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Bridging Attitudes and Evidence: Climate Change Perspectives in Italy

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Abstract: The most visible and well-known consequence of natural and environmental disasters is displacement. The paper analyzes environmentally induced displacement and attitudes towards climate change in Italy between 2013 and 2023. For this purpose, the Gradient Boosting Model (GBM) is used to analyze environmental displacement, while the Fuzzy-Hybrid TOPSIS is implemented to study climate change concerns. The results show that weather-related disasters are the most important casual climate effect on displacement. Furthermore, the issue of climate change is far from uniform and varies significantly across socio-economic factors such as age, education, religion, and income.

Keywords: climate change; attitudes; displacements; natural disasters; Italy

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1. Introduction

Climate change is emerging as one of the most pressing global challenges and is also a priority issue in Italy, a "Mediterranean hot spot", an area identified as particularly vulnerable to climate change [1]. Clear signs of ongoing climate change include increasingly hot summers, milder winters, prolonged droughts, and unusually frequent floods, with serious consequences for human health and significant damage to various economic sectors such as agriculture and energy [2,3]. The increase in these phenomena has other important implications: societies tend not to prepare for historically unlikely events that have never happened before. This makes them particularly vulnerable to rare conditions that are possible in a changing climate. There is a tendency to underestimate the problem because it is often perceived as "distant" [4]: people take measures to reduce their vulnerability only when they feel truly exposed to a risk [5].

Despite increasingly urgent reports from the Intergovernmental Panel on Climate Change (IPCC) since 1990 [6], the public debate on climate change still resists becoming a very important and widespread opinion among the public [7]. Public perceptions of this change vary widely for strategic, political, psychological, sociological, and cultural reasons that differ from country to country [7]. In fact, comparative research between countries has revealed significant differences in public beliefs and perceptions of climate change. At the European level, international comparisons show that British citizens are less concerned about climate change [8] and less likely to believe that it is caused by human activity than citizens of other European countries such as Italy, France, and Spain [9].

Globally, climate change is generally perceived as a significantly higher risk in developing countries [10,11]. Some authors argue that perceptions of climate change are shaped

by cultural and individual experiences [12]. Indeed, personal experience is thought to play a key role in risk perception; the perceived likelihood of risk tends to increase if it has been experienced recently or is easily imagined. The Intergovernmental Panel on Climate Change (IPCC) has emphasized that understanding individual perceptions is crucial for fully understanding environmental challenges and designing effective solutions, as public opinion can positively or negatively influence government action [13].

Currently, there are few studies on citizens' attitudes towards climate change. Antronico et al. [14] pay particular attention to the risk perception and the social vulnerability of the population living in coastal areas affected by climate change in Malta and Calabria (Italy). Sabato [15], uses a qualitative study to explore the perception of climate variability among young students aged 16–20 from different nationalities living in Sicily. Others investigate the relationship between farmers' perceptions of climate change and the current and future availability of water resources for agriculture in southern Italy [16].

The main aim of this study is to fill the current gap in the academic literature on Italian citizens' perceptions of climate change and whether they are linked to environmental disasters and their consequences, such as human displacement. The main research questions aim to explore the underlying dynamics of these perceptions across individual socio-economic characteristics and how they are aligned with real environmental disasters happening in Italy.

This paper is structured as follows: firstly, the data, presented in Section 2, set out the datasets used; the methodology, outlined in Section 3, provides an overview of the methodologies adopted; and finally, the results, presented in Section 4, present the findings obtained. The paper concludes with the discussion and conclusions sections, which offer an in-depth analysis of the results and the conclusions drawn from the study.

2. Brief Theoretical Background

The concept of risk perception is inherently complex, encompassing the construction and evaluation by individuals of the perceived severity and probability of a potential hazard [17]. In contrast to objective risk assessments, which are based on empirical data and statistical probabilities, risk perception is a subjective process influenced by a multitude of psychological, social, and cultural factors. In the context of climate change, these perceptions frequently underlie public attitudes, policy preferences, and individual behaviors, and thus are crucial for comprehending societal responses to environmental threats [18].

Thus, Climate Change Concerns (CCCs) encompass not only immediate hazards such as floods, hurricanes, and heat waves but also long-term concerns like rising sea levels and biodiversity loss [19]. However, the CCCs linked to these phenomena can vary considerably depending on personal experience, cultural background, political ideology, and trust in scientific information. For instance, individuals who have personally witnessed extreme meteorological occurrences frequently evince heightened apprehension regarding climate change, whereas those lacking such exposure tend to perceive it as a phenomenon largely detached from their proximate experience [20]. Similarly, political and ideological beliefs may act as crucial mediators of perception, with some groups interpreting climate change as an exaggerated or manufactured issue [21].

The formation of CCCs is a multifaceted process that encompasses both cognitive and emotional dimensions. As in [22], from a cognitive perspective, individuals draw upon their existing knowledge and understanding of climate change to assess the associated CCC. This evaluation process is frequently influenced by cognitive biases, such as the availability heuristic, whereby the ease with which an individual recalls vivid events—such as destructive wildfires or hurricanes—can result in an overestimation of their probability. Emotionally, feelings such as fear, anxiety, or apathy can exert a significant influence on the

perception of risks. For example, fear may motivate protective actions, whereas feelings of hopelessness may result in inaction or denial. The emotional intensity of climate risks is frequently amplified by personal exposure to disasters, which serves to reinforce the association between personal experiences and perceived threats [23].

The influence of social and cultural factors on CCCs is a further complicated factor. The way climate change is represented in the media is of great consequence, as the framing of this issue can serve to either amplify or downplay its perceived urgency [24]. The sensationalist coverage of disasters may serve to heighten public concern, but it can also result in the dissemination of misinformation or a desensitization to the issue over time. Cultural values also exert an influence on perceptions. Collectivist societies frequently place an emphasis on the notion of collective responsibility regarding the mitigation of climate risks. In contrast, individualistic cultures tend to prioritize the personal impacts of climate change [25]. Moreover, the level of trust placed in government, scientific, and humanitarian institutions has an impact on how climate warnings and policies are perceived. A lack of trust can lead to skepticism, even in regions that are already experiencing severe environmental impacts [26].

Public perceptions and behaviors related to climate change result from a complex interplay of personal beliefs, social identities, and perceptions of policy effectiveness. Rode et al. [27] found that interventions aimed at influencing climate change attitudes in the United States had modest effects, that climate change beliefs were more easily modified than policy support, and that misinformation was more powerful than pro-climate messaging. Fielding and Hornsey [28] emphasize the centrality of social identity in shaping environmental attitudes and behaviors, with group norms and intergroup relations seen as critical to sustainable behavior and environmental conflict. Extending this perspective internationally, Dechezleprêtre et al. [29] showed that across 20 countries, support for climate policies depends heavily on perceptions of policy effectiveness, fairness, and personal impact, with educational messages about policy mechanisms being more effective than narratives about climate impacts. Taken together, these studies underscore the importance of tailored interventions that target the level of individual beliefs, group dynamics, and contextual concerns for meaningful climate action.

In contrast, climate-induced migration creates a feedback loop that further complicates the perception of displacement. In instances where events such as flooding, wildfires, or storms result in displacement, there is a potential for increased awareness of climate risks among the affected population, as well as the formation of attitudes within the broader society that reflect a heightened perception of these risks [30]. In such instances, entire communities where mass displacement occurs may begin to perceive climate change as an imminent and tangible phenomenon, thereby reinforcing public concern for the issue and potentially encouraging behavioral changes and policy support [31]. Conversely, in contexts where displacement is less visible or occurs infrequently, climate risks may remain abstract and not necessitate immediate attention [32].

While there is an increasing body of literature on CCCs, significant gaps persist in understanding their dynamics in relation to climate change and displacement. For example,

1. How are intersecting factors like socio-economic status, education, and political ideology mediating climate change concerns?
2. Is there a gap between public perceptions and documented impacts of climate change in Italy?

This study adds to the literature by examining how climate-induced displacement intersects with public perceptions of climate change. By setting these dynamics within the Italian context, where recent disasters have brought climate risks into sharper focus, this re-

search aims to provide a nuanced understanding of the interlinkages between displacement experiences and societal attitudes toward environmental threats.

3. Data

This study employs data from Round 10 of the European Social Survey (2020) to investigate attitudes toward climate change. The ESS is a biennial cross-national survey designed to monitor and assess public attitudes, beliefs, and behaviors across Europe. The ESS is renowned for its sound methodology, which includes random probability sampling, high response rates, and standardized data collection procedures across countries. These features guarantee the reliability and generalizability of the findings, thus making it an optimal resource for cross-national and regional comparisons [33]. Moreover, previous research has demonstrated the value of the ESS in examining environmental attitudes and behaviors, particularly within the European context [34,35].

The sample demonstrated a range of perspectives on the causes of climate change. A noteworthy proportion of respondents (44.77%) ascribed the phenomenon of climate change primarily to human activity, while a smaller group (11.74%) espoused the view that it was entirely caused by natural processes. A smaller group (0.91%) held the view that climate change did not occur at all. The dataset comprises 2633 respondents, thereby enabling an examination of the interaction between attitudes towards climate change and various socio-economic factors. The respondents identified themselves as 52.5% female and 47.5% male. The age range of the sample was extensive, encompassing younger adults under 25 (11.52%) and older adults over 65 (26.97%), thereby providing a comprehensive demographic profile. The employment status of respondents was also considered. Of the respondents, 48.48% indicated that they were currently employed, while 20% reported that they were retired. Smaller groups reported being unemployed or permanently disabled. Religion emerged as a significant variable, with the majority of respondents identifying as Roman Catholic (69.13%), followed by those who reported no religious affiliation (26.44%) or another religion (4.43%). The analysis was further enriched by the inclusion of income. While 31.59% of respondents indicated that they were living comfortably, nearly half reported that they were managing, and a smaller proportion indicated that they were facing financial difficulties or serious difficulties. For further details, please refer to Table 1.

Table 1. Descriptive Statistics.

Group	n	%	Group	n	%
Born in the country	2439	92.39%	Roman Catholic	1825	69.13%
Foreign-born	194	7.35%	Other Religion	117	4.43%
Entirely by natural processes	52	1.97%	No Religion	698	26.44%
Mainly by natural processes	154	5.83%	Paid work	1280	48.48%
About equally by natural processes and human activity	857	32.46%	Education	226	8.56%
Mainly by human activity	1182	44.77%	Unemployed, looking for a job	135	5.11%
Entirely by human activity	310	11.74%	Unemployed, not looking for a job	57	2.16%
I do not think climate change is happening	24	0.91%	Permanently sick or disabled	29	1.10%
Male	1254	47.50%	Retired	528	20.00%
Female	1386	52.50%	Living comfortably on present income	834	31.59%
under 25	304	11.52%	Coping on present income	1286	48.71%
26–35	299	11.33%	Difficult on present income	367	13.90%
36–45	349	13.22%	Very difficult on present income	70	2.65%
46–55	476	18.03%			
56–65	500	18.94%			
over 65	712	26.97%			

Three distinct items have been extracted for the purpose of measuring individuals' Climate Change Concerns (CCCs) in Italy. Each item is associated with a specific semantic scale, which indicates the range or intensity of responses that participants can provide, thus facilitating the interpretation of the responses on each item. In the context of the CCC latent variable, it gauges individuals' perspectives using three distinct scales, as described in Table 2:

Table 2. Items.

	Item	Scale
(a)	Important to care for nature and the environment	From 1 "Very much like me" to 6 "Not like me at all"
(b)	To what extent feel personal responsibility to reduce climate change	From 0 "Not at all" to "A great deal"
(c)	How worried about climate change	From 1 "Not at all worried" to "Extremely worried"

Item a has been reverted in order to associate higher values with more concerned positions on climate change. Additionally, item b has been recoded from a value of 1 to a value of 11 in order to achieve greater uniformity across all items for further analysis.

According to [36,37] data from the Internal Displacement Monitoring Centre (IDMC) are used in the paper to analyze displacement due to natural disasters in Italy. The IDMC adheres to the definition contained in the Guiding Principles on Internal Displacement, for environmental disaster, which defines internally displaced persons as "Persons or groups of persons who have been forced or obliged to flee or leave their homes or places of habitual residence, in particular as a result of, or to avoid the effects of, [. . .] natural or human-made disasters, and who have not crossed an internationally recognized State border" [38].

Displacement data serves as a crucial metric for gauging the extent of such events, often providing tangible and measurable insights into the immediate impact of climate-related and geophysical hazards. This approach will thus enable the study to ascertain whether societal attitudes are aligned with the documented consequences of natural disasters. For this reason, the IDMC dataset has been included in the study because it allows for the examination of displacement patterns with a high degree of detail over an extended period of time (2013–2023) and covers a range of disaster types. In this study, the inclusion of data on 23 disasters during the specified period has enabled the capture of a comprehensive overview of the landscape of displacements in Italy. The dataset indicates that Italy experienced 42,000 instances of internal displacement due to disasters, with 37,000 resulting from storms, 3400 attributed to wildfires, and 1200 caused by floods. This figure illustrates the disproportionate impact of specific types of events, with storms being more prevalent and intense due to the observed increase in climate change.

The use of displacement as an analytical perspective allows the research to address a significant gap in the existing literature regarding the potential relationship between subjective attitudes and objective environmental consequences. Displacement represents an objective outcome, thereby providing a means of evaluating public perceptions against a quantifiable standard. Furthermore, the depth and granularity of displacement data enable the identification of patterns and trends, such as the large spikes associated with large-scale disasters.

4. Methodology

4.1. Fuzzy-Hybrid TOPSIS

According to Di Nardo et al. [39], the responses yielded by surveys are frequently ambiguous due to the intrinsic uncertainty and subjectivity inherent in the data collected. In light of these challenges, we are implementing a methodology specifically designed to address the ambiguities inherent to survey data. Fuzzy Set Theory (FST) provides a robust framework for addressing the ambiguities inherent in survey data [40,41]. This permits truth values to vary continuously between 0 and 1, thereby extending the domain of classical Boolean logic [42]. The responses to the survey are transformed into triangular fuzzy numbers (TFNs), which are represented by three tuples (a_1, a_2, a_3). The range of these values is typically normalized to a scale from 0 to 100.

In this study, three items from the European Social Survey (ESS) are employed to examine attitudes towards climate change. These items pertain to the following domains: (a) the importance of caring for nature and the environment, (b) the extent to which individuals perceive a personal responsibility to mitigate climate change, and (c) the level of concern about climate change (see Table 2). The original scales are transformed in accordance with the specifications outlined in Table 3. The original scales are not homogeneous, and each item considers a different type of scale, resulting in three different conversions.

Table 3. Triangular Fuzzy Numbers conversion.

Raw Scale	TFNa	TFNc	TFNc
1	(0, 0, 10)	(0, 0, 10)	(0, 0, 15)
2	(15, 25, 35)	(0, 10, 20)	(25, 40, 55)
3	(40, 50, 60)	(10, 20, 30)	(45, 60, 75)
4	(65, 75, 85)	(20, 30, 40)	(70, 80, 90)
5	(80, 90, 95)	(30, 40, 50)	(85, 100, 100)
6	(95, 100, 100)	(40, 50, 60)	
7		(50, 60, 70)	
8		(60, 70, 80)	
9		(70, 80, 90)	
10		(80, 90, 100)	
11		(90, 100, 100)	

To simplify the complex fuzzy information, we transform the TFN into crisp values using the weighted average formula:

$$C = (a_1 + 2a_2 + a_3)/4$$

C represents the defuzzified value for each response, thereby balancing the central tendency and uncertainty surrounding it. Accordingly, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is employed to quantify the Climate Change Concerns Indicator [43]. This multi-criterion decision-making method is employed to identify optimal solutions and to calculate distances to rank groups based on their attitudes toward climate change. The method comprises four distinct phases.

Step 1: Create a defuzzified decision matrix

The defuzzified decision matrix is created from the crisp values obtained in the defuzzification step. Each element of this matrix represents a crisp value of the group's response to a specific indicator.

Step 2: Determine the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS)

PIS and *NIS* can be considered as the maximum and minimum values of the defuzzified matrix for each item of analysis, and are calculated as follows:

$$PIS = \{max(Cij) \mid j = 1, 2, \ldots, n\}$$

$$NIS = \{min(Cij) \mid j = 1, 2, \ldots, n\}$$

where *Cij* is the defuzzified value for each group *i* and item *j*.

Step 3: Calculate distances to ideal solutions

The Euclidean distance of each group to *PIS* $(D+)$ and *NIS* $(D-)$ are calculated as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{J} (PIS_i - V_{ij})^2}$$

$$D_i^- = \sqrt{\sum_{j=1}^{J} (NIS_i - V_{ij})^2}$$

Step 4: Calculate the TOPSIS indicator

The TOPSIS approach assumes that the best "solution" is the one that is closest to the ideal solution and farthest from the negative ideal solution [44]. In this study, this corresponds to the highest level of Climate Change Concerns (CCCs). Thus, the synthetic indicator that measures the CCCs for each segment group of analysis is given by the following:

$$CCC_i = \frac{D_i^-}{D_i^+ + D_i^-} \rightarrow [0, 1]$$

Thus, the higher the CCC values approach 1, the more concerns are towards climate change.

The TOPSIS method is integrated with FST in order to develop a composite indicator of CCCs. The TOPSIS method is selected for its established status as a multi-criteria decision-making approach that ranks alternatives in accordance with their proximity to positive ideal and negative ideal solutions. This makes it an effective method for synthesizing diverse attitudes into a single metric that can be meaningfully compared across groups or periods. The integration of fuzzy logic with TOPSIS results in an enhanced TOPSIS that is more effective in accounting for uncertainty and has produced more robust results [45].

4.2. Causal Relationship Analysis

This study also examines the impact of various disaster types on displacement outcomes in Italy between 2013 and 2023. Each disaster (e.g., earthquake, storm, flood, fire) is classified and consolidated into a monthly time series, which represents the number of individuals displaced due to each event. In this paper, the Gradient Boosting Model (GBM) has been selected for its suitability for analyzing complex nonlinear relationships and interactions in time series data. GBM presents a few advantages that make it an appropriate method for assessing the impact of different types of disasters on displacement outcomes. For example, the capacity to handle nonlinear relationships is a key advantage of the Gradient Boosting Model [46]. The phenomenon of displacement is contingent upon a multitude of disaster types, including, but not limited to, earthquakes, storms, and floods. Each of these disaster types may exhibit complex and nonlinear effects. The iterative optimization process and ensemble learning approach inherent to GBM make it particularly well-suited for capturing these nonlinearities. The GBM algorithm provides the Importance Score (IS), which assists in determining the contribution of each disaster type to displacement outcomes [47]. This will facilitate an appreciation of the most valid causes of displacement. The robustness of the method to noise and missing data are also a noteworthy advantage.

GBM demonstrates resilience in the presence of noisy or incomplete data, particularly given the complexity that can be expected to arise from a decade's worth of displacement data [46].

To assess the impact of each disaster type on displacement, we employ the Gradient Boosting Model (GBM), which is adept at discerning nonlinear relationships and intricate interactions within time series data [46]. The model calculates an IS, indicating the extent to which each disaster type contributes to the displacements. The Gradient Boosting Model (GBM) employs an iterative process to minimize the squared loss function [47]. GBM iteratively minimizes the squared loss function:

$$L(\hat{y}, y) = \sum_{i=1}^{N} (y_i - \hat{y}_i)^2$$

where

y_i is the observed displacement count,

$\hat{y}_i$ is the predicted count,

N represents the total number of observations.

The model calculates a feature importance score that shows how each disaster type contributes to reducing the loss function in all decision trees in the ensemble [48,49]. Thus, it indicates that specific hazards can affect displacement outcomes. The Importance score $IS(X)$ is defined as follows:

$$IS(X) = \sum_{t=1}^{T} \Delta L_t(X)$$

where

T is the total number of trees,

$\Delta L_t(X)$ is the reduction in the loss function attributed to splits involving feature X in tree t.

The high importance scores assigned to certain environmental events suggest that these hazards are primarily responsible for displacement in Italy. In contrast, lower scores for other types of hazards may suggest that, while they contribute to displacement, their impact is less consistent or significant in comparison to earthquakes and storms.

5. Results

5.1. Climate Change Concerns

This section illustrates how perceptions and attitudes toward climate change differ among various groups of respondents. Table 4 evaluates three specific aspects: the importance assigned to environmental care, the sense of personal responsibility in mitigating climate change, and the level of concern about the impact of climate change. For each item, the "positive ideal solution" score (PIS) and the "negative ideal solution" score (NIS) are shown. Regarding the first item, those who believe that climate change is primarily caused by human activity show a strong commitment to environmental care. In contrast, those who believe that climate change is not happening display a more detached attitude toward the environment. Regarding the sense of personal responsibility for reducing climate change, the group of respondents attributing climate change entirely to human activity feels responsible, with a PIS of 64.04, suggesting that they believe their actions can help mitigate climate change. Conversely, consistent with the belief that climate change is mainly by natural processes, it is less inclined to feel responsible for actions necessary to counter it. Furthermore, those who perceive that climate change is happening entirely due to human activity have the maximum value of worries about climate change, while those who think that climate change is mainly by natural processes present the minimum value.

Table 4. Ideal Solutions.

Item	Group	PIS	Group	NIS
Important to care for nature and the environment	Entirely by human activity	83.76	I do not think climate change is happening	65.31
Feel personal responsibility to reduce climate change	Entirely by human activity	64.04	Mainly by natural processes	30.20
How worried about climate change	Entirely by human activity	64.04	Mainly by natural processes	32.26

Table 5 presents the CCCs synthetic indicator, obtained through the TOPSIS method, disaggregated by sociodemographic groups, with values ranging from 0 to 1, where higher scores indicate greater concern. With regard to the place of birth, individuals born in Italy exhibit a level of concern that is 0.78, which is higher than that observed among foreign-born individuals (0.61). Another significant factor is the perception of the causes of climate change. It is evident that those who attribute the phenomenon entirely to human activity reach the maximum concern score (1.00), while those who believe in a mixed cause—resulting from a combination of human activity and natural processes—show a moderate level of concern (0.69). In contrast, individuals who attribute climate change primarily or exclusively to natural causes exhibit markedly low values (0.18 and 0.21). Furthermore, individuals who wholly reject the existence of climate change exhibit a CCCs score that is below the mean, at 0.54.

Table 5. Climate Change Concerns Synthetic Indicator.

Group	Variable	CCCs	Group	Variable	CCCs
Country-born	Born in the country	0.78	Age	under 25	0.77
	Foreign-born	0.61		26–35	0.84
Climate Change Opinion	Entirely by natural processes	0.21		36–45	0.83
	Mainly by natural processes	0.18		46–55	0.82
	About equally by natural processes and human activity	0.69		56–65	0.82
	Mainly by human activity	0.90		over 65	0.63
	Entirely by human activity	1.00	Main Status	Paid work	0.81
Household income perception	I do not think climate change is happening	0.54		Education	0.84
	Living comfortably on present income	0.81		Unemployed, looking for a job	0.77
	Coping on present income	0.73		Unemployed, not looking for a job	0.75
	Difficult on present income	0.80		Permanently sick or disabled	0.64
	Very difficult on present income	0.74		Retired	0.65
Religion	Roman Catholic	0.78			
	Other Religion	0.72			
	No Religion	0.74			

Income perception appears to exert a slight influence on CCCs. Those who live comfortably and those who find it challenging to manage their income exhibit comparable levels of concern (0.80 and 0.74, respectively). The influence of religion is also limited. Catholics and non-believers exhibit comparable levels of concern (0.78 and 0.74, respectively), which are marginally higher than those observed among individuals adhering to other religious traditions (0.72). Significant variations are observed with regard to age. The findings indicate that the CCCs score is relatively high across all younger age groups. Individuals aged 26 to 35 exhibited the highest level of concern (0.84), while those aged

65 and above demonstrated comparatively lower levels of concern (0.63). This indicates a trend of declining concern with advancing age.

Significant differences are also evident with regard to employment status. Two distinct profiles emerge: those who are employed and the unemployed exhibit relatively high CCCs scores (0.81 and 0.77, respectively), while those who are retired and individuals who are permanently sick or disabled demonstrate the lowest levels of concern (0.64 and 0.65, respectively).

5.2. Climate-Induced Displacements

The data on population displacement in Italy from 2013 to 2023 demonstrates the considerable influence of geophysical and meteorological hazards on human mobility. Geophysical hazards, including earthquakes, volcanic activity, and mass movements, have been responsible for more than 30,000 instances of displacement. Such occurrences, frequently abrupt and severe, result in immediate and often considerable disruptions, particularly in regions susceptible to tectonic activity. However, the figure of 60,000 displacements related to weather events represents an even greater cause for concern (Figure 1). This category encompasses extreme weather events, including floods, storms, and other climate-related occurrences that are becoming increasingly prevalent and intense as a consequence of climate change. In contrast to certain geophysical occurrences, which may be more localized or episodic in nature, the effects of climate change are characterized by an ongoing trend.

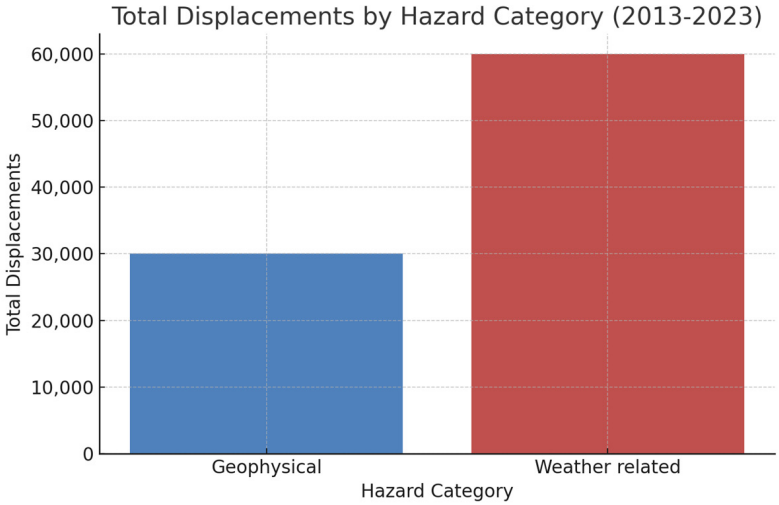

Figure 1. Displacements by disaster. Source: own elaboration.

Figure 2 illustrates the ten most significant events in Italy, delineating the highest average displacements between 2013 and 2023. This provides a comprehensive representation of the extent to which specific disasters have resulted in extensive disturbances. This visualization elucidates the profound impact of disparate natural phenomena, particularly storms, earthquakes, and floods, on population displacement. It also underscores the susceptibility of Italian communities to both abrupt and climatic-related hazards. The Emilia-Romagna storm of 14 May 2023, is notable for its exceptionally high average displacement, illustrating the severity and far-reaching impact of this severe weather event. The storm, which brought unprecedented precipitation levels, resulted in extensive flooding across the region, necessitating the evacuation of thousands of individuals from their homes and causing considerable damage to infrastructure.

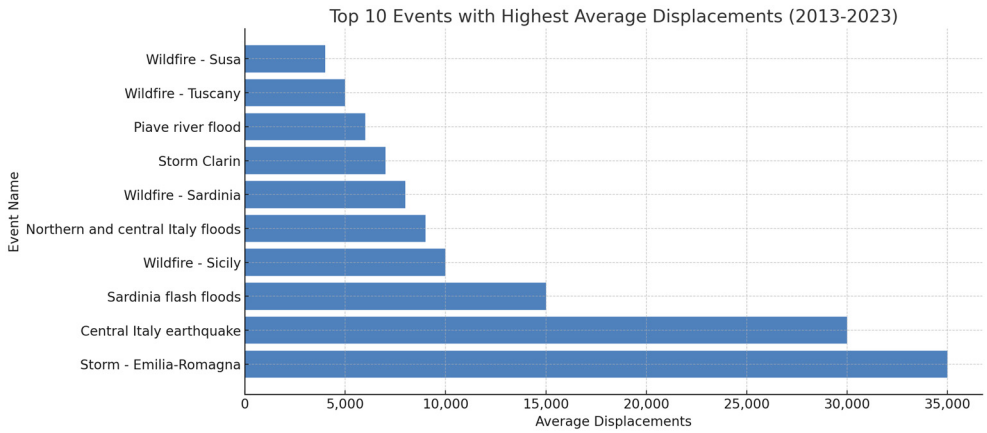

Figure 2. Events–displacements. Source: own elaboration.

The extent of displacement resulting from this singular event serves to underscore the increasing peril posed by extreme weather conditions, particularly because climate change is increasing the frequency and intensity of such storms. The storm was closely followed by an earthquake in central Italy that caused displacement levels to reach a similarly high point. In contrast to storms, which are often preceded by warning signs, earthquakes are sudden and unpredictable, resulting in immediate and severe impacts on communities. The earthquake resulted in the evacuation of large numbers of people from affected areas, due to the severe damage or unsafe condition of buildings and basic infrastructure.

Other noteworthy occurrences include the flash floods in Sardinia caused by Cyclone Cleopatra (2013), which exemplified the destructive potential of sudden and intense rainstorms. Flash floods swept through villages, causing extensive damage to property and forcing a significant number of people to evacuate. Furthermore, various wildfires across Italy, such as those in Sicily and Tuscany, demonstrate how dry and hot conditions during the summer months create an environment conducive to fast-spreading fires. In addition to displacing residents, these fires also devastate local ecosystems, thereby underscoring the wider environmental and social impacts of these hazards.

Figure 3 illustrates the IS derived from the Gradient Boosting Model and elucidates the hazard types that exhibit the greatest predictive capacity with regard to displacement. This analysis identifies earthquakes and storms as the two most influential features, exhibiting a significant lead over other hazard types. The "Earthquake" feature is of the greatest importance, indicating that earthquakes are the most influential variable in predicting displacements. This finding is consistent with observations in the real world, where earthquakes often result in significant displacement due to their immediate and devastating impact on infrastructure and habitability, particularly in areas with high seismic activity.

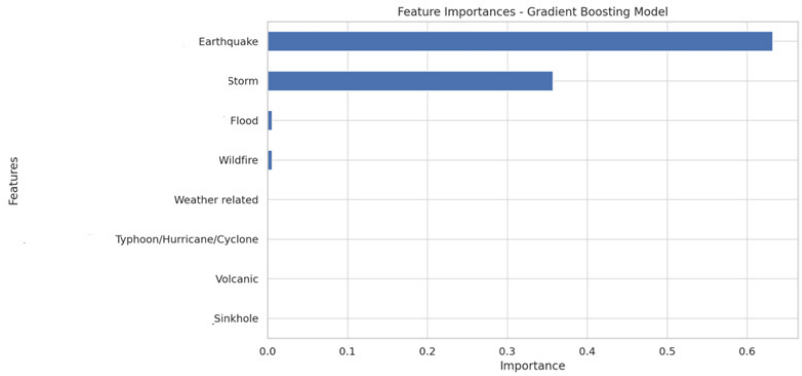

Figure 3. Importance of features derived from the Gradient Boosting Model. Source: own elaboration.

The second most important element, "Storm", also has a high importance score, reflecting a significant impact on displacement caused by adverse weather events such as storms. The phenomenon of climate change is responsible for an increase in the frequency and intensity of storms, which are becoming a significant driver of both temporary and permanent displacement. This underscores the necessity for the implementation of targeted adaptation strategies to safeguard communities from the adverse effects of climate-related risks. In contrast, other hazard types, such as floods and forest fires, have relatively low importance scores in this model. While these hazards can also result in displacement, their capacity to predict such occurrences is considerably less than that of earthquakes and storms. This may be attributed to the more localized nature of floods and wildfires or the variability of the impact of their displacement based on the implementation of preparedness and mitigation measures. It is noteworthy that categories such as "weather-related", "typhoon/hurricane/cyclone", and "volcanic" have minimal to no significance in the model. This may suggest that, despite their recognition as hazards, these phenomena may not exhibit as consistent or severe movement patterns as those observed for earthquakes and storms in the dataset used for this model.

6. Discussion

6.1. Socio-Economic Differences in CCCs

The findings of this study underscore the existence of notable discrepancies in perceptions and attitudes toward climate change, which are shaped by a multitude of socio-economic and cultural factors that influence levels of concern. Such differences can be understood by analyzing the factors that shape diverse views on climate change and the socio-economic influences that affect respondents' degree of worry [50,51]. Opinions on climate change range along a continuum from skepticism to personal responsibility and active engagement [50]. Individuals who perceive climate change as predominantly anthropogenic tend to exhibit a heightened sense of personal accountability and a stronger inclination towards environmental stewardship. For these individuals, the question "What can we do to address climate change?" becomes central, given the growing awareness of the phenomenon's effects. This finding is supported by previous studies that indicate how the perception of personal responsibility and the belief that one's actions can have an impact are essential in motivating pro-environmental behaviors [52–54].

For people to be effectively motivated to take climate-positive actions, concern alone is not enough; direct personal responsibility is essential [55]. Furthermore, the findings indicate that individuals born in the country tend to exhibit greater concern about climate change than those who immigrated, suggesting that cultural background and place of birth may influence the level of concern. It is probable that natives are more exposed to climate change communication and more integrated into local discussions on this topic, which may result in a more immediate perception of its impact. In contrast, immigrants, who are often preoccupied with economic and social issues related to their living conditions, may have different priorities [56].

Age is identified as a significant variable, with younger individuals exhibiting heightened levels of concern compared to their older counterparts. This awareness is also reflected in the active involvement of young people in environmental movements such as the Sunrise Movement and in the activism of figures like Greta Thunberg. A survey conducted by the Pew Research Center lends further support to the assertion that members of Generation Z and the Millennial generation are more inclined to advocate for tangible measures to address climate change than their elders [57]. Income [58] and education levels [59] have been identified as significant predictors of climate opinions. Although income appears to have a slight effect on climate change concerns, several studies indicate a complex relation-

ship. Some studies suggest that higher incomes may correlate with lower concern, possibly because wealthier families perceive themselves to be at lower risk. However, other studies indicate that people with higher incomes are more aware of environmental risks due to their greater resources and access to information [60–64].

In contrast, education is associated with greater concern about climate change. Prior research indicates that individuals with higher levels of education tend to demonstrate heightened environmental awareness and are more likely to engage in sustainable behaviors [65]. Finally, the impact of religion appears to be relatively modest, with minimal distinctions observed among Catholics, non-believers, and individuals of other religious affiliations. Nevertheless, religion can still exert an influence on perceptions, affecting how people understand and experience climate change. Some studies indicate that religious beliefs can influence both adaptation and response to climate change based on community values and the perception of divine control over events [66].

6.2. Climate Disaster Induced Migration

The data on the ten most significant events in Italy, in terms of average displacement, from 2013 to 2023, illustrate the considerable challenges posed by both natural and climate-related risks. These figures illustrate the diverse and substantial impacts of various types of disasters on communities throughout the country, and they reveal patterns that necessitate a considered and comprehensive response. The storm that occurred in Emilia-Romagna in May 2023 appears to be the single most significant event of the past decade in terms of the number of people displaced. This storm serves to illustrate the considerable extent of the meteorological risks currently faced by Italy, while also indicating a broader tendency for climate-related occurrences to become increasingly intense.

The devastation caused by this storm is part of a growing pattern observed across Europe, whereby extreme weather events have become more frequent and intense, largely as a consequence of climate change. Such events demonstrate the vulnerability of Italy and other Mediterranean countries to climate change, which is leading to an increase in the frequency and intensity of extreme weather events, including hotter summers, more frequent droughts, and irregular rainfall patterns [67]. Each of these changes contributes to the frequency and intensity of storms and floods, which can result in both temporary and, in some cases, permanent displacement [68]. While weather-related events dominate, geophysical hazards also leave a lasting impact, as evidenced by the earthquake in central Italy, which ranks second in terms of displacement impact. Earthquakes, although less frequent, are deeply disruptive when they occur because they pose an immediate threat to lives and infrastructure [69]. Thus, following [70], Italy's seismic landscape makes certain regions particularly vulnerable to such events, leading to mass evacuations and long-term displacement. Unlike weather events, which can sometimes be predicted with some accuracy, earthquakes remain unpredictable [71], highlighting the critical need for rapid response capabilities and preparedness measures to mitigate their impacts.

It is also noteworthy that flooding represents a persistent challenge in Italy [72]. The findings point to numerous cases of significant flooding, such as those affecting northern and central Italy, as well as the regions around the Piave river basin. Due to the country's mountainous terrain and extensive coastline, heavy rainfall can quickly lead to flooding, especially in urban and low-lying areas [73]. This trend signals an urgent need for Italy to strengthen its flood management strategies, including building resilient infrastructure such as dikes, improving drainage systems, and implementing better land-use planning to reduce vulnerability in high-risk areas [74]. As extreme rainfall events become more common with climate change, adaptation to flood risks will be a key part of Italy's resilience strategy.

6.3. Bridging Attitudes and Evidence

This case study of Italy illustrates the necessity to bridge the gap between perception and reality with regard to climate change. The relationship between public perceptions of climate change and its documented impacts is complex and contradictory. In Italy, where evidence from climate-related disasters is increasing, this relationship is particularly challenging to discern. While a variety of studies indicate that a significant proportion of Italians acknowledge the existence of climate change [75]; however, the depth of concern and sense of urgency associated with this phenomenon vary considerably. These variations can be attributed to a number of factors, including education, generational perspectives, and regional experience.

Notwithstanding the considerable acknowledgment of climate change, a notable discrepancy persists between the perceptions of the general public and the tangible consequences of climate change [76]. In Italy, over the past decade, there has been a notable intensification of extreme events, including the severe flooding in Emilia-Romagna and the disastrous forest fires that occurred across regions such as Sicily and Sardinia [77]. Following [78], the following examples illustrate the tangible and intensifying impact of climate change on media reports. These realities are inconsistent with the widespread public recognition of the urgency to take action, particularly in areas less directly affected by such disasters. The unequal distribution of climate impacts across the country contributes to a fragmented perception of risk, whereby regions experiencing greater vulnerability reinforce regional differences in awareness and concern [79].

The discrepancy can be attributed, in part, to how the issue of climate change is communicated and perceived [80]. As in Boykoff [81], media reporting frequently concentrates on sensational incidents without contextualizing them within the broader framework of climate trends. Such news may garner immediate attention but will not necessarily contribute to a coherent perception of systemic risks. Consequently, many Italians will continue to view climate change as an abstract or remote issue rather than a current and urgent challenge.

As in Van der Voorn and De Jong [82], cultural norms and values exert a profound influence on perceptions of climate change in Italy, which in turn informs policy responses. Italy's approach to crisis management, as exemplified by its response to the COVID-19 pandemic, illustrates the efficacy of the Mediterranean model of policymaking, which entails swift and stringent measures such as lockdowns, border closures, and strict enforcement [82]. Furthermore, cultural factors, such as the presence of strong regional identities coupled with socio-economic disparities, exert a significant influence on perceptions of climate risk [61]. In economically vulnerable regions, the immediate priority of finding employment often supersedes environmental concerns, thereby contributing to the fragmentation of perceptions of urgency. This dynamic is reminiscent of the regional variation observed during the pandemic, where disparities influenced compliance and attitudes toward policy [61]. In addition, the majority of populist parties in Italy frequently downplay the scientific consensus on climate change, instead focusing their efforts on national priorities over global challenges [83,84]. This approach may diminish the perceived urgency of climate action, particularly in regions where populist influence is strong.

Following Durbin and Filer's [85] study, to enhance public awareness of the present-day dangers of climate change and its function as a catalyst for displacement, it is essential to implement targeted strategies that resonate with the general public. The messaging could be tailored to the local context, emphasizing the connection between floods or wildfires and the impact of climate change in the immediate vicinity. Educational campaigns should elucidate the scientific principles underlying climate change, along with its socio-economic ramifications, employing straightforward language and illustrative examples [86].

7. Conclusions

This article aims to examine the phenomenon of displacement resulting from natural disasters and the attitudes of the Italian population towards climate change during the period between 2013 and 2023. The primary objective is to gain insight into how extreme weather events, often exacerbated by climate change, have driven internal migration and how socio-economic variables influence community actions and opinions regarding the climate crisis.

The analysis employs advanced tools, including Fuzzy-Hybrid TOPSIS and Gradient Boosting Model, to identify the principal drivers of displacement. Among these, earthquakes and storms emerge as the primary causes of population displacement. Such phenomena can exert an immediate impact on affected territories, while also influencing public perception and awareness of the necessity to address climate change. Furthermore, the study underscores the pivotal role of specific socio-economic characteristics, including age, education level, income, employment status, and religious orientation, in shaping actions and attitudes toward climate change. Attitudes are not homogeneous; rather, they vary depending on demographic and social contexts. This variability is of critical importance for the design of strategies aimed at enhancing community resilience and reducing disparities in the ability to respond to extreme events.

By using the European Social Survey dataset, this paper benefits from a solid and widely respected source of validated data, ensuring the reliability and cross-national comparability of the results. In fact, the use of some quantitative techniques, such as Fuzzy-Hybrid TOPSIS and Gradient Boosting Models, allows for a complex relationship between climate perceptions, displacement, and socio-economic factors. These methods provide an orderly integration of diverse data and allow actionable insights to be derived. However, the study also has limitations. First, the analysis is limited to Italy, a country with specific cultural, economic, and climatic characteristics that may not be illustrative of other international contexts. As a result, the conclusions may not be readily applicable to regions with different socio-economic or geographical structures. Another limitation is the limited set of socio-economic variables considered. The analysis places significant emphasis on a limited set of independent factors, such as income, education, and age, while excluding other potentially relevant variables. Factors such as residence in an urban or rural area, family structure, social and geographical mobility, and energy consumption patterns could have provided a more comprehensive and nuanced understanding of perceptions and actions toward climate change.

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