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Exploring the intersection of religion, religiosity, ideology and climate change perception of Americans

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Abstract

The existing literature on the intersection between religion, religiosity, ideology and perceptions of climate change effects is limited. There is a notable gap in understanding how religious beliefs and practices shape individuals' attitudes towards the impacts of climate change. However, a recent survey provides an excellent opportunity to fill this gap in the context of American society. A fuzzy hybrid analysis approach was used to analyse the dataset obtained from a survey conducted by the Pew Research Center, which included 10,156 respondents, forming a nationally representative sample. The latent variable of climate change effects was measured using four items based on the likelihood of four events happening within the next 30 years. These events are: (1) Lower quality of life; (2) More extreme weather events, such as tornadoes, flooding and droughts; (3) An increase in refugees and displaced people; and (4) Food and water shortages. The results of the study highlight that religion, religiosity and ideology are key determinants in explaining the latent variable under investigation. Among the seventy-nine variables analysed, the influence of religious practices and beliefs stands out as particularly significant, underscoring their critical role in shaping the perceptions toward climate change effects.

Keywords Climate change effects · Ideology · Religion · Religious practices · Fuzzy-hybrid analysis · PEW

1 Introduction

Contemporary climate activism is usually seen as a new "religion" or a "cult" (Kyyrö et al. 2023, p.1). Climate change activists are now acting as priests trying to convince new advocates, so some religious citizens are more difficult to convince. In fact, according to Pew Research Center (2022), "on average, less religious people tend to be more concerned about the consequences of global warming. For example, religiously unaffiliated adults—those

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who describe themselves as atheists, agnostics or "nothing in particular"—are much more likely to say climate change is an extremely or very serious problem (70%) than are religiously affiliated Americans as a whole (52%) (p. 8)".

The issue of climate change gained significant attention in national and international politics during the 1980s. This was due to the discovery of greenhouse gases produced by industrialised human societies in most of the developed world. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established, followed by the United Nations Framework Convention on Climate Change in 1992. Subsequently, various climate treaties, such as the Kyoto Protocol 1997, were introduced and later superseded by the Paris Agreement 2015 (IPCC 2023).

Pew Research Center (2022) found that a significant portion of the sample acknowledges the existence of global warming, with 53% of those individuals attributing this phenomenon to human activities, such as burning fossil fuels. Climate change is a critical issue, with 62% anticipating an increase in extreme weather events and 58% foreseeing more refugees and displaced individuals due to climate change within the next three decades. Furthermore, 54% expect food and water shortages, while 46% anticipate a negative impact on their quality of life due to climate change.

Noy and O'Brien (2018) argued that science and religion seem incompatible and that being a religious person is positively correlated to having less favourable views of science and vice versa. Similarly, the Pew Research Center (2022) did not find an easy explanation for the apparent antagonism between religious beliefs and climate change environmental concerns. The inherent tension between environmental concerns and specific religious beliefs is especially related to some interpretations of Abrahamic religions. The tension is theoretically grounded by a seminal study (White 1967) that suggested that the Judeo-Christian tradition's emphasis on human dominion over nature had contributed to environmental degradation.

However, whereas religion refers to institutionalised traditions of belief, ritual and dogma (e.g. Christianity, Islam or Buddhism) (Bownie 2021), religiosity refers to the intensity or frequency of religious beliefs and behaviours such as prayer, church attendance or the self-reported significance of religion (Gallagher and Tierney 2020). This distinction is important when explaining how institutional commitment and personal devotion influence perception of climate. Furthermore, the political context provides an additional valuable dimension on which to base this debate. Following Fiorino (2022), for instance, allegiance to right-wing populist party has been found to be closely associated with scepticism about climate change. This is particularly evident among evangelical Protestants, whose political and religious affiliations further exacerbate scepticism towards environmental regulation (Veldman et al. 2020; Shao and McCarthy 2020). Including this variable enables us to conduct our analysis within an expanded ideological and institutional framework.

This theory has been debated and critiqued over the years. Some scholars argue that White's interpretation of Christianity is too simplistic and that other aspects of the faith, such as stewardship and creation care, promote environmental responsibility (Jenkins 2009). Many religious figures and organisations have actively championed environmental causes, demonstrating that religion and environmentalism are not necessarily at odds (Wilkins 2022).

This paper aims to contribute to this debatable issue of the intersection of environmental concern and religion by three overlapping objectives: (1) to compute a synthetic index of the Americans' climate change perception (ACCP), using a Fuzzy Hybrid Analysis TOPSIS (FHA-TOPSIS) method; (2) to analyse the blurred and unstudied intersection of ACCP and Americans' religion, religiosity and ideology; and (3) to provide a nuanced

understanding of the role that religious groups, political parties and their leaders could exert on forming ACCP regarding their moral authoritas within their communities. For example, when they speak about climate change as a moral issue, they can inspire followers to take action. We acknowledge that the study's primary contribution is empirical and that our findings might not be directly translated into a formal theoretical framework or immediate practical applications at this stage. However, they provide valuable empirical evidence for future theoretical development and practical strategies.

The remainder of the paper is organised as follows: Sect. 2 offers some insights from the literature, Sect. 3 describes the data, Sect. 4 details the methodology, Sect. 5 presents and discusses the results, and Sect. 6 offers some concluding remarks.

2 Literature review

2.1 Climate change effects

First, the section provides the main context to the four items included in the analysis of ACCP, namely how climate change is expected to impact the quality of life of Earth planet dwellers; to provoke more extreme weather events, such as tornadoes, flooding and droughts which will become more frequent; to induce an increase in refugees and displaced people of the named climate change refugees; and to affect food and water shortages that will become more acute in some parts of the planet.

Climate change is causing multiple effects on several industries, such as tourism, food, water, infrastructure, transport and energy. Natural disasters are becoming more regular events, triggering a significant concern worldwide. Abbass et al. (2022) found that, over the years, several climatic and natural disasters have adversely affected crop production in several countries. These adverse effects burden the quality of life of the most vulnerable citizens in affected nations. Godfray et al. (2010) and Ortiz et al. (2021) mentioned that climate change imposed severe costs on agriculture and the food industry, lowering the farmer's quality of life and causing, in several cases, a direct path to poverty as the food and water supplies are critically endangered.

Robinson (2021) contended that climate change primarily impacted extreme weather events such as floods, forest fires, droughts and tornadoes. The authors found that wide variations in rainfall, flood duration, and droughts are highly affected by climate change. All these extreme weather events impacted water-related health issues in the Mekong Delta Basin. Exposure to frequent extreme weather events also affects the psychological and mental stress of humans living in areas more likely to be affected by such circumstances. Odgen (2018) found that survivors of Katrina's hurricane suffered from posttraumatic mental stress.

The relationship between climate change and migration has undoubtedly been studied in the last twenty years. The analysis of why millions of people emigrate from hazardous environmental places to more secure locations (Rigaud et al. 2018) will be even more prominent in the future. The authors found that climate change will push over 143 million displaced people in the year 2050 in three regions –Sub-Saharan Africa, South Asia, and Latin America- unless more severe corrective actions are undertaken to mitigate the effects of climate change. The reality of migration has also ignited the political debate in which

right-wing populist discourses demonise immigrants, ironically crucial to maintaining the social welfare systems of some high-income countries (Abubakar et al. 2018).

Several areas of the world suffer from persistent droughts that make the subsistence of an underdeveloped agriculture unmaintainable. Some wells are dry, and the lack of water is a chronic event that makes some rural areas lack potable water. The effects of the loss of agriculture led to an unprecedented food shortage that provoked the move of some rural communities. Roudier et al. (2014) commented that climate change is the leading cause of more atypical rainy seasons that alternate between extreme events characterised by droughts and floods. The weather unpredictability and the lack of a proper rainy season make access to water and subsistence more difficult in some areas of the planet, if not impossible. Access to a water source is vital and a primary necessity for the subsistence of human beings (Cochrane 2020).

2.2 The intersection between ACCP, religion, religiosity and ideology

The intersection of religion and climate change perception is complex and multifaceted, varying widely across religious traditions and individual interpretations. Religious beliefs and values significantly shape how individuals and communities perceive and respond to climate change. Climate events can sometimes be seen as chain reactions of the spiritual divinity –God's actions- (Byg and Salick 2009; Holzhausen and Grecksch 2021; Sherpa 2014). Grounded religious conceptions could shape climate change policy not only as a matter of concern but also for the community's survival (Sachdeva 2016). Some religious frameworks, particularly those that emphasise humans as caretakers of the planet, can motivate environmental stewardship and pro-environmental behaviours (Moyer 2018; Agusalim and Karim 2024; Martinez et al. 2024).

Conversely, certain religious beliefs, such as eschatological views or dominion theology, may lead to climate change denial or apathy towards environmental issues (Lindsey and Carlson 1970; Rock 2011). White (1967) argued that the ecological crisis is mainly provoked by the triad of science, technology and democracy, developed by the Western Christian cosmology, which stands out for human domination over nature. Jenkins (2009) contended that the intense debate about White's thesis made it hegemonic. Nevertheless, two main fields, environmental ethics and, religion and ecology, have contested White's legacy. Environmental ethics have moved the focus from anthropocentrism toward civic experience. Meanwhile, in religion and ecology, the main critics questioned the uniform vision between environmental concern and cosmology.

Moreover, the relationship between religious beliefs and climate change scepticism has been extensively explored by Ecklund et al. (2017). Their research highlights that scepticism about climate science is often correlated with broader anti-science sentiments, particularly within conservative religious communities. This resistance is particularly pronounced among evangelical Protestants, where religious identity significantly influences perceptions of climate change (Veldman et al. 2020). However, religion is not only a barrier to climate action. Moyer and Brandenbarg (2021) argue that faith can also serve as a source of resilience and collective action in the face of environmental challenges. This dual role of religion—both as a source of scepticism and a driver of community-based responses—illustrates its complex influence on climate discourse. Zielke (2023) also explores the role of religious institutions in shaping community responses to climate change. His case studies show how different religious teachings, such as those within Buddhism, can either

inspire proactive environmental engagement or contribute to inaction, depending on how they are interpreted.

Different religious traditions may vary in their emphasis on environmental protection, with some advocating for active engagement in climate activism, while others may prioritise spiritual teachings over environmental concerns (Hulme 2009; Druckman and McGrath 2019). Consequently, individuals' levels of religiosity—such as belief in the importance of faith in addressing societal issues—can act as drivers or barriers to increasing awareness of climate change effects. Nevertheless, Boorse and Jablonski (2024) argued that, despite these divergent views, many faith-based organisations, natural scientists and development organisations collaborate more closely to address climate change, providing formal and informal education assets. The collaboration will remove prejudices and former obstacles through better integration, education, dialogue, and a commitment to developing partnership skills that find common ground among different and diverse groups for promoting shared environmental values and responsibilities.

Additionally, religious organisations can play a crucial role in disseminating information and shaping social norms related to climate change, either promoting or hindering environmental action. For example, Sachdeva (2016) contended that it does not matter if some credo believers agree with the fact that climate change will make severe weather events, such as hurricanes, floods, wildfires, heat waves, and droughts, more acute and more frequent simply because of their religion and religious beliefs and practices provide 'an existential framework to help people justify why loss and destruction occur particularly as a result of "acts of God." (p.16).

Thus, it can be concluded that the influence of religion on climate change perception is still subject to debate. Jenkins et al. (2018) concluded that, by the end of the 1990s, social researchers in the United States affirmed that, ceteris paribus, other factors like an ideology weighed more than religion in forming the perception toward the effects of climate change. However, in the last decade, the climate change opinion in the United States has become more polarised, so the study is more important than ever.

Environmental ethics transcends religious boundaries, uniting people from all types of credos in a shared commitment to protecting our planet. Consider the powerful example of Greta Thunberg, a young activist whose passionate advocacy for climate action resonates with people of diverse backgrounds, regardless of their religious beliefs. In her speech to the UN when she was 16, Greta Thunberg declared, "You have stolen my dreams and my childhood with your empty words. And yet I'm one of the lucky ones. People are suffering. People are dying. Entire ecosystems are collapsing. We are in the beginning of a mass extinction, and all you can talk about is money and fairy tales of eternal economic growth. How dare you!" (NPR 2019).

The lack of uniformity is found by Wardekker et al. (2009), who contended that, as should be expected, there is a large diversity of views on environmental concerns within and among American Christian denominations. The authors highlighted particularly the voice of evangelical leaders in their strong influence among Republican voters and that environmentalism and environmental concerns are highly contested within this ideological position. Lowe et al. (2023) also found that political ideology was significantly related to this issue, with political liberals and centrists being far less likely than conservatives to say that Christians and the government should give a low or medium priority to addressing the climate change effects. The authors showed empirical evidence that supports the idea that political ideology is among the most critical drivers, more than any other specific socioeconomic or demographic variables explaining ACCP. Similarly, Kulin et al. (2021) found that the most critical driver of ACCP was ideology, as political conservatives and self-identified

Republicans were more likely than liberals and Democrats to express climate change sceptical views.

3 Data

3.1 Survey and respondents

A nationally representative sample of the U.S. population, including Alaska and Hawai, aged 18 years and older (n = 10,156) was invited to participate in the Pew Research Center survey that explores the relationship between American's religious beliefs and their views about the environment and climate change. The survey respondents are part of Pew Research Center's American Trends Panel (ATP), an online survey panel recruited through national random sampling of residential addresses. Respondents participate via self-administered web surveys, and for those who do not have internet access at home, Ipsos, a well-known multinational marketing company which manages the panel, provides them with a tablet and wireless internet connection. Interviews are conducted in both English and Spanish. The dataset was obtained from all the surveys completed from April 11 to April 17, 2022. The margin of sampling error for the total sample is plus or minus 1.6 percentage points. The questionnaire was developed by the Pew Research Center in consultation with Ipsos. All respondents received an incentive that ranged from $5 to $20 depending on the traditional response propensities. Other details of the data collection can be found in the study's technical report (Pew Research Center 2022).

3.2 Variables

Four questions included in the survey could be used as indicators of the ACCP latent variable. The four items were included in the variable named (CLMWRRY), for which respondents were asked, "How likely do you think each of the following is to happen within the NEXT 30 YEARS because of global climate change? The four items were randomised to minimise the potential biased responses and correspond to the following wordings: (1) Lower quality of life; (2) More extreme weather events, such as tornadoes, flooding and droughts; (3) An increase in refugees and displaced people; and (4) Food and water shortages. The answer format options for each item were based on a full 5-point semantic scale: 1 Extremely likely, 2 Very likely, 3 Somewhat likely, 4 Not too likely, and 5 Not at all likely. According to the respondents ' perception, the answers were reverse-coded to have higher figures when the likely ACCP is more prevalent.

The selection of covariates to analyse ACCP is mainly based on the objectives of the study. Thus, the following questions in the survey associated with ten variables are included in the analysis: To what extent do you consider yourself a religious person?; Do you believe in God?; Type of God; Do you think humans are more important than all other living things?; How well do the following statements describe your views? -God gave humans the right to use the Earth, including the plants and animals, for humanity's benefit; How well do the following statements describe your views? -God gave humans a duty to protect and care for the Earth, including the plants and animals; Thinking about the sermons you hear at your congregation or place of worship, how much discussion of climate change is there?; Religion; Religious service attendance; Ideology.

4 Methodology

Fuzzy set methods have proven to be highly fitted tools to treat imprecise information respondents provide when answering questionnaires. Imprecise information usually means vagueness instead of lack of knowledge, as some questions cannot be entirely answered with one hundred per cent precision. Zimmermann (2013) contended that "fuzzy set theory provides a strict mathematical framework (there is nothing fuzzy about fuzzy set theory!) in which vague conceptual phenomena can be precisely and rigorously studied (p. 6)."

The information dataset for the latent variable is based on the answers given by the panellists in a 5-point semantic scale, so the use of fuzzy-hybrid multi-criteria decision-making (MCDM) method to calculate ACCP is adequate (Martín et al. 2020; Saayman et al. 2016; Zimmermann 2013). The fuzzy methods present multiple advantages over traditional methods, such as structural equation models dealing with the imprecise nature of the responses (Biasetton et al. 2023; D'Urso 2007; Lin & Yeh 2013). The popularity of the fuzzy set methods is shown in the figures and the specialised fields of the applications. According to Zimmermann (2013), the figures from 1984 to 2000 rocketed from four thousand to thirty thousand.

As said, the use of fuzzy set analysis presents multiple advantages over other methods: (1) the fuzzy numbers are more flexible when the information is subjectively provided and uncertainty on the answers does exist (Sinova et al. 2012); (2) fuzzy sets are well grounded and conceptualised within a general theory that presents numerous advantages (Coppi and D'Urso 2002; Martín and Indelicato 2023); (3) fuzzy numbers are more intuitive and understandable than other methods based on black-box assumptions (Sinova et al. 2012; Sohrabi et al. 2012); and (4) fuzzy sets can be adapted to a wide range of imprecise data and fields(Sinova et al. 2012; Sohrabi et al. 2012; Wang et al. 2014).

4.1 Triangular fuzzy numbers

It is well known that respondents' answers are vague regarding whether they consider some event, such as an increase in refugees and displaced people, will happen within the next 30 years because of global climate change. The answer tries to capture a subjective human opinion in which it is evident that the answer extremely likely has a different connotation than the answer not likely at all. Zadeh (1975) defined this type of answer as a linguistic variable expressed in a natural language and introduced the fuzzy sets as an application to approximate reasoning by a quintuple component list: (1) the name of the variable; (2) the set of terms used for the answer format or the collection of linguistic values; (3) a universe of discourse formed by real numbers; (4) a syntactic rule that generates the set of terms; and (5) a semantic rule that associates each linguistic term with a fuzzy set included in the universe. Different universes and associations have been proposed in the literature (Biasetton et al. 2023; Cantillo et al. 2020).

In this paper, the triangular fuzzy numbers $\tilde{A}$ are parameterised using a triplet (a_1, a_2, a_3) with the following membership function $\mu_A(x)$:

$$\mu_A(x) = \begin{cases} \dfrac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2, \\ \dfrac{x - a_3}{a_2 - a_3}, & a_2 \leq x \leq a_3, \\ 0, & otherwise. \end{cases} \tag{1}$$

According to Zadeh's (1975) recommendations, the researchers select a universe of discourse. In our study, the universe of discourse is the real numbers between 0 and 100, as in previous studies (Martín & Indelicato 2023; Leon and Martín 2020). Then, the 5-point semantic scales of the survey instrument that conformed to the set of linguistic terms need to be associated with triangular fuzzy numbers (TFNs) included in the universe of discourse. Thus, following Leon and Martin (2020), the association is established as: Not at all likely (0, 0, 30), Not too likely (20, 30, 40), Somewhat likely (30, 50, 70), Very likely (60, 70, 80) and Extremely likely (70, 100, 100). The membership function (Eq. 1) represents the relative truth in each of the answers provided by the respondents. Zadeh (1965) introduced the concept of a fuzzy set as a class of objects with a continuum of grades of membership. Thus, a set is characterised by a membership function which assigns to each object a grade of membership, breaking the old concept of a set as elements that do belong (probability is equal to one) or not (probability is equal to zero).

Zimmermann (2013) contended that fuzzy set methods are so specialised that newcomers find them challenging to understand and interpret. Nevertheless, their philosophy, formalism and potential applications make them a superior tool for modelling the vague information in most surveys. In other cases, the methods are considered complementary to classical approaches. However, it is not only the adequacy of properly treating linguistic information that makes fuzzy set methods attractive. Other advantages, such as relaxation, compactification, meaning preserving reasoning and efficient determination of approximate solutions, are discussed in Zimmermann (2013).

One of the main advantages of fuzzy set methods is that they are rooted in the algebra of fuzzy sets. Thus, the aggregation of TFNs that can be made according to different segmentation variables is again a TFN. For example, it is pretty standard to segment the responses by gender, age or any other socioeconomic variable of interest. Formally, the average fuzzy number of n TFNs $\tilde{A}_i = \left(a_1^{(i)}, a_2^{(i)}, a_3^{(i)} \right)$, where $i = 1, 2, 3, \ldots, n$, is determined by:

$$\tilde{A} = (a_1, a_2, a_3) = \left(\frac{1}{n} \right) \cdot \left(\tilde{A}_1 \oplus \tilde{A}_2 \oplus \cdots \tilde{A}_n \right) = \left(\frac{\sum_{i=1}^{n} a_1^{(i)}, \sum_{i=1}^{n} a_2^{(i)}, \sum_{i=1}^{n} a_3^{(i)}}{n} \right) \tag{2}$$

The $\cdot$ operator denotes the external multiplication of a scalar and a TFN, and $\oplus$ is the internal addition of TFNs. As said, the properties of the algebra of the fuzzy sets can be used to conclude that the aggregated value is also a new TFN (Buckley 1985). Thus, the aggregated value inherits the fuzzy nature of the individual information.

4.2 The defuzzification of the TFN information matrix

Using the association explained above, the information matrix is converted into a TFN information matrix. Then, Eq. 2 transforms the individual TFN matrix of the 10,156 respondents into the aggregated TFN matrix that can be used to obtain the aggregated TFN matrix of the 377 segments analysed in the study using seventy-nine variables of interest. The dimensions of the matrixes depend on the analysis of the latent variable (number of items included in the analysis) and the extension and type of the survey instrument. In the current study, an information TFNs matrix of dimension (4, 377) is obtained by applying Eq. 2. The matrix is then deffuzzified and converted to a regular matrix in which the TFNs are converted into real numbers.

The centroid method proposed by Chen (1996) is still one of the most popular methods to defuzzify used in the literature since its inception. It is calculated as $v_{\tilde{A}} = (a_1 + 2a_2 + a_3)/4$. It can be seen that it is a weighted average which gives more importance to the vortex of the triangle than to the inferior and superior extremes. The method is robust and unaffected by the optimism or pessimism of researchers' judgements (Kaufmann & Gupta 1988). Kumar (2017) recently showed that it is equivalent to the total integral value.

4.3 TOPSIS

This section describes how the synthetic indicator ACCP is obtained after obtaining the aggregated crisp information matrix. The index is obtained after applying the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), one of social science's most employed multi-criteria decision-making techniques (Hwang and Yoon 1981; Zeleny 1982). The method is computed as follows:

$$
\begin{aligned}
A^+ &= \left\{ \left(\max V_{ij} | j \in J \right), \left(\min V_{ij} | j \in J' \right), i = 1, 2, \dots, m \right\} \\
A^- &= \left\{ \left(\min V_{ij} | j \in J \right), \left(\max V_{ij} | j \in J' \right), i = 1, 2, \dots, m \right\}
\end{aligned}
\tag{3}
$$

where J and J' divide the set of the linguistic terms included in the scale of the latent variable according to whether they can be considered a benefit or a cost. In our case, the four items included in the scale can be considered a benefit; higher figures mean that respondents think the events are more likely to happen within the next thirty years.

Once the ideal solutions are calculated, the relative ACCP index for each population segment can be calculated taking into account the distances of each observation concerning the obtained ideal solutions (Eq. 3) observed in the aggregated defuzzified matrix according to:

$$
\begin{aligned}
S_i^+ &= dist(V_i, A^+) = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - A_j^+ \right)^2} \quad i = 1, 2, \dots, m \\
S_i^- &= dist(V_i, A^-) = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - A_j^- \right)^2} \quad i = 1, 2, \dots, m \\
ACCP_i &= \frac{S_i^-}{S_i^+ + S_i^-} \quad i = 1, 2, \dots, m
\end{aligned}
\tag{4}
$$

where $0 \leq ACCP_i \leq 1$. Thus, it is possible to determine whether a particular segment is more or less worried than another concerning the effects of climate change by comparing the relative indices obtained for both segments. A particular segment is more concerned about climate change whenever the relative index is closer to 1. Thus, it is possible to find which segment is the most and least concerned about the effects of climate change by ranking all the segments in the analysis according to the descending order of *ACCP*. The fuzzy-hybrid TOPSIS index ranks segments based on the index values. This score is higher for segments whose crisp information vector is closer to the virtual positive ideal solution (A^+) and farther away from the virtual negative solution (A^-). The ranking rationale is clear and straightforward.

4.4 Elasticities

We end this section by introducing the concept of elasticity, which measures the sensitivity of the obtained synthetic index ACCP to changes in the values of each item or linguistic terms included in the scale of the studied latent variable. Thus, policymakers, religious authorities, and NGO managers could obtain very interesting insights regarding whether the effects of climate change are more or less elastic on any of the individual items. The analysis of the elasticity values determines those items that are key for each segment. Mathematically, the elasticity of ACCP for each population segment i over any item j can be calculated as:

$$\eta_{ij} = \frac{\Delta\%ACCP_i}{\Delta\%item_{ij}} = \frac{dACCP_i}{ditem_{ij}} \frac{item_{ij}}{ACCP_i} \tag{5}$$

The elasticity values are fundamental as they are specific to each (item, segment) pair researchers are interested in. In the current study, 377 different segments can be analysed for each of the four items included in the scale. The feature of elasticities is fascinating because it identifies the items that climate change analysts should prioritise when educating society.

5 Results

The positive and negative ideal solutions (A$^+$ and A$^-$) are obtained (Eq. 3). Table 1 shows the ideal solutions, the representative segment of each component, and the percentage variation between both ideal solutions. It can be seen that the representative segments for both ideal solutions are highly concentrated in two particular population groups. Those who consider it extremely likely that the United States will lose its standing in the world by not taking climate change seriously, and those who consider that climate change is not a problem. The only exception in A$^+$ is observed in the item referred to as the extreme weather events represented by those whose ideology is very liberal. All the results will be discussed in the next section.

On the other hand, the negative ideal solution is always obtained for those who consider that climate change is not a problem, and this is a consistent result that validates the way respondents have answered the questionnaire. Regarding the last column of the table, it can

Table 1 Fuzzy Hybrid TOPSIS Ideal Solutions

Item	A$^+$	A$^+$. Rep	A$^-$	A$^-$. Rep	Perc.Var
Lower quality of life	77.83	(*)	38.01	(**)	104.8%
More extreme weather events, such as tornadoes, flooding and droughts	85.42	Very liberal	30.72	(**)	178.1%
An increase in refugees and displaced people	82.34	(*)	38.73	(**)	112.6%
Food and water shortages	81.73	(*)	36.08	(**)	126.5%

[*]The United States will lose its standing in the world by not taking climate change seriously. Extremely likely

[**]Climate Change is not a problem

be seen that respondents show very heterogeneous answers for all the items. Table 2 shows the results of the ACCP synthetic index for the population segments of interest.

Regarding the religiosity of the Americans, the results show the antagonism that exists between being religious and having an environmental concern. The same pattern is obtained for those who believe or do not believe in God and for the type of God of believers. The latter results show that those who believe in something that is not entirely aligned with the Bible perceive more concern than those who believe in the God of the Bible.

The results on those who give more importance to humans than the rest of all other living things show a lower environmental concern than their counterparts. The results of human dominion cosmology show that the opponents to this vision are those who show the highest ACCP. The results of the cosmological vision of taking care of the Earth are less conclusive, as the pattern is unclear—those who mostly agree show intermediate ACCP figures.

Regarding whether climate change is discussed in sermons, our results show that Church priests can influence the ACCP. It can be seen that those who have heard about climate change issues a great deal or quite a bit in congregations have more environmental concerns than those who have not heard anything at all. Thus, sermons can frame climate change as a moral imperative, emphasising humanity's responsibility to care for creation. This can resonate deeply with congregants who view environmental stewardship as a religious duty.

Regarding religion, the results range from one extreme of those more concerned, such as atheists and Buddhists, compared to those processing the majoritarian religion in the US, namely Protestants and Roman Catholics. In line with the findings of Veldman et al. (2020), it is also noteworthy to observe that the religious groups exhibiting the least concern were those of the Mormons and Protestants. Another interesting variable is that of service religious attendance, which correlates with responses to the religiosity variable. It can be seen again that those who attend more religious services are less concerned than those who attend never or seldomly. Regarding the ideology, the results also separate the Americans between conservatives who are less concerned, moderates who are located in the middle ranges regarding environmental concern and liberals who are the most concerned American citizens.

Table 3 shows the elasticity values of the synthetic index ACCP for the whole sample and the population groups extracted from the religiosity variable, depending on the answers to the question (RELPER): "To what extent do you consider yourself a RELIGIOUS person? The possible answers were obtained using a four-point semantic scale from very religious, somewhat religious, not too religious and not at all religious.

It can be inferred from the elasticity values that the synthetic index is inelastic concerning all the items included in the scale and for all the segment groups under analysis. As explained above, the table can be analysed bi-dimensionally by each item of concern and segmentation group pair. Focusing first on the whole sample, it can be concluded that the index is more elastic for extreme weather events and less elastic concerning lowering the quality of life. Thus, it can be concluded that education campaigns should emphasise explaining that societies need to be more alert about the recurrence of extreme weather events. On the other hand, it seems there is less heterogeneity regarding the perception that climate change will decrease the quality of life.

A similar pattern is observed for each of the groups included in the table, so it can be concluded that religiosity elasticity values are correlated with the total sample. It would be interesting to analyse whether this pattern is also confirmed for the rest of the segmentation variables, but this is out of the scope of the current study. It is also possible to analyse

Table 2 American's climate change perception. Synthetic index

Variable	Category	ACCP	Variable	Category	ACCP
Religious	I am very religious	0.4416	Religion	Mormon (Church of Jesus Christ	0.4500
	I am somewhat religious	0.5445		Protestant	0.4917
	I am not too religious	0.5839		Roman Catholic	0.5528
	I am not at all religious	0.7326		Orthodox	0.5825
Believe in God	I do believe in God	0.5372		Hindu	0.6207
	I do not believe in God	0.7501		Jewish	0.6238
Type of God	I believe in God of the Bible	0.4940		Religion. Nothing in particular	0.6439
	I believe in something else (unclear)	0.5036		Muslim	0.7138
	I believe in something else	0.6701		Agnostic	0.7414
	I do not believe in anything	0.7554		Other religion	0.7497
Human importance	Humans are more importan t than all other living things (Y)	0.4417		Buddhist	0.7618
	Humans are more importan t than all other living things (N)	0.6901		Atheist	0.8452

Table 2 (continued)

Variable	Category	ACCP	Variable	Category	ACCP
Human dominion cosmology	God gave humans the right to use the Earth (Completely)	0.4804	Attendance	Attendance. More than once a week	0.4346
	God gave humans the right to use the Earth (Mostly)	0.5216		Attendance. Once a week	0.4745
	God gave humans the right to use the Earth (Somewhat)	0.5892		Attendance. Once or twice a month	0.5393
	God gave humans the right to use the Earth (A little bit)	0.6370		Attendance. A few times a year	0.5715
	God gave humans the right to use the Earth (Not at all)	0.7345		Attendance. Seldom	0.5972
Human Earth caretaker cosmology	God gave humans a duty to protect and care for the Earth (Somewhat)	0.4551		Attendance. Never	0.6941
	God gave humans a duty to protect and care for the Earth (A little bit)	0.4841	Ideology	Very conservative	0.2664
	God gave humans a duty to protect and care for the Earth (Mostly)	0.4984		Conservative	0.3672
	God gave humans a duty to protect and care for the Earth (Completely)	0.5959		Moderate	0.6324
	God gave humans a duty to protect and care for the Earth (Not at all)	0.6461		Liberal	0.7772
Climate change in sermons	In sermons, climate change is discussed. None	0.3517		Very liberal	0.9208
	In sermons, climate change is discussed. A little	0.5267			
	In sermons, climate change is discussed. Some	0.6673			
	In sermons, climate change is discussed. A great deal	0.7462			
	In sermons, climate change is discussed. Quite a bit	0.7581			

Table 3 Religiosity elasticity values

Item	Total	(1)	(2)	(3)	(4)
Lower quality of life	0.4813	0.5216	0.4889	0.4810	0.4964
More extreme weather events, such as tornadoes, flooding and droughts	0.6890	0.8596	0.7251	0.6825	0.5075
An increase in refugees and displaced people	0.5556	0.6543	0.5760	0.5523	0.4644
Food and water shortages	0.5669	0.6515	0.5852	0.5644	0.5070

(1) very religious; (2) somewhat religious; (3) not too religious; and (4) not at all religious

the results of all the pairs included in the table if we focus on only the table's three highest and lowest values. This analysis shows that the synthetic indicator is more elastic for the item of the extreme weather events in the whole sample and the segments of the very or somewhat religious persons. Meanwhile, on the other hand, the index is less elastic for the following pairs (lowering the quality of life for the whole sample and the not-too-religious segment) and the pair (an increase in refugees and displaced people for the not-at-all-religious segment). This is an interesting issue because citizens seem to be more sensitive to climate change effects when there is news about extreme weather events than other types of news.

The low elasticity values presented in the segment of not at all religious persons could be explained by the fact that secular individuals are more likely to accept the scientific consensus about climate change effects. In addition to trusting more in science and being more rational, seculars do not conflict with some religious beliefs regarding the interpretation of sacred books on human beings' responsibility to the environment. In this sense, it is interesting to highlight how climate change affects new religious formations and how secular organisations copy religious practices through demonstrations, parades, and silent rallies (Jenkins et al., 2018). Similar results are found by Mazaheri (2024), analysing a very different context –the Middle East. The author found that "Muslims who self-identify as religious and advocate Islamist government tend to be less concerned about climate change compared to those who are committed to secularism (p.59)."

6 Discussion

The ideal solutions results show a high heterogeneity of responses between the different groups studied. The results concur with those obtained by Leiserowitz et al. (2013) and Poortinga et al. (2011). In both studies, the authors found an essential heterogeneity of perception regarding the existence of climate change effects or global warming, and this trend will not disappear as there is an increase in climate change scepticism and uncertainty worldwide. Schuldt et al. (2011) also contended that heterogeneous responses might be derived from different knowledge on the topic by their own personal interest, educational background or even questionnaire wording.

The results on religiosity concurred with those obtained in Lowe et al. (2023), in which the authors found that when citizens are more religious, the attitudes toward the government involvement in reducing global warming decreased by giving about one and a half times less importance to the prioritisation of anti-climate-change measures. Sherkat and Ellison (2007) discussed that besides religiosity is not the only force determining CC concerns and behaviour, they disagreed with Greeley's (1993) premise that the findings on the

negative religious influence on environmental concern are spurious because the attitudes reflected the political conservatism of the group. The authors contended that religiosity could be considered an indirect cause of conservatism, and the environmental concern is more directly related to ideology and not to the direct perception of the religious variable.

The religious results concur with those obtained by Pew Research Center (2022), where the report raises the following question: If many religiously affiliated Americans, including most Christians, see a connection between care for the environment and their religious beliefs, then why are they less likely to be concerned about the environment than people with no religion? One possible answer is that climate change is not a significant issue in U.S. congregations. For those who attend religious services regularly, there existed a connection between the attendees' views on the environment and how much they could remember hearing in sermons. Evangelical Protestants, particularly those of white ethnicity, represent the most sceptical major religious group in the US concerning climate change (Veldman et al. 2020). The grounds for such scepticism are numerous and include religious, political and cultural reasons. Their political allegiance to the Republican Party, which historically champions free-market policies, is a salient factor impeding climate action (Veldman et al. 2020; Shao and McCarthy 2020; Choi and Jung 2021). Religious convictions also exert a substantial influence on this scepticism. As Defoe (2024) notes, Evangelicals frequently prioritise scriptural teachings over scientific evidence, reinforcing their scepticism regarding climate change. Moreover, conservative media and political influences amplify anti-climate change narratives further, thereby strengthening this scepticism (Lowe et al. 2022). "Meanwhile, members of non-Christian religions and people who do not identify themselves with any religion—particularly self-described atheists and agnostics—consistently express the highest concern about climate change. Other Christian subgroups, such as Catholics, generally fall somewhere in between (p. 82)". Moreover, Wilkins (2022) commented that the release of Pope Francis's encyclical, Laudatio Si, on the environment in 2015 was seen in the international community as a definitive document that would spur Catholics worldwide to join forces struggling against climate change effects.

The results of human importance and human dominion cosmology concur with the theory provided by White (1967). According to White, Western Christian cosmology qualified humanity as superior to other species, having the right to dominate nature –also known as the "anthropocentric" nature of Christianity. This viewpoint places humans at the centre of moral and ethical considerations, arguing that human interests and well-being should take precedence over those of other species. Under this vision, human beings have unique capacities for reason, creativity, and advancement. Proponents argue that humans possess the intelligence and capabilities to harness nature for their benefit, leading to technological advancements and improvements in quality of life. This perspective fosters a sense of stewardship, where humans are seen as responsible for controlling and managing the natural world. Human interest prioritisation over nature is tied to the belief that humanity has a unique role to play in shaping the world.

The results of the human caretaker cosmology are partly confounded by those citizens who are not religious but are firm believers that climate change effects are happening. In addition, those who completely agree with the statement that God gave humans a duty to protect and care for the Earth also have an important environmental concern. The unsurprising results can result from the documents signed by the leading Abrahamic religious authorities (Francis 2015; Abdellah 2020; Tirosh-Samuelson 2024). In all the documents, the authorities proclaimed that humans are called to be Earth's caretakers or stewards (khalifas).

Regarding the religion results, it can be seen that atheists and Buddhists are the most concerned in comparison with Christians (Mormons, Protestants and Catholics), who are the least concerned. The results of the atheists are concordant with those of Hand and Van Liere (1984) and Roser-Renouf et al. (2016). Hand and Van Liere (1984) found that atheists and agnostics exhibited higher levels of environmental concern than did Jews or Christians. Roser-Renouf et al. (2016) developed a framework to segment American attitudes toward climate change into six categories, from alarmed (12%) to dismissive (11%), finding that there were more agnostics and atheists in the alarmed segment and more Baptists and Protestants in the dismissive category. Morrison et al. (2015) found that Buddhists were more likely than Christians to believe that climate change effects were already a palpable reality. Pontoriero (2022) highlighted that Buddhists are more focused on the oneness of humankind jointly with the creator and nature.

The results of the Christians can also be confounded by the conservative ideology, as explained above. In addition, it can also be the result of the discourse of conservative Christian public policy groups like the Cornwall Alliance, which denies the anthropogenic nature of climate change, arguing that recent climate events are part of natural cycles and that human activity has a negligible effect on temperature changes. They advocate for free-market solutions, opposing drastic CO_2 emissions reductions, which can only harm economic growth, affecting more vulnerable populations (Wanliss 2011).

Religious service attendance results concur with those obtained by Lowe et al. (2023). In their study, Lowe et al. (2023) defined religiosity as an index that combined four variables: frequency of service attendance, the personal importance given to religion, whether the Bible is the highest authority for belief, and the personal importance given to evangelism. The authors found that religiosity was a significant predictor of attitudes about the degree of priority that government should give to global warming, finding that more religious respondents were more inclined -almost one and a half times more likely- to say that governments should give a low versus high priority for each unit increase in the religiosity index. In addition, the Pew Research Center (2022) also contended that "the survey also finds that highly religious Americans (those who say they pray each day, regularly attend religious services and consider religion very important in their lives) are far less likely than other U.S. adults to express concern about warming temperatures around the globe (p.6)".

The section ends with the results on ideology, finding that conservative ideology appears to be alienated with fewer concerns about climate change effects, which were also present in previous studies (Kulin et al. 2021; Lowe et al. 2023). Kulin et al. (2021) found empirical evidence that conservatives and right-wing party supporters are more likely to be less concerned about climate change than their political counterparts. Lowe et al. (2023) found that global warming attitudes can be explained by political ideology, with conservatives not being as enthusiastic as liberals and centrists to control global warming.

7 Conclusions

This research investigated the intersection between religion, religiosity, ideology, and Americans' perceptions of climate change effects. A gap related to the diverse ways that religion shapes climate change perception, according to Jenkins et al. (2018), provides one future line of research on the topic. The authors concluded that better data are needed to study this multifaceted relationship. For this reason, recent data provided by PEW (2022)

have been used in the study to analyse the impact of ten different variables related to religion, religiosity and ideology.

The ten covariates include features related to religious beliefs and practices (religiosity, belief in God, type of God, religion and religious service attendance), the intersection of religion and nature (human importance, human rights to use the Earth and human stewardship to protect Earth), the intersection of environmental and service attendance (discussion of climate change in sermons), and ideology. To our knowledge, this is the first time this broad panoply of variables related to religion and religiosity has entered into the set of potential drivers of *ACCP*.

An additional significant contribution of the study resides in the rigorous application of a well-grounded fuzzy hybrid TOPSIS method that obtains the elasticity values of the *ACCP* synthetic indicator for a group of pairs of item-segmentation variables. The analysis provides several insights into how religion, religiosity and ideology intersect with Americans' perception of climate change effects. Our results show that the four items included in the latent variable construction were not iso-likely events for the whole sample of respondents, being Americans more worried by the extreme weather events, secondly by the increase of refugees and displaced people, then by the food and water shortages, and lastly by the lower quality of life.

The elasticity values obtained in the study offer valuable insights into the prioritisation of sermon topics for religious individuals. These findings suggest specific areas where religious leaders can focus their messages to better resonate with their congregations and address their concerns regarding climate change –extreme weather events. Furthermore, the results reveal greater homogeneity among the secular population in their perception of climate change effects. This indicates a shared understanding of the issue by the lack of conflict with individual religious beliefs.

The study presents several limitations that can be used as fruitful lines for future research. First, from a methodological perspective, the *CCE* scale can introduce more items or some existing items could be separated into distinct items in the future, like, for example, extreme weather events. Secondly, while fuzzy logic adequately handles the vagueness from the Likert scale used in the administration of the survey, the answer format itself is still vague, and this can be counter-rested by including less vague terms using the answer format based on probabilities or even TFNs. Thirdly, our results showed that the ten variables included in the study significantly influenced the *ACCP* synthetic indicator. However, questions about the relative importance of each variable and the interaction between them remained unsolved.

Moreover, the study only analyses the case of the U.S. using a well-grounded quantitative method based on fuzzy logic. The advantages of using this method and comparing the results with other quantitative methods like Multi-Group-Confirmatory-Factor-Analysis (MGCFA) have already been done in previous studies. However, the study could benefit from applying the method to other parts of the world, especially the Global South, to see if the results can be generalised. Last but not least, narratives or other qualitative methods could also complement the results obtained in the study, reinforcing its validity. Qualitative methods can be better fitted to explain how historical narratives, like devastating climate events, could be transferred to the local population climate change effects imaginary (Holzhausen and Grecksch 2021).

While this study primarily offers valuable empirical insights, we recognise its limitations in directly establishing a comprehensive theoretical framework or yielding limited practical results. Nonetheless, the empirical evidence presented here lays a crucial foundation for both future theoretical advancements and the development of less limited practical

approaches. Furthermore, we believe that incorporating qualitative research methods could significantly enrich and expand upon these findings, providing a deeper understanding of the nuances and complexities underlying the perception of climate change effects.

Declarations

Conflict of interest The authors declare no conflict of interest.

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