social representations, rurality, and the environment

To achieve a comprehensive approach to the psychosocial dimensions of the environment in rural contexts, the framework of social representations is particularly valuable due to its capacity to encompass the understanding of a dynamic, contingent, and ever-changing representational object such as environmental problems (Flores & Amigón, 2018). Social representations can be defined as shared understandings of a specific social object, based on organized or diverse opinions, beliefs, and knowledge shaped by cultural sources, experience, common sense, traditions, and formal education (Moscovici, 1981; Núñez, 2019).

For the purposes of this study, social representations are conceived as dynamic, changing, and tensioned phenomena (Jodelet, 2015). Accessing the displacement of environmental problems and solutions in rural contexts provides evidence that allows for a closer examination of the proximities, variability, and tensions present within these representations (Villas Bôas, 2014; Murekian, 2020). In line with the research objective and the empirical design, the study adopts an exploratory and

comparative perspective grounded in Social Representations Theory, drawing primarily on processual and sociodynamic contributions in accordance with the comparative logic employed (Jodelet, 1984; Doise et al., 1993). The exploratory orientation aims to identify patterns of stability or change in the prioritization of environmental problems and solutions across different cohorts. These patterns are interpreted as indicators of shifts in socially shared meanings and priorities, while simultaneously allowing for a more in-depth examination of specific representational dimensions (Lo Mónaco & Rateau, 2025).From the intersection between climate change, rurality, and social representations, studies such as that of Rodríguez et al. (2021) have demonstrated a relationship among these elements, deepening the understanding of problems associated with climate change from bioecological effects that impact both the environment and human health to psychosocial dimensions that integrate objective and subjective aspects of the perception and representation of the phenomenon.

At the global level, studies such as those by Forero et al. (2014) and Tam et al. (2021) point to the absence of literature addressing environmental issues such as climate change in specific population samples such as rural inhabitants and, in particular, their forms of mitigation and adaptation over time in developing countries. In line with this, the aim is to contribute to the field of psychological research on the environment in Latin America, which remains scarce and relatively recent (Sapiains & Ugarte, 2017b; Reveco-Quiroz et al., 2022; Mardones & Berroeta, 2024).

Likewise, in methodological terms, socio-environmental studies have predominantly leaned toward quantitative approaches linked to correlations and experimental designs (Tam et al., 2021). Nevertheless, the value of mixed, cohort, and multilevel designs for environmental studies is recognized, with an emphasis on the development of a qualitative strand that allows for a committed engagement with socio-historical and political realities (Tam et al., 2021; Mardones & Berroeta, 2024).

Finally, social representations theory has the potential to become a substantive framework for transitioning from perception studies to the representation of environmental risk. The latter emphasizes the importance of reference frameworks, context, and local knowledge in how environmental problems and solutions are conceptualized and operationalized (Smith & Joffe, 2013; Chen, 2019; Peña-Garay & Sandoval-Díaz, 2024).

METHOD

Social representations theory offers a flexible and exploratory conceptual framework that enables an understanding of how members of rural communities construct, modify, and express their social realities over time within their respective environments. Thus, they become a useful tool for exploring social transitions based on empirical data, allowing for the adoption of multi-methodological and theoretically embedded perspectives (Piermattéo, 2014; Lo Mónaco & Rateau, 2025).

Guided by the research question—focused on patterns of stability and change in social representations of environmental problems and solutions—the method was organized into two complementary levels.

First, a qualitative content analysis of open-ended responses was carried out, with the purpose of describing the semantic structure and content of social representations' definitions, causes, responsibilities, and mitigation measures, thereby complementing the general interpretation of the study based on participants' open responses, without comparative or longitudinal aims (Murunga et al., 2022).

Second, at the quantitative level, the study adopts a comparative non-parametric approach, based on repeated cross-sectional trend analyses, aimed at examining representational patterns and trends of stability or change through the ranking of environment-related problems and solutions across three different years (2019, 2020, and 2022), with the year 2021 excluded due to the COVID-19 pandemic (Doise et al., 1993; León & Montero, 2002).

In this way, the quantitative component makes it possible to identify patterns of stability and change in environmental priorities, whereas the qualitative component, collected in the final year of application, provides an understanding of representational content without seeking to evaluate transformations over time, but rather to support their interpretation.

This functional differentiation clarifies the role of each approach: whereas the qualitative component provides interpretive depth regarding how representations are configured, the quantitative analysis identifies patterns of stability and change in their prioritization. Such forms of complementarity align with the modalities of partial integration described in the mixed-methods

literature (Fetters, Curry, & Creswell, 2013), thus the study adopts a multimethod approach, consistent with calls for a reflexive use of these methods (Núñez-Moscoso, 2017).

Participants

A non-probabilistic convenience sampling method was adopted (León & Montero, 2002). Different groups of participants were selected for each year of the study: 30 participants in 2019, 75 in 2020, and 55 in 2022, as shown in Table 1. All participants were required to meet two inclusion criteria:

(a) be 18 years of age or older, and (b) reside in the Ñuble Region of Chile and live in a rural territorial context according to the criteria established by the World Bank (WB, 2024).

Table 1

Sociodemographic Characteristics of the Rural Sample by Year of Cohort Application of the Instrument

Characteristics / Cohort	2019 (%)	2020 (%)	2022 (%)	Total (%)
Gender				
Female	66,7%	57,3%	30,9%	50%
Male	33,3%	42,7%	67,3%	49,3%
No-binary	0	0	1,8%	0,6%
Age range				
18 to 24 years	40,0%	84,0%	69,1%	70,6%
25 to 38 years	13,3%	8,0%	16,4%	11,9%
39 to 75 years	46,7%	8,0%	14,5%	17,5%
Belongs to an NGO or environmental movement				
Yes	3,3%	13,3%	12,7%	11,3%
No	96,7%	86,7%	87,4%	88,8%
Political affinity				
Left	23,3%	12,0%	16,4%	15,6%
Center	3,3%	13,3%	12,7%	11,3%
Right	0%	4%	12,7%	6,3%
Apolitical	73,3%	24%	29,1%	35%
Civic activist (non-partisan)	0%	46,7%	29,1%	31,9%
Occupation				
No paid employment	66,7%	65,3%	43,6%	58,1%
Elementary jobs	3,3%	14,7%	41,8%	21,9%
Technical jobs	20%	13,3%	5,5%	11,9%
Professional jobs	10%	6,7%	9,1%	8,1%
Highest educational level attained				
No formal education	3,3%	0%	0%	0,6%
Incomplete primary education	6,7%	0%	23,6%	9,4%
Complete primary education	3,3%	1,3%	27,3%	10,6%
Incomplete secondary education	0%	0%	34,5%	11,9%
Complete secondary education	43,3%	81,3%	14,5%	51,2%
Incomplete higher education	30%	0%	0%	5,6%
Complete higher education	13,3%	16,0%	0%	10%
Complete postgraduate education	0%	1,3%	0%	0,6%
Monthly income or salary				
Less than $250,000 per month	33,3%	54,7%	0%	31,9%
Between $250,000 and $500,000 per month	36,7%	20%	32,7%	27,5%
Between $500,000 and $750,000 per month	6,7%	8,0%	29,1%	15,0%
Between $750,000 and $1,000,000 per month	13,3%	13,3%	10,9%	12,5%
Between $1,000,000 and $1,500,000 per month	6,7%	2,7%	3,6%	3,8%
Between $1,500,000 and $2,000,000 per month	0%	1,3%	5,5%	2,5%
More than $2,000,000 per month	3,3%	0%	18,2%	6,9%

Procedure

Data collection was carried out in 2019, 2020, and 2022. No compensation was provided to participants for their collaboration in the study. The first round took place between July and August 2019 and was conducted in the respondents' homes, with an average duration of 20 minutes. Due to the COVID-19 pandemic, the second round was conducted virtually through a Google Form in December 2020. The third round, at the end of 2022, followed the same virtual format.

Data were collected by previously trained university students. They were instructed in clarifying the study's objectives, emphasizing the voluntary nature of participation, ensuring confidentiality, managing application time, and appropriately addressing emerging questions. Before completing the data collection instrument, participants were informed of the nature and objectives of the research through an informed consent form, which they had to accept before proceeding. Finally, the study received approval from a research ethics committee as part of FONDECYT Project No. 11200683.

Instruments

The survey covered three key areas: (i) sociodemographic characterization of the participants, (ii) three brief open-ended questions about climate change (CC) regarding knowledge, causes, consequences, and possible solutions (only for the year 2022), and (iii) two sections for ranking both environmental problems and potential solutions.

The environmental problems to be ranked were: climate change, resource depletion, overuse of water, plastic pollution, biodiversity loss, and pollution-related diseases.

The proposed solutions to be ranked were: reduce, reuse, recycle; provide more environmental education and information; save energy; take action against biodiversity loss; pressure governments to act; change the economic model; use dry firewood or stop using firewood for heating; and consume less meat.

Both environmental problems and solutions were assessed using an ordinal ranking scale, where a value of 1 indicates the highest perceived importance and higher values indicate lower perceived importance. The selection of these problems and solutions was carried out by the authors of the study, based on existing literature in the field and informed by problematizations presented in reports, bulletins, and publications from credible, reliable, and prestigious national and

international institutions in the area (Bergamini et al., 2017; Ministry of the Environment [MMA], 2017; United Nations Environment Programme [UNEP], 2021; IPCC, 2021; Bergamini & Rasse, 2022; WB, 2024; FAO, 2024). Although climate change constitutes a broad category that may encompass issues included in the other options, its inclusion as an independent item responds to a theoretical criterion specific to social representations studies, allowing access to different levels of abstraction within the same representational field.

Data Analysis

For the analysis of qualitative data, the content analysis technique was used (Willig, 2013), implementing a hierarchical categorical system composed of two levels: categories and codes (Taylor & Bogdan, 1987). The procedure was carried out in three coding phases. In the first phase, an initial exploration of the data was conducted to assign meaning labels to categories and codes; in the second phase, these units were expanded and refined; and finally, in the third phase, the interrelationships among them were established. The entire process was performed using ATLAS.ti v.22, a tool that optimizes qualitative analysis of large volumes of information and supports researcher interpretation (Lopezosa et al., 2022; Rodríguez, 2020).

After creating the project in ATLAS.ti, all data were coded following the three phases described, and a descriptive and exploratory analysis focused on code frequencies was subsequently conducted. Then, an analysis using proximity operators was performed, culminating in a co-occurrence analysis of codes. Based on the refined data provided by the co-occurrence table generated by the software, a Sankey diagram was created.

Second, for quantitative data, a descriptive review of environmental problems and solutions was conducted through a frequency analysis using RStudio 4.4.1. With the assistance of the same software and given the nature of the variables, the non-parametric Kruskal–Wallis H test was applied to compare the distribution of rankings across the three periods, assessing the presence of statistically significant differences in the representation of each environmental category, an appropriate approach for ordinal or non-normally distributed data (Nwobi & Akanno, 2021).

Subsequently, in order to identify the specific time periods in which differences emerged in the evaluation of the proposed solutions to climate change across the study years, a post hoc analysis using the Mann–Whitney U test was conducted, applied exclusively to the variables that

showed significant differences in the Kruskal–Wallis H test (Zamora-Mayorga et al., 2023). This strategy allowed for pairwise comparisons between years. Additionally, a Bonferroni correction was applied, adjusting the significance level to $p < .0167$ (0.05 divided by the three comparisons conducted), thereby strictly redefining the criterion and identifying only those differences that remained robust against the risk of false positives, thus strengthening the inferential validity of the analysis (Dagnino, 2014; Romaní-Romaní et al., 2023).

RESULTS

The results are divided into two sections. The first, qualitative in nature, presents the findings derived from the instrument's open-ended questions. The second subsection reports the quantitative data obtained from the descriptive analysis of the environmental problems and solutions identified through the applied instrument.

Given that the open-ended responses allow for the identification of culturally shared meanings that structure social representations, evidence of temporal variation comes exclusively from the quantitative analysis of the rankings enabling systematic comparisons across years.

Qualitative Results

Initially, the qualitative results are presented descriptively, detailing the frequency of occurrence of the codes. Subsequently, an analysis was conducted using proximity operators, specifically through the semantic co-occurrence of ideas present in the open-ended responses provided by the participants.

Table 2

Percentage of Code Frequency by Category of Analysis

Category	Code		%
Definition of climate change	Consequences of the Overuse of Natural Resources		3%
	Changes in Environmental Conditions		28%
	Environmental Phenomenon Caused by Humans		69%
		Total	100%
Responsibilities regarding climate change	Shared Responsibilities (Individual and Collective)		20%
	Government Responsibilities		20%
	Individual Responsibilities		28%

	Private Sector and Corporate Responsibilities	32%
	Total	100%
Climate change mitigation Measures	Reducing or Avoiding the Use and Consumption of Certain Elements	6%
	Legal and Governmental Measures for Individuals and Companies	18%
	Protecting Natural Resources: Recycling and Reusing	27%
	Personal Changes through Education and Promotion	49%
	Total	100%
Climate change effects	Individual Effects	6%
	Social Effects	13%
	Environmental Effects	81%
	Total	100%

Source: Own elaboration

The frequency of the codes indicates that the definition of climate change (CC) is primarily associated with an environmental phenomenon induced by human activity (69%). Likewise, shared responsibility is observed among individuals (28%), private entities (32%), and the government (20%). A clear example of this can be seen in the following quote:

"The changes that are currently occurring are due to the misuse of natural resources by humans and to the pollution caused both by individuals and by large industries" (Participant 32, 2022).

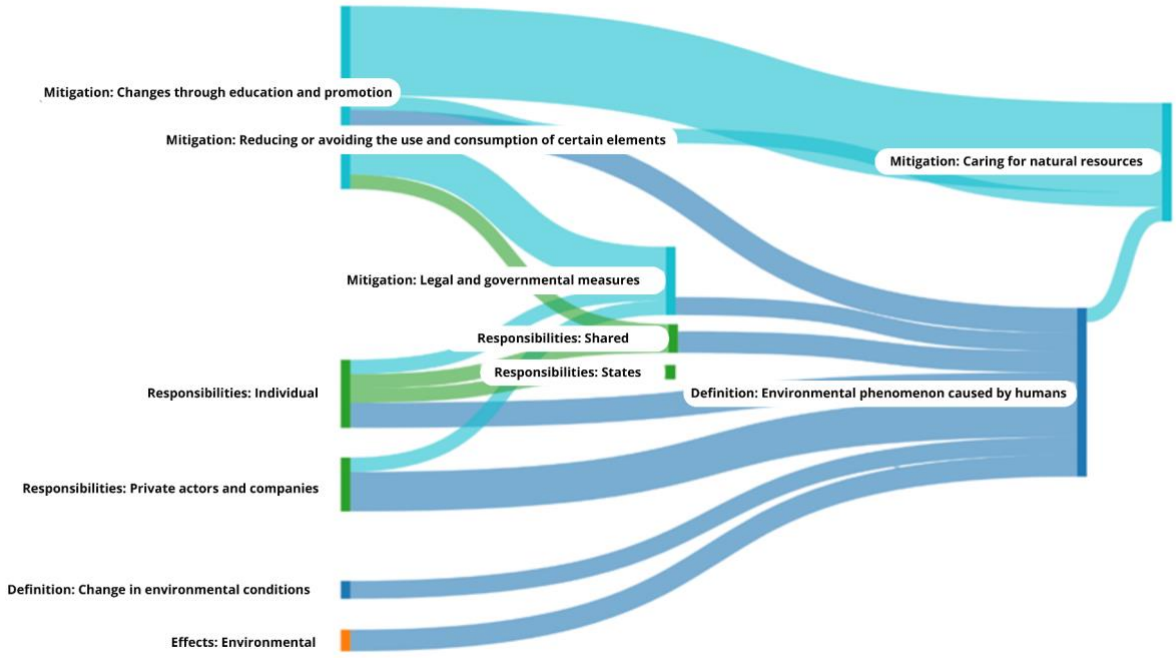
Here, the co-occurrence of these codes is evident, as the definition attributes environmental changes to human actions, while responsibility is assigned mainly to individuals and private entities.

Regarding measures to mitigate the effects of CC, ideas related to personal changes through education and awareness-raising predominate (49%), followed by actions aimed at protecting natural resources, such as recycling and reusing (27%). In terms of effects, environmental consequences stand out (81%). The presence of both themes is illustrated in the following quote:

"We all have to change something, because we all live on this planet and we need to contribute our grain of sand; we are all one, and we cannot simply place blame without taking action in the face of the serious effects on the environment" (Participant 5, 2019).

Figure 1

Sankey Diagram of Semantic Co-Occurrence Regarding the Definition, Responsibilities, Mitigation Measures, and Effects of climate change



The Sankey diagram in Figure 1 illustrates the flow and relationships among the codes used to analyze the participants' narratives. On one hand, the flow widens when there is a greater recurrence between two codes. On the other hand, the relationships are visualized through the colors that move from one code to another.

In this regard, among the themes, ideas, and perceptions that exhibit proximity in participants' accounts, a high-density co-occurrence node is the definition of the concept of climate change, which is associated with an environmental phenomenon caused by human activity. This definition is linked to themes such as shared responsibilities between individuals and private entities, as well as the perception that CC primarily involves changes in environmental conditions.

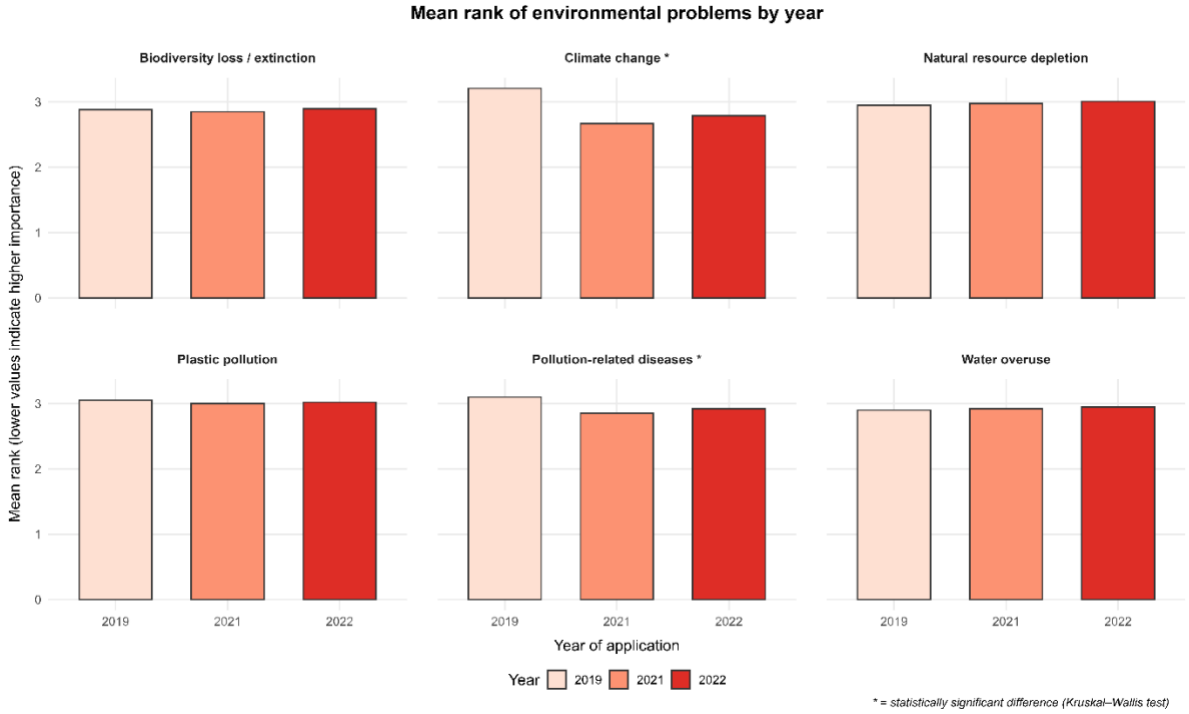
Another marked tendency is observed to associate personal changes driven by education and awareness with two main areas. First, the care of natural resources is emphasized, for example, through recycling and reusing. Second, the importance of implementing legal and governmental measures directed at individuals and companies is highlighted.

Quantitative Results

Figure 2 presents the results of the mean-rank comparisons of environmental problems across the 2019, 2021, and 2022 measurement periods, displaying the average rankings assigned to climate change, plastic pollution, natural resource depletion, water overuse, biodiversity loss/species extinction, and pollution-related diseases. To assess whether statistically significant variations in perceived importance emerged across measurement periods, non-parametric Kruskal–Wallis H tests were conducted to compare the distributions of mean ranks across cohorts.

Figure 2

Bar chart showing Kruskal–Wallis H test of the mean-rank comparisons of environmental issues by cohort years. R



Source: Own elaboration

To strengthen the analysis of mean-rank differences identified by the Kruskal–Wallis H test, pairwise comparisons were subsequently conducted using the Mann–Whitney U test with Bonferroni correction, as reported in Table 3.

Table 3

Integrated results of the Kruskal–Wallis test and the Mann–Whitney post hoc analysis (Bonferroni correction) for environmental problems with significant differences

Significant problems	**χ^2 (gl = 2)**	**p (KW)**	**comparative**	**p (Bonferroni)**
Climate change	14.16	<.001	2019 v/s 2021	0,00072
			2019 v/s 2022	0,02136
			2021 v/s 2022	1,00000
Pollution-related diseases	7.54	0.023	2019 v/s 2021	0,023
			2019 v/s 2022	0,161
			2021 v/s 2022	1.000

Source: Own elaboration

The results showed that, in the three measurement periods, pollution-related diseases showed a statistically significant difference in only one pair-wise comparison, which was not sustained in subsequent periods. Furthermore, after applying post hoc adjustments, only climate change consistently showed lower mean range values and statistically significant differences over time. This pattern indicates a progressive strengthening of climate change as an environmental problem whose perceived importance increased over the measurement periods, while the temporal variation observed for pollution-related diseases does not persist over time.

In the case of diseases caused by pollution (p = .023), after the Bonferroni adjustment, only the 2019–2021 comparison is significant, while the other comparisons are not. In contrast, biodiversity loss/species extinction (p = .264), depletion of natural resources (p = .280), plastic pollution (p = .861), and overuse of water (p = .650) does not show statistically robust changes across the years studied.

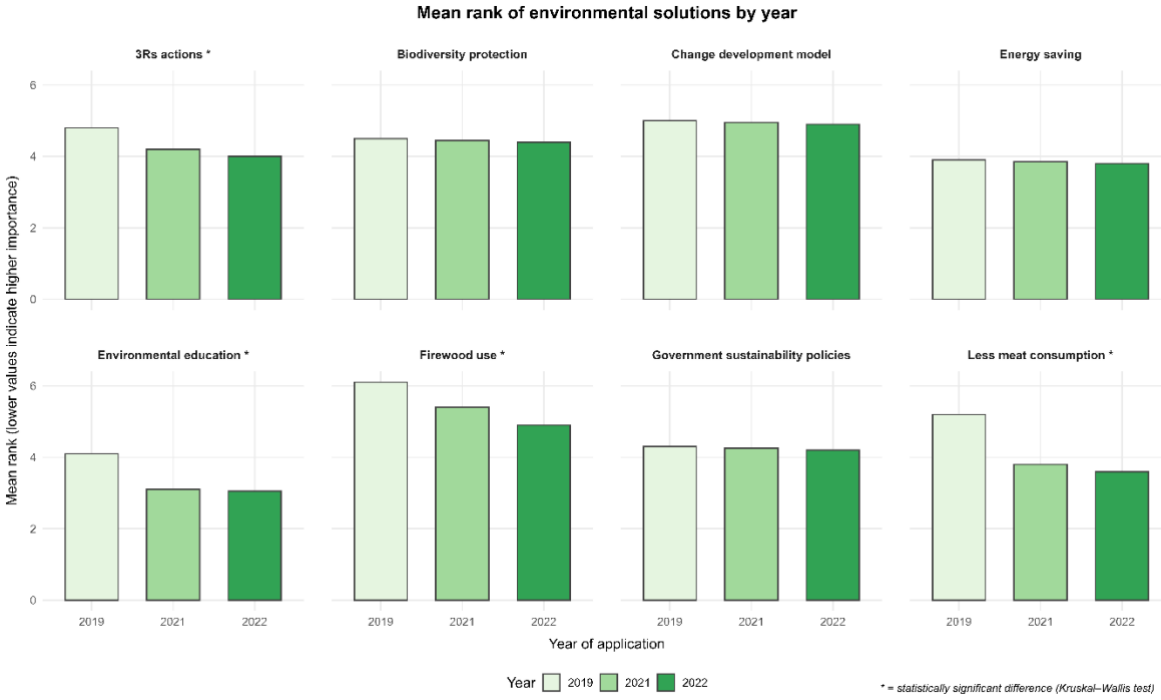
For climate change, significant differences were evidenced between 2019 and 2021 (p = .00072) and between 2019 and 2022 (p = .02136), while the comparison between 2021 and 2022 was not significant (p = 1.000). This indicates a strong and sustained increase in the importance assigned to the problem, consolidating climate change as the only problem whose importance grows significantly and consistently over time.

Figure 3 presents the results of the mean-rank comparisons of environmental solutions across the 2019, 2021, and 2022 measurement periods, displaying the average rankings assigned to environmental education, 3R actions (reduce, reuse, recycle), reduced meat consumption, energy saving, biodiversity protection, pressure on governments to act, changes in the development model,

and firewood use or non-use for heating. To assess whether statistically significant variations in perceived importance emerged across measurement periods, non-parametric Kruskal–Wallis H tests were conducted to compare the distributions of mean ranks across cohorts.

Figure 3

Bar chart showing Kruskal–Wallis H test results of the mean-rank comparisons of environmental solutions by cohort years.



To further substantiate the mean-rank differences identified for environmental solutions through the Kruskal–Wallis H test, pairwise comparisons were subsequently performed using the Mann–Whitney U test with Bonferroni correction, as reported in Table 4.

Table 4

Integrated results of the Kruskal–Wallis test and the Mann–Whitney post hoc analysis (Bonferroni correction) for environmental solutions with significant differences

Significant solutions	**χ^2 (gl = 2)**	**p (KW)**	**comparative**	**p (Bonferroni)**
Promote environmental education	21.20	<0.001	2019 v/s 2021	0.008
			2019 v/s 2022	2.2e-05
			2021 v/s 2022	0.116

3Rs actions	15.50	<0.001	2019 v/s 2021	0.10697
			2019 v/s 2022	0.00022
			2021 v/s 2022	0.10599
Lower meat consumption	41.80	0.001	2019 v/s 2021	5.8e-06
			2019 v/s 2022	1.2e-09
			2021 v/s 2022	0,11
Reduction in the use of firewood	13.00	0.0015	2019 v/s 2021	0.0222
			2019 v/s 2022	0.8305
			2021 v/s 2022	0.0037

The results indicate that across the three measurement periods, environmental education exhibited statistically significant differences in the comparison of decreasing mean-rank values across two pairs of years, indicating a progressive strengthening of its perceived importance and its consolidation as a highly prioritized solution over time. In contrast, 3R actions were significant in only one pairwise comparison, suggesting a more punctual reorganization of preferences rather than a sustained temporal trend. Conversely, reduced meat consumption and the non-use of firewood for heating showed significant differences associated with higher mean-rank values in the comparisons, indicating an initial and sustained decline in their prioritization over time. This temporal variation suggests a loss of centrality of these practices as prioritized environmental solutions.

First, the implementation of environmental education exhibited significant variations between 2019–2021 (p = .008) and 2019–2022 (p = 2.2e-05), demonstrating a sustained consolidation in its importance from the initial period. In the case of the 3R actions, results showed significant differences only between 2019 and 2022 (p = .00022), suggesting an abrupt prioritization in the assessment of these practices.

Moreover, reducing meat consumption varies significantly between 2019–2021 (p = 5.8e-06) and 2019–2022 (p = 1.2e-09), indicating an early change followed by stabilization. Additionally, the non-use of firewood for heating revealed a pattern with significant differences between 2019–2021 (p = .0222) and 2021–2022 (p = .0037), suggesting a lower sustained positioning as a solution over time.

Finally, solutions such as energy saving, biodiversity protection, the promotion of sustainability policies, and changes in the development model maintain relatively homogeneous distributions, without notable shifts toward higher or lower levels.

DISCUSSION AND CONCLUSION

From the theory of social representations, a dual representational process is proposed: while environmental problems maintain a stable and coherent configuration over time, the solutions exhibit a flexible and transformative dynamic.

The persistence of climate change as the main concern across the three cohort years, becoming the only problem whose importance increases significantly positions the representation of the environmental problem at an abstract level, with diffuse implications for rural participants. The consolidation of climate change as a concerning issue, from its sociogenesis, reinforces Pawson's (2020) argument that climate change constitutes a contingent environmental controversy in the current global context, despite the blurred and variable definitions and operationalizations surrounding the problem.

In this context, it becomes particularly relevant to examine the impact of environmental problems on the mental health of rural communities (Kumar et al., 2021). Although climate change is consolidated as a relevant, albeit abstract, problem, it is precisely this abstractness that demands greater mental processing. Combined with the increasing frequency of extreme events, such as droughts, heatwaves, and wildfires that generate stress, anxiety, and direct threats to life and livelihoods, as well as uncertainty about the future and the potential loss of homes, crops, or livestock, these dynamics contribute to rising anxiety, depression, and chronic stress (Obradovich et al., 2018; Clayton et al., 2020).

These challenges are further exacerbated by perceptions of social exclusion and unequal access to opportunities and resources, intensifying emotional distress and mental health problems (Carvacho & Valladares, 2020; Vollrath, 2022; Cunsolo & Ellis, 2018). Therefore, climate change and its consequences must be considered in adaptation and mitigation plans across multiple scales macro and micro, local and global, and through both technocratic and psychosocial dimensions (Jodelet, 2018; Landauer et al., 2019; Clayton et al., 2020).

In addition, rural inhabitants interpret environmental problems as fundamentally anthropogenic phenomena, attributing their origins to private companies, individuals, and

governments (Palacios-Abrantes et al., 2022). The associated impacts are linked primarily to environmental effects, identifying human action as a key factor in both the degradation and the protection of the environment.

Among the prioritized problems, pollution-related diseases follow climate change, reflecting issues anchored in the everyday experiences of rural life and giving them a territorial grounding. As proposed by Wang et al. (2021), environmental risks such as water, air, and soil pollution increase the incidence of diseases and affect the economic and social security of rural households, placing these issues firmly on the public agenda (Georgilas et al., 2021). Likewise, diseases and resource depletion generate feelings of helplessness, distress, fear, and hopelessness, especially among those who depend directly on their health and these resources for their subsistence (Cianconi et al., 2020; Helm et al., 2020).

The results show an absence of significant shifts highlighting resource depletion or water overuse, even though these phenomena are closely tied to the management of natural commons, which according to Martínez & Salazar (2023), are highly relevant for rural settings where inhabitants exhibit a degree of dependence on these resources. These issues can affect household agricultural production, contribute to environmental degradation of territories, and even lead to changes in lifestyles at biophysical, sociocultural, and psychosocial levels (Flores & Amigón, 2018; Carvacho & Valladares, 2020; Siclari, 2021).

In contrast, the domain of solutions shows fluctuations, with a notable rise in environmental education and information as a collective and transformative strategy whose increasing statistical significance stands out.

The growing relevance of environmental education observed in the rankings can be interpreted as a contextual response to the perceived intensification of environmental problems. This shift suggests that rural participants increasingly view environmental education as a concrete tool for understanding environmental change and discussing locally grounded responses. It emerges as a knowledge-based tool with the potential to serve as a collective mechanism for action in the face of the environmental crisis (Bermúdez & Escalante de Urrecheaga, 2018; Florencio Da Silva et al., 2023). In this regard, it is important to consider the multiple dimensions through which this strategy may operate in addressing environmental problems. For the population studied, it is recommended to establish mechanisms for both formal and non-formal environmental education, while also safeguarding territories from misinformation mechanisms that hinder the recognition,

understanding, and generation of alternatives to environmental problems (López-Gómez & Bastida, 2018; Ranney & Velautham, 2021; Zikargae et al., 2022).

Additionally, the identification of education and environmental stewardship promotion as a highly valued and significantly consolidated measure aligns with contemporary frameworks on education for sustainability. The UNESCO International Conference on Education for Sustainable Development, held in Berlin in 2021, defined environmental education as a continuous and contextualized process that strengthens values, practices, and competencies oriented toward community-based climate action (UNESCO, 2021).

Following education, the next preferences correspond to individual pro-environmental behaviors that require minimal changes in lifestyle, such as recycling or saving energy (Corral-Verdugo, 2008). This pattern is not exclusive to rural contexts but is a general phenomenon in environmental behavior, where people tend to prefer low-cost actions (Steg & Vlek, 2009). However, profound modifications in individual lifestyles—such as reducing meat consumption or eliminating the use of firewood—showed a downward trend and tend to find their referential niche in rural contexts. This reflects resistance to change in territories where traditional ways of life prevail and where food and housing needs depend on certain products (Santiago et al., 2018; Kipp et al., 2019; Siclari, 2021).

Conversely, actions aimed at socio-structural transformation, such as modifying economic models or demanding more effective environmental policies, continue to be relegated to a secondary role. This reality highlights the challenge involved in questioning and transforming dominant socioeconomic paradigms, particularly those linked to the Anthropocene, understood as the capitalist system that exacerbates the ecological crisis and shapes representational systems (Caillaud, 2010; Moore, 2015). In this sense, the need to strengthen structural changes and promote an active understanding of the ecological representational fields of rural communities is emphasized, in order to foster climate action that is territorially relevant and avoids compromising its effectiveness and sustainability over time.

Therefore, it is proposed that rural contexts exhibit a collective approach to addressing an abstract environmental education problem in the face of the climate crisis, while agentic changes and transformations in lifestyle are relegated to a secondary plane. This sidelines the relevance of individual actions and vital commitments in rural inhabitants' responses to climate change, not due to a diffusion of responsibility, but rather interpreted in relation to the influence of the historical,

social, and territorial context that shapes and constrains their behaviors, rituals, and ways and means of life (Corral-Verdugo et al., 2006; Institute for Global Environmental Strategies [IGES], 2019; Msimanga & Mukwada, 2022).

The rural environments of Ñuble, Chile face challenges that require situating education about climate change and its understanding as a phenomenon that, while linked to emissions mitigation, is also multidimensional. It encompasses a series of vulnerability factors and adjacent problems that trigger emission-producing processes and compromise the natural environment in which we live through its arbitrary intervention. Therefore, climate change must be understood both as a cause and as a product (Veracierto et al., 2021; Ramírez & Pedraza, 2022; Medina-Arboleda & Páramo, 2024). This perspective recognizes the interconnection between human beings and nature, emphasizing that human actions affect both the environment and the social fabric in the pursuit of improving quality of life and ensuring social and economic well-being (Corral-Verdugo et al., 2008; Santiago et al., 2018; Núñez, 2019; Vollrath, 2022).

Another important point is the sociopolitical context during the study period. In 2019, Chile experienced a period of intense social unrest known as the "social uprising" (*estallido social*) (Martucelli, 2022). In Latin America, such social movements often manifest as protests arising in contexts of representational crisis and democratic fragmentation, leading to ineffective dialogue among civil society, political parties, and legislative institutions (Morales-Quiroga, 2020). Within this framework, Chilean citizens raised demands directed at authorities, calling for greater consideration of community needs, including those related to environmental justice (Friz, 2021).

Although the initial data collection period coincided with the 2019 social uprising, the comparative analyses show that the patterns of importance attributed to environmental problems and solutions remained stable in the subsequent cohorts. Therefore, we acknowledge the contextual relevance of the event. However, no causal link can be established between the sociopolitical situation and the observed results. This suggests that environmental demands have long constituted a persistent and recurrent social concern, evidencing a consolidated representation of environmental issues across the cohort years in Chile (Aguirre et al., 2022).

Regarding limitations, it should be noted that the sample size was not equivalent across the three cohorts, nor was there traceability of participants that would allow for a longitudinal study. Additionally, the absence of data corresponding to the year 2021 prevents full assurance of the temporal consistency of the results. Another limitation of the study relates to differences in

participant composition across the three measurement periods. Although the same instrument was applied in comparable rural contexts except for the qualitative question incorporated in the final year, the samples do not consist of the same individuals over time. Consequently, the absence of temporal comparison in the qualitative component does not indicate a lack of evolution in representations, but rather reflects a deliberate methodological decision and an inherent limitation of the study design. Furthermore, variations in sociodemographic characteristics, such as gender, age, and occupational profiles, were observed across years, which precludes direct comparisons at this level. As a result, the analyses correspond to repeated cross-sectional measurements rather than longitudinal panel design.

Nevertheless, this study is considered valuable due to its exploratory methodological and theoretical contribution to the field of social representations and environmental problems and solutions in relation to rural contexts analyzed through trends.

For future projections, it is suggested that upcoming studies focus on the structural dimension of social representations of environmental education or of highly valuable natural commons—such as water, natural resources, and biodiversity—within these contexts, in order to explore the content and structure of themes emerging in the present (Martínez & Salazar, 2023). Moreover, the promotion of mixed-method, longitudinal, and qualitative studies is encouraged, incorporating discourse analysis through multi-methodological and theoretically embedded models that allow for an in-depth examination of social representations of climate change, its solutions, and particularly of dynamic social phenomena such as environmental problems in general (Salazar et al., 2007; Caillaud, 2010; Piermattéo et al., 2014; Lo Mónaco & Rateau, 2025).

Finally, public policy pilot initiatives are recommended to promote both formal and non-formal environmental education programs adapted to and relevant for rural territories, considering their particularities, ways of life, and forms of representing environmental problems.

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