Italians and Global Warming Skepticism: opinions and Ways of information

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Abstract

Scientists, policy-makers, entrepreneurs, and citizens are strongly concerned about the harmful consequences of climate change. Individual beliefs about social norms and economic and political orientations regarding trust and social relationships call into question values such as care for the environment, autonomy, freedom of choice, and risk. Given the influence of the media on public perceptions, it is essential to consider how, with what means, and towards which issues citizens orient themselves to address this epochal phenomenon. Using quantitative and qualitative methods of analysis, the present study investigates the characteristics and reasons of the individuals who are skeptical of the evidence of global warming in Italy and how the Italians inform themselves about this issue. Quantitative analysis was performed on two representative samples of 1011 and 1030 individuals from Observa Science in Society in 2022 and 2023 through a structural equation model (SEM) to study the dimensions associated with climate change skepticism. Qualitative research on a panel of 93 Italians selected by gender, cultural level, and area of residence further highlighted the information channels, methods of use, and the main dimensions of interest in climate change. This robust mixed-mode methodology, which ensures the credibility and reliability of the study's findings, is a key strength of this research. Our results confirm that less trust in science and older age are associated with skepticism. Furthermore, traditional media are the primary means of information despite the growing importance of social relations - including social networks - in shaping opinions on the environment and climate change. The conclusions also reveal that experts influence the public, even if personal experience often mediates this effect. These findings have practical implications for understanding and addressing climate change skepticism in Italy, equipping researchers, policymakers, and individuals interested in this issue with the knowledge to make informed decisions and take effective action.

Keywords: Climate change skepticism, Communication, Media, Public opinion, Italy.

Introduction

Climate change is one of humanity's most crucial challenges, and the effects on human well-being and how it can change our lives are studied by researchers with various evidence that also demonstrates the impact on the environment and biodiversity. Rising temperatures increase the frequency and intensity of heatwaves, which can cause heat exhaustion, heatstroke, dehydration, and even death. Vulnerable populations, such as the elderly, children, and those with pre-existing health conditions, are particularly at risk.

Another significant effect on human health is the development of new diseases and epidemics (Williams et al., 2021).

Considering effects on the environment and the biodiversity, many species are struggling to adapt to rapidly changing climate conditions. Habitat loss, shifting ecosystems, and rising temperatures have contributed to the endangerment and extinction of species (Weiskopf et al., 2020). For example, polar bears are losing their sea ice habitat, and coral reefs are dying due to ocean warming and acidification. As glaciers and polar ice caps melt, sea levels are rising, threatening coastal habitats and human settlements. Flooding, erosion, and saltwater intrusion into freshwater sources are becoming more frequent, affecting millions of people living in coastal regions. Entire ecosystems are shifting due to climate change. For instance, temperate zones are moving poleward, and some plants and animals are migrating to cooler areas (Shivanna, 2022).

But what is the point of view of the non-expert public? Sector studies have explored public perception's main dimensions, including beliefs, facts, values, and opinions (Baiardi, 2023; Crawley et al., 2020). These investigations have been carried out to grasp the extent of the perception of climate change in the collective imagination. At the same time, other research has found that a high level of skepticism can undermine the effectiveness of actions and policies to mitigate the effects of climate change (Hornsey et al., 2020 or, for research in the USA, see Ding et al., 2011). De Graaf et al. (2023) define climate change skepticism as "[…] any beliefs that reflect non-acceptance of the current understanding and portrayed by mainstream climate science."

Two particularly effective interpretative models explained the personal orientation to be responsible in the fight against climate change. The first, the Norm Activation Model, describes the tension to act based on particular conditions that allow individuals to confirm their adherence to shared social norms (Schwartz, 1977). Even more, the second interpretative mode - the Value Believe Norm Theory - focuses on the subject ability to act in conditions of evident threat to a value considered relevant; this way, the subject can operate to counteract the unwanted effects of specific events (Stern, 2000, 2012).

Considering public opinion, research has found widespread concern among citizens about this epochal phenomenon (European Commission, 2019; Pew Research Center, 2022).

For European citizens, the most alarming problems affecting the world are poverty, hunger, and lack of drinking water (20%), armed conflicts (19%), and climate change (17%, European Commission, 2023). Respondents in seven countries - Belgium, Denmark, Germany, Ireland, Malta, the Netherlands, Austria, Finland, and Sweden - evaluate climate change as the world's most severe problem. Considering the general trend, it ranks in the top three in 16 out of 27 countries. When asked to point to a problem, 46% of respondents believe climate change is one of the world's most severe problems, placing it in third place

behind poverty, hunger, and lack of drinking water (58%), and armed conflicts (52%). More than one in five respondents in each European Union state believes climate change is one of the world's most critical problems (European Commission, 2023).

As our quantitative study will demonstrate later, perceptions and emotions play an essential role when faced with incumbent dangers (such as environmental ones) often reported with great emphasis by the mass media (Brosch, 2021).

The literature provides some valuable indications on these aspects. Recent studies distinguish between climate worries and climate concerns. The first is described as an experiential element of action-oriented awareness. The second is an emotional element centered on risk and fear. Worries are an attitude that can quickly produce actions and, in the case of climate change mitigation, trigger actions (Bouman et al., 2020). Worries about climate change indicate the disposition of an individual who is actively and emotionally engaged with climate change. The subject is disturbed by its consequences and, therefore, is willing to act to overcome the problem or mitigate its effects. Several studies and models – such as the hierarchy of concerns model (Van der Linden, 2017) and the gateway beliefs model (Van der Linden et al., 2015, 2019) – have defined worries about climate change as one of the main elements that predict climate mitigation behaviors and political support. Alongside these studies, others have highlighted a link between worries about climate change and the disposition to act. Of course, these trends do not demonstrate that all individuals experiencing these worries will likely engage in them.

The controversy surrounding climate change is complex, involving a mix of scientific, economic, political, and social dimensions. Understanding these different aspects is crucial for informed discussions and effective policymaking.

Most scientists agree with this thesis regarding human responsibility for climate change, although a small minority are skeptical. Predictive models and major IPCC (Intergovernmental Panel on Climate Change) reports remain the most reliable and certain documents for most experts and communicators (IPCC, 2023). From an economic and political point of view, the public debate often focuses on the need to reduce fossil energy consumption in favor of investments in renewable energy. The most skeptical in this regard, however, argue that these measures could harm economic growth by increasing the cost of energy and reducing the sector's workforce (García-García, 2020).

Studying the media landscape allows us to recognize the growing "greenwashing" effect aimed at denouncing climate emergencies and the need to move on to resilience and mitigation actions (De Freitas et al., 2020; De Jong et al., 2020). Conversely, phenomena of misinformation and disinformation have tried to counter scientific evidence by minimizing the unwanted effects of climate change by devising counter-information campaigns (Lewandowsky, 2021; Lomborg, 2001).

On the legal and political front, international agreements like the Paris Agreement aim to unite countries in the fight against climate change, although levels of commitment and implementation vary. Therefore, there are equity issues: climate change disproportionately affects poorer regions and communities that contribute less to greenhouse gas emissions, raising ethical concerns about justice and equity (Loucks, 2021). Transitioning to renewable energy sources, improving energy efficiency, and reforestation are mitigation strategies for reducing greenhouse gas emissions. Adaptation measures for addressing the effects of climate change also include building resilient infrastructure, developing drought-resistant crops, and improving disaster response systems (De Abreu et al., 2022).

Other research focuses on public opinion and climate change concerns information. Many investigations have highlighted the influence of the media, particularly the power to propose an agenda and the priority of news to the public (McCombs, 2004; Dumitrescu & Mughan, 2010). Results highlight, on the one hand, the media's commitment to offering balanced information capable of proposing the reasons of the deniers and the scientific truths and, on the other hand, the intensification of media campaigns in specific periods when problematic situations erupt (Boykoff & Boykoff, 2004). In this case, critical issues are observed when the media propose conflicting versions, producing undesirable cognitive outcomes, including confusion, backlash, and attitudinal ambivalence (Gustafson & Rice, 2020).

In recent years, the media have dedicated considerable space to environmental issues and sustainability. This type of commitment has been defined as greenwashing, a phenomenon that has affected all media, from the most traditional to the digital ones (Zych et al., 2021). The massive information campaigns by institutions and research centers in support of investments for environmental sustainability and public protest actions have attracted the attention of the public worldwide to respond to the emergencies created by climate change (EESCCR, 2020). The phenomenon has some critical aspects regarding the use that some information campaigns have made of the environmental theme. In various cases, companies have used the theme of environmental protection to propose products that are actually not eco-friendly (Yilmaz & Baybars, 2022).

Some studies highlight the public's difficulty in accepting high levels of uncertainty caused by ambiguous and controversial news, and this is one of the reasons why communicators and scientists often hesitate to communicate insecurity and indecision on the effects of climate change (Johnson & Slovic, 1995; Fischoff. 2012).

The climate change issue reaches peaks of interest depending on the periods and media coverage that raise the topic's salience in the public. The International Climate Change Observatory identified 2010 as the most notable peak and 2022 as the third most relevant media moment. [Media and Climate Change Observatory, 2024; Figure 1].

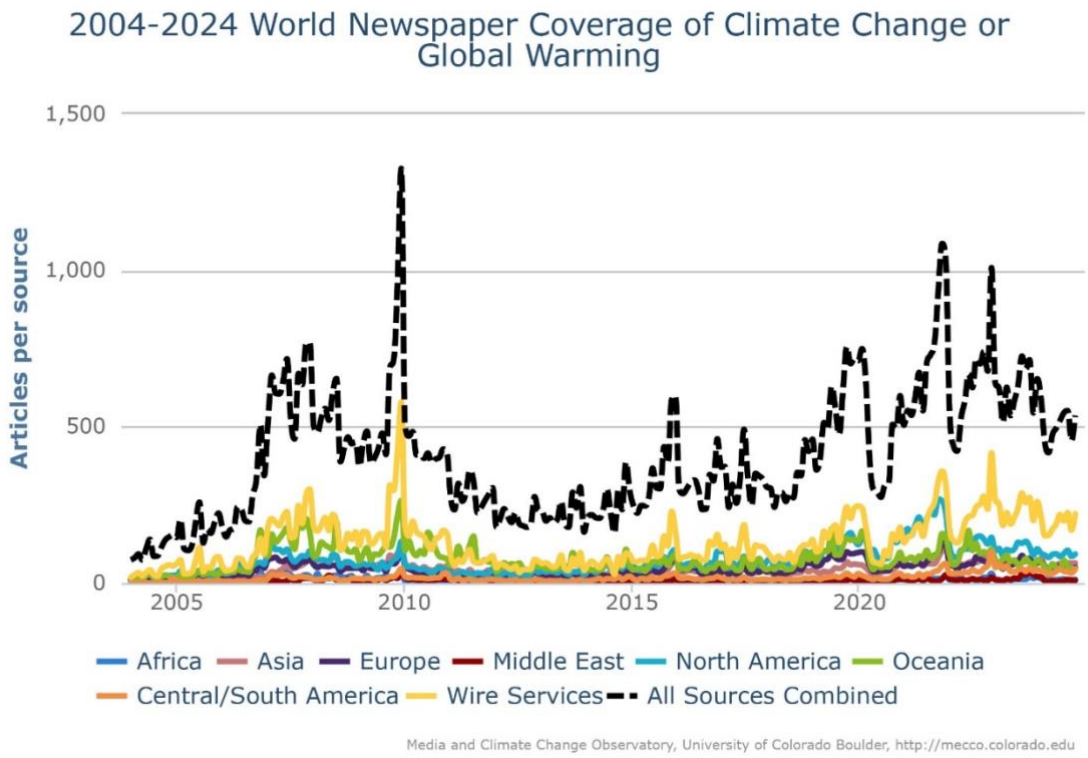
International studies have investigated which sources the public uses to gather information on climate change. One of the most relevant studies conducted in 40 countries shows that television is the most used medium. Secondly, the websites of prominent institutions and organizations dealing with the environment are consulted. Only 9% of the international public gets information via social networks (Newman et al., 2020).

Considering Italian public opinion, more than eight out of ten citizens agree to consider climate change a significant problem (European Commission, 2023). This is due, to a large extent, to particular conditions experienced by citizens in the national territory. The geological configuration of Italy subjects the territory to frequent instability and flooding caused by global warming, in particular by extreme heat events affecting the Mediterranean Sea. Citizens of various areas of Italy are increasingly hit by torrential and sudden rains. The protection and resilience system of institutions and civil society is not yet able to face all the challenges that the phenomena caused by global warming pose to the country (Antronico et al., 2020). The narrative regarding the atmospheric conditions and the geological situation of the country is also present in the public discourse of decision-makers and the media (Ghinoi & Steiner, 2020).

Some studies have shown that traditional media (TV and newspapers) are the primary sources of information, even if the share of people who get information via the Internet is growing over time (Beltrame et al., 2017; Bucchi et al., 2024).

Only a few research studies investigate how the public gets information and, precisely, the most controversial issues or public opinion polarization (Bayes et al., 2023; Chinn et al., 2020). The lack of studies is because these topics can be analyzed with more accurate research from a qualitative point of view, which only sometimes leads to broad generalizations. However, given the complexity of the topic, it is helpful to carry out more analytical studies to understand the different modes of information and the attributions of meanings.

Figure 1: Newspaper media coverage of climate change or global warming in sixty-six sources across fifty-nine countries, including Italy, in seven different regions worldwide, from January 2004 through December 2023. (Media and Climate Change Observatory, 2024).



Methodology and Research Questions

For our research, we used a mixed method of research: quantitative and qualitative. The following key attributes of the quantitative and qualitative methodology can be underlined to study global warming perception.

1. The quantitative method seeks to obtain accurate and reliable measurements that allow statistical analysis, trying to grasp the public's main concerns.

2. The qualitative methodology intends to understand a complex reality and the meaning of actions in a given context within its natural setting, in our case, Italy (Mezmir, 2020). This is particularly useful for studying the use of the media and identifying communication priorities.
3. A quantitative research approach allows the researcher to identify the most important variables of specific public attitudes, in this specific case, skepticism.
4. Quantitative and qualitative methods allow us to move from a general level of abstraction to more particular dimensions and particularly significant elements. In the present work, they were used to study the motivations of those skeptical about global warming, how they use the media, and the most critical major communication areas.

For our study, we used the data collected by Observa Science in Society[1] . Observa has been studying Science and Society in Italy since 2001 through a research project involving a representative sample of about 1000 subjects every year. The 2022 survey included a section about the perception of global warming, representing a valuable source for the present work. These data can be analyzed to study those who believe the climate is changing and those, on the contrary, who are skeptical. Therefore, the first research question we aim to answer in this work is: RQ1) What are the characteristics and reasons of those against the evidence of global warming?
Alongside this question, a qualitative analysis of the points of view of a sample of 93 Italian citizens specifically convened to discuss climate information will allow answering two further questions: RQ2) How do Italians inform themselves on climate change issues? And RQ3) Which communication areas are most critical?
In their analysis of the same dataset, Bucchi et al. (2023) found that in 2022, almost nine out of ten Italians (89.0%) believe that the earth's climate is becoming increasingly warmer, compared to only 5.2% who think the opposite and 5.8% who do not have an opinion. Furthermore, starting from 2009, the number of skeptics has progressively reduced, while the share of those convinced has risen constantly: the skeptics were 19.1% in 2009, while those who believed that the climate was changing were 71.7%.
The present work uses a quantitative method to better focus on the skeptical and identify which sociocultural dimensions correlate with Italians' opinions about climate change. A qualitative method will be used to identify and study in more depth the environmental issues Italians are more interested in and the channels through which they prefer to get information.

Method

Quantitative research

The data presented in this article were collected through a survey by Observa Science, Society, and Technology. Every year, the Observa Monitor, a research project about Italians and science, collects the

[1] https://www.observa.it/en/.

opinions of a representative sample of about 1,000 Italians. To study the Italian public's orientation on climate change, we examine the national surveys carried out in 2022 and 2023.

The 2022 survey was conducted between April 28 and May 10, 2022; the 2023 survey was conducted between May 2 and May 9, 2023. The sample size was 1011 in 2023 and 1030 in 2022. Data collection of both the survey wave was carried out through a mixture of CATI (Computer Assisted Telephone Interviewing) and CAWI (Computer Assisted Web Interviewing) techniques, interviewing a sample of Italians aged 15 or more, proportional to the whole population and representative by gender, age class, and province of residence of the population. Moreover, the sample obtained was weighted to make its structure correspond to that of the Italian population concerning gender, age group, and educational qualification.

A structural equation modeling (SEM) of the Observa 2022 wave was developed to study which variables are related to climate change skepticism (Joreskog & Sorbom, 1993). One advantage of this multivariate technique is that it allows the measurement of latent variables and the relationships between exogenous (i.e., independent) and endogenous (i.e., dependent) variables included in the model (Tarka, 2018). Moreover, SEM analysis can be used to develop causal models to test hypotheses on the interactions between the variables included in the model. In the present study, the analysis focused on a simple saturated model, testing only the direct relationships between skepticism and the independent variables.

Independent variables used in our model of climate change skepticism included demographic variables (age, gender, geographical area), educational qualifications, political opinion, scientific literacy, and trust in science (Table 1).

Table 1: Variables included in the structural model of skepticism.

Dependent	
SKEPTICISM	In your opinion, is the earth's climate actually getting warmer? (No = 5.2%, Don't know = 5.7%, Yes = 89.1%)
Independent	
SEX	Sex (52.2 F, 47.8 M)
AGE	Age of respondents (Range 18-91, mean age: 50.8)
EDUCATION	Education (primary or none: 14.7, secondary school key stage 3: 38.2, secondary school key stage 4 and 5: 31.6, university: 15.5)
RIGHT	If you were to vote in a national election today, which of the following parties would you most likely vote for? (FDI or Lega: 16.3%, other: 83.7%)
SCIENTIFIC LITERACY	Correct answers to five questions about science. (Range: 0-5, mean: 2.97, Std. Dev.: 1.34)
TRUST IN SCIENCE	Trust in 1) science in general, 2) in research institutions, 3) in scientists, and 4) in experts (Range: 0-24, mean = 8.2, Std. Dev. = 2.50)

The dependent variable (SKEPTICISM) was measured using a single question: "In your opinion, is the earth's climate actually getting warmer?" (Possible answers were yes, no, and do not know, considered as an intermediate degree of skepticism). It is useful to note that the question asked in the survey concerns global warming and, therefore, a specific aspect of climate change. However, although the two concepts are different, we will use global warming as a proxy for climate change in this analysis.

As regards the independent variables, the first is gender (SEX), for which no hypothesis has been made. The second is age (AGE), and the hypothesis is that older people could be more skeptical. The third is education (EDUCATION), divided into four categories: primary school, secondary school key stage 3, secondary school key stage 4 and 5, and university, for which it is possible to predict greater awareness of climate change among those who are more educated. The fourth independent variable is the political position (RIGHT), built as a variable based on the question: "If you were to vote in a national election today, which of the following parties would you most likely vote for?". The variable was built with two categories. The first category included those who declared to be closer to the mainstream populist right-wing parties of the country (FDI and Lega), and the second all the other respondents. Right-wing positioning was tested as a possible skepticism factor because previous research has shown how this dimension relates to higher hesitancy about environmental change (McCright et al., 2015; Gregersen et al., 2020).

The fifth is scientific literacy (SCIENTIFIC LITERACY), measured as an additive index by summing the number of correct answers provided to five questions on science: 1) Electrons are smaller than atoms; 2) Antibiotics kill both viruses and bacteria; 3) The sun is a planet; 4) Nitrogen is the most widespread element in the air and 5) The bit is the unit of measurement of the quantity of information. The possible answers for each question were true, false, or I do not know. Do not know was considered an incorrect answer[2] . The hypothesis is that those more informed about science should be more aware of climate change.

Finally, trust in science (TRUST IN SCIENCE) was measured as an additive index considering trust in 1) science in general, 2) in research institutions (universities, research institutes), 3) in scientists, and 4) in experts who speak publicly (e.g., on TV or social media). For each dimension, the possible answers were "A lot," "Quite a bit," "A little," and "Not at all." A principal components analysis and Cronbach's alpha confirmed the one-dimensionality of this issue, which showed that the first component extracted explained 50.4% of the variance. Considering this dimension, we expect that those who trust science and the scientists - who frequently raise alarms about the state of the climate - will also be less skeptical.

Qualitative research

This analysis is based on the workshop conducted on September 14, 2019, by Observa at Villa Valmarana ai Nani (Vicenza - Italy), with the participation of 93 people (50 males, 43 females) from 37 different Italian municipalities and educational levels (Primary ed.: 1, Lower secondary ed.: 14, Upper secondary ed.: 36, University degree: 42; age 18-19: 10, 20-39: 34, 40-69: 45, >70: 4)[3] .

[2] For further information on the measurement of scientific literacy see Tipaldo (2011) and Pellegrini & Rubin (2020).

[3] The European project Concise n. 824537 (Communication role on perception and beliefs of EU Citizens about Science) was coordinated by the University of Valencia and carried out research in five countries:

The ten group tables around which the workshop was organized resulted in over 80 hours of recorded audio and almost 600 transcription pages. The audio transcription underwent a statistical content analysis of 4.797 speech turns, resulting in 209.213 words.

The qualitative analysis followed a three-step approach to determine how the public collects information and which communication areas they focus on (Brondi & Pellegrini, 2021).

The first step was a thematic investigation (Vaismoradi, 2013). In this phase, evident and latent elements were studied to describe the main discursive components while also trying to identify some interpretations. The second step aimed to identify some key terms that characterize the discussion around climate change. In this way, it was possible to identify some of the priorities expressed by the participants and the testimonials that were considered particularly reliable (Grodal et al., 2021). Finally, particular attention was given to three dimensions that characterize the public discussion on climate change through the analysis of lexical correspondences (Faggiano, 2022). These dimensions represent an interpretative framework of the positions taken by the participants on the topic of climate change.

Results

Quantitative analysis

Figure 2 presents the SEM model of climate skepticism to answer our first research question. The model included all the direct relationships between the dependent and independent variables. However, only trust in science and age significantly affected skepticism, thus confirming the related hypotheses, while the other hypotheses did not hold.

Trust in science is negatively related to the opinion toward global warming. It has the strongest structural parameter (TRUST IN SCIENCE, -0.37), indicating that greater trust in science is also associated with less skepticism. The association with age (AGE) is positive (0.16); therefore, older people are more skeptical. Both dimensions are associated as expected. Of the other variables, scientific literacy and voting for a right-wing party are associated in the expected sense but not significantly, thus not confirming the expected hypothesis. The remaining dimensions, i.e., education and gender, have almost no effect.

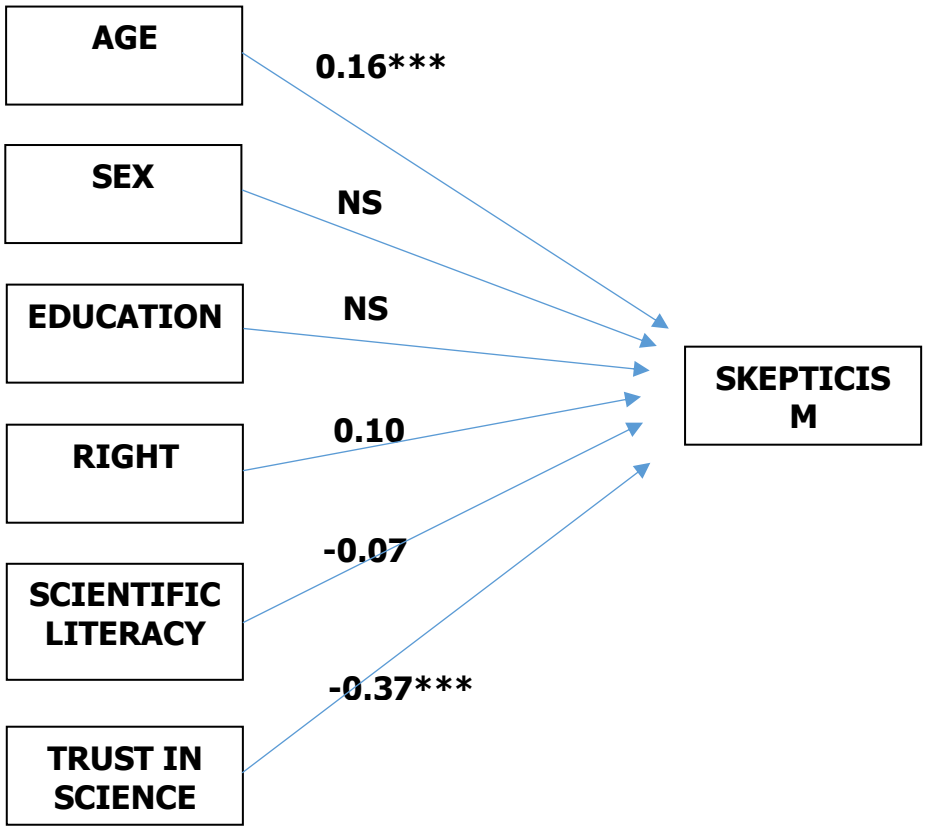
The result about political position is of interest because it contradicts previous findings. For example, if we had limited our analysis to the bivariate level, the difference between right-wing and non-right-wing voters would have been significant, given that skeptics are 18.1% among those who identify with the right and just 9.5% among those who identify with a center or left party.

Although related to the Italian case, the SEM model can help better understand at least four aspects of climate skepticism. However, some limitations must also be added. First, the model was tested for linear relationships, but the linearity might not hold for some variables. For example, skepticism could increase to a certain point and then decrease. Secondly, given that only the direct relationships between the independent variables and skepticism were tested, other analyses could investigate whether different dimensions indirectly affect opinion about global warming. For example, education could correlate with trust

Italy, Poland, Portugal, Slovenia and Spain. The scientific direction is entrusted to Prof. Carolina, for Italy the activities are carried out by Observa.

in science and scientific literacy. Third, the model explains less than one-fifth (R2 = 0.18) of skepticism's variance. This result highlights the need to study this phenomenon through other instruments, such as qualitative interviews and analysis, to understand skepticism's in-depth aspects and motivations. For example, a qualitative study could grasp the emotional aspects linked to experiencing the harmful effects of climate change on the lives of the respondents or their families. Fourthly, most people believe that the planet's temperature is getting warmer and warmer year after year; therefore, only a minority are skeptical, making it difficult to study their profile unless an ad hoc survey is carried out on this subset of the population.

Figure 2: SEM Model for Global Warming Skepticism (data: Observa 2022).



n. = 1,030. R^2 = 0.18. Model fit: DF = 0, P = 1.0, RMSEA = 0.000.
(saturated model, *** = 0.001 statistically significant structural parameters).

As Observa also collected other information about climate change, it is possible to investigate other aspects of this phenomenon, such as the reasons that justify the answer that the earth's temperature is or is not changing (Table 2). Notably, over half (55.8%) of the skeptics base their opinion on the perception that temperatures do not vary much yearly. The same is true for those who think the opposite (53.3%). On the contrary, scientific evidence in support of or against climate change is mentioned by approximately one in five skeptics (21.1%) and just over one in three of those who believe the climate is changing (35.7%).
This result supports the idea that personal experience and emotions constitute powerful decision-making drivers when humans have to take a position related to a harmful situation. In other words, emotions activate

an adaptive process functional to the survival of individuals in case of immediate risk, given that they act on cognitive processing by triggering time-tested responses to universal experiences such as loss, injustice, and threat (Lerner et al., 2015) this is because the emotion system plays an essential role in mediating decision biases (De Martino et al., 2006). Furthermore, this psychological process can also help clarify why the emotional side prevails over the rational one, leading most of the population to base their climate change opinion on what they perceive rather than on the rational explanations provided by the scientists. These positions can be explained considering that the brain modulates the effect of the bias introduced by emotions to approximate a condition (conditioned by this emotional bias) of rationality (De Martino et al., 2006).

Table 2: Opinions about climate change (Valid answers = the climate is not changing: 53; the climate is changing = 901).

What makes you think the earth's climate is not actually getting warmer?	**%**
Seasonal temperatures are more or less the same	55.8
Environmentalists always exaggerate	22.3
There is no scientific evidence to prove this	21.1
Does not know	.8
What makes you think the earth's climate is actually getting warmer?	**%**
The summers are increasingly hotter, and the winters are less cold	53.3
Many scientific studies prove this	35.7
Environmentalists have been saying this for years	7.4
Does not know	3.6

Our results also confirm that the dichotomy between rationality and emotions does not work when the respondents are asked to indicate the most authoritative interlocutors who should be listened to before deciding the measures to adopt to contrast the rise in the planet's temperature. Based on the Observa dataset, over two out of three (68.0%) respondents say that we should listen to scientists, while only a few mention the young people protesting for the planet (13.7%), such as the Fridays for Future movement, or the environmentalists (13.0%), and a residual fraction indicates politicians.

In conclusion, individuals often try to make rational choices, even if they are sometimes mistaken. Our results suggest that interventions to raise public awareness should focus on the reputation of the interlocutors. With their authority, these individuals can recommend the best solutions, instilling confidence in the public. This approach is particularly effective, as our analysis shows that those who trust science are less skeptical about global warming. Therefore, an aspect to be explored and investigated further concerns the ability and ways scientists communicate the results of their research on climate change (Sarathchandra & Haltinner, 2020). Interventions to lower skepticism and promote pro-environmental behavior should not only rely on rational arguments but also leverage emotional aspects. By allowing individuals to internalize solid opinions, these interventions can engage and connect people to the issue of climate change, motivating them to take action.

Qualitative analysis

The first step of our qualitative thematic analysis of elementary contexts made it possible to identify four main issues through which discourses about climate change were summarised. The first issue frames scientific information within the field of public communication (e.g., debate, discuss, public, deal); the second issue frames scientific information within the field of daily communication proposed by traditional (e.g., television, Rai[4], documentary, television news, radio, newspaper, book) or digital media (e.g., Internet, websites, Youtube, social platforms such as Facebook, Instagram, Linkedin, TikTok, etc.); the third issue frames scientific information within the field of medical communication (e.g., physician, pharmacist) and the last issue frames scientific information within the field of institutional communication (e.g., ministry, politician, scientist). The data collected allows us to answer the second research question.

The media is the most used information channel, with a slight preference for traditional media over digital ones. Among traditional media, television is by far the most cited, with numerous references to news programs and documentaries and specific channels (including international ones) or programs. Then follow the newspapers (mainly national, but also local or international), magazines, books (including school or university books), scientific magazines, and the radio. Although cited, brochures, essays, and films have less relevance than the other media. Among digital media, the Internet (and specific specialized or non-specialized sites, forums, and, more generally, Google) is undoubtedly the most mentioned channel, followed by social networks and, to a much lesser extent, blogs, messaging applications, snapshots, and emails.

Alongside the media, interpersonal relationships commonly support the commitment to inform the public about scientific issues. They are addressed in discussions (above all) in terms of personal experiences at school, university, or work environment, but also through word of mouth, which remains a means of exchanging points of view, opinions, and advice on topics such as climate change. In addition to personal experiences, direct communication also plays an important role: participants in the workshop often evoke friends and the family circle as the main channel or source of information, even if there is no shortage of references to acquaintances, colleagues, teachers, or students and, even to strangers.

The qualitative analysis then allows us to detect other sources of information cited during the discussions, although not predominantly. Scientists have a strong influence, especially in the medical field (e.g., general practitioners, medical specialists, pediatricians, and pharmacists), as do communicators (including experts, journalists, and opinion leaders). Institutional sources, however, are less indicated: among these sources, the Ministry of Health and universities or research institutes stand out. Likewise, governmental or non-governmental organizations and companies are little used as a channel or source of information, remaining relatively marginal during the entire workshop. Finally, politicians receive little attention, and their voices are little considered to gain insight into scientific issues.

The second step of the qualitative study of opinion about climate change focused on analyzing the specificities, making it possible to identify relevant words within each debated subject. In this way, it was possible to answer the third research question by identifying critical areas.

Climate change is discussed as a current (e.g., today) and global (e.g., world) issue that concerns and can harm everyone (e.g., us, our), but above all, the new generations (e.g., boys, young people). The

[4] Rai is the public Italian broadcast.

preferential channels to retrieve and understand information (e.g., search, understand, read, find, watch, follow) are both traditional media (e.g., television, newspaper) and digital media (e.g., social media, Facebook), which are also used as a sounding board to disseminate information (share) actively. The working environment (e.g., work) is where conversations on the topic most often occur. The leading figures are Greta Thunberg, often mentioned in opposition to Donald Trump, and - at a national level - Piero Angela and Luca Mercalli[5]. Scientific communication on climate change is generally perceived as qualitatively inadequate, mainly due to the spread of fake news, alarmist news, and contradictory or distorted information.

Table 3 summarizes the main results obtained with the two types of qualitative analysis.

Table 3: Climate change information: ways, actions, and critical elements (data: Observa 2019).

Sources and communication channels	Television, newspapers, the Internet, experts, and influencers
Actions	Search for recognized competent experts.
Critical elements	Poor information from the institutions

Source: Made by authors

The last analysis is based on an analysis of lexical correspondences and made it possible to identify three semantic dimensions that play a role in organizing the discourses around climate change:

1) The "private-public" continuum: On one side, the information is used for purely personal use. Conversely, on the other side, it is used for the "public debate."

2) The "passive-active" continuum: The "passive" side sees citizens as excluded and loaded with fear and doubts; on the contrary, the "active" side represents an inclusive process of acquiring and appropriating information, in which citizens interpret and transmit messages.

3) The "direct-mediated" continuum: The "direct" side represents a process where the subjects acquire information based on interpersonal relationships; conversely, the "mediated" side evokes a form of scientific communication proposed by media or institutions.

Discussion and conclusions

Climate change is a complex phenomenon that must be studied from a multidimensional perspective (Moser, 2010). Research on climate skepticism must, for example, involve aspects relating to communication (Moser, 2016), the search for factors that support skepticism (Schmid-Petri, 2017; Dunlap & Brulle, 2020), and, recently, also those that contribute to spreading misinformation online (Treen et al., 2020).

[5] Two popular italian science communicators.

Our analysis has shown that when it inspires trust, science can foster the perception of the real dimensions of the problem. However, individuals' perception is also linked to the personal experience of the problem. Uncertainty and insecurity activate evolutionary mechanisms. In the event of danger, a process is triggered whereby individuals, after having experienced the threat of the problem and becoming aware of its severity, decide to act.

Furthermore, although there is now a broad consensus that the climate is changing, it is also true that people are more reluctant to change their behavior to counteract its effects. For this reason, it is important to trigger virtuous mechanisms so that action to defend the environment is perceived as a collective action. Identifying with a group and feeling that I am telling the story of a group that is in danger is, from an evolutionary point of view, one of the aspects that can activate action (see, for example, in the case of the insecurity generated by populist communication, the frame proposed by Forgas, 2023).

As for the narration of climate change, traditional media are still the most used. In this regard, some research has found that narratives in the form of stories are more effective than those of an exclusively narrative nature (Morris et al., 2019). Furthermore, people are more motivated to change their behavior if communication is able to leverage positive emotions, for example, by focusing on the fact that changing one's lifestyle will lead to improving the individual well-being of individuals (Harth, 2021). Too strong narratives of the negative effects of change can push some individuals to seek a calmer and safer narrative, even if wrong (Haltinner & Sarathchandra, 2018).

In this work, we have focussed on the Italian case and investigated the opinions and sources of information about global warming. We studied the factors related to a skeptical position, considering socio-graphic dimensions, scientific knowledge, and political orientation. From the point of view of social research, the opinion about global warming is conditioned at an individual level by rational and irrational elements and at a public level by the media's influence on individual positions. To deal with this complexity, we have applied quantitative and qualitative analysis methods to understand a phenomenon that presents different facets.

Our quantitative analysis found that less trust in science favors skepticism. At the same time, among the demographic variables, only older age is associated with believing that the climate is not changing. These results are consistent with the existing research. For example, Crispino and Loberto (2024) found that attention to this problem decreases in older age groups, and the same result was found by Whitmarsh (2011). However, other studies on data collected at the beginning of the Millennium did not reveal significant age-related differences (Beltrame et al., 2017). To this purpose, future studies should also consider that age can moderate other dimensions, including education or the willingness to fight to build a safer environment for humanity. The role of trust in science as a mediator of awareness that the climate is changing was instead found by Diehl et al. in 2021 in their analysis of over 18,000 interviews carried out in 20 countries, including Italy. Moreover, since the developed model explains less than a fifth of the variance, our quantitative analysis highlights that to understand this phenomenon, it is also helpful to add a qualitative investigation of the opinions of the public. The reason is that opinions of greater or lesser skepticism are favored by personal experimentation with change, for example, increasingly extreme meteorological events, and by their communication by the media and scientists. Future research should focus both on skeptics – with a targeted sampling of this segment of the population – and on the link between the belief that climate is changing and action to counteract this phenomenon.

Furthermore, research needs to consider that discourse in the media and social networks can vary or be contradictory and distorted. The non-expert public is not always able to verify the reliability of the sources and news proposed on climate change and considers aspects that are not always objective. The data collected by Observa, therefore, confirm how the effectiveness of policies to mitigate the adverse effects of global warming involves the weighing of both rational aspects, such as scientists' alarms, based, for example, on the observation of data and historical series also in the long term, and the perception and communication of more irrational aspects, such as the opinions about those who communicate the news or their concerns about climate-related events, or protesting to demand action to mitigate their effects.

The study of sources, channels, and levels of trust in science and technology developed thanks to the Italian workshop has allowed us to identify how the public declines global warming topics. The qualitative study offers interesting results but must also be considered with respect to its limitations. These include the limited number of participants and the difficulty, given the time constraints, of delving into all the topics related to climate change. However, the complexity of the contents expressed during the meeting described briefly in the previous sections can be ideally summarized in three main dimensions: mediated-direct, public-private, and active-passive.

The qualitative analysis highlights how traditional media surpasses digital media. Indeed, TV and the press are still the favorite channels to retrieve information, especially when individuals want to delve deeper into a topic of interest. However, relational methods should not be underestimated, as they, especially in the case of environmental and climate change, are essential sources of information and discussion. Family and friend circles are areas of comparison and exchange in which opinions, critical attitudes, and views related to science and technology are formed. These paths of information acquisition and opinion formation indicate that the power of the media is not as decisive as we often think. Furthermore, the influence of political discourse and expert communication might not be decisive in conditioning the opinion of the public, as studied in other research (Carmichael & Brulle, 2017).

From this perspective, the public-private dimension allows us to identify the role of institutional and expert sources in the scientific debate. At the same time, it is appropriate to recognize the effect of personal experience in incorporating this knowledge into the practice of everyday life at the private sphere level.

Finally, the active-passive dimension underlines the contribution of citizens in the co-construction of technoscientific issues. On the one hand, channels that imply direct interactions are evoked with peers or experts. However, the desire to learn more via traditional or digital media channels also denotes a certain degree of interest and involvement of individuals. On the other hand, methods of communication lowered from above by institutions and scientists might fail as they leave the citizens in a decentralized position concerning the scientific debate.

Although opinion about climate change is undoubtedly influenced by traditional or digital communication, it is helpful to consider other ways citizens can inform themselves (Mata et al., 2023). The presence and interaction of various channels confirm the complexity of the topic and the need to study its many facets to interpret the public's orientation correctly and make effective public policies to mitigate the effects of global warming.

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