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What do you think about climate change?

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ABSTRACT

To answer this question, this paper reviews the huge and growing body of empirical literature on climate change awareness, and summarizes insights emerging from a critical review of about 140 papers. In particular, this survey provides (*i*) a historical overview of climate change awareness worldwide, (*ii*) a guide to the most widely used datasets, with a peculiar attention to the question wording employed to measuring climate change awareness when the analysis is performed at individual level; (*iii*) a detailed review of the main socio-economic and climatological determinants of climate change awareness, such as age, gender, education, political values, experience of extreme weather conditions, social and institutional trust and the stage of development of the country where people live; and (*iv*) a summary of the main implications of these findings in terms of public policy responses.

Keywords: climate change awareness, individual perceptions, question wording, socio-economic determinants; policy implications

1. Introduction

What do you think about climate change? What do you know about it? The answers of a climate scientist to these important and (apparently) simple questions are based on an objective, scientific and circumstantial description of the main features and effects of the problem. But answers from non-experts are more difficult to pin down. Measuring environmental awareness is a difficult task, as it entails '*an individual's insight that humans endanger the natural environment combined with the willingness to protect nature*' (Franzen and Volg, 2013, p. 1002). In this context, emotions, imagery, personal experience, trust, values and worldviews influence the way in which individuals process their knowledge and experience, and are thus very important players for perceptions of climate change (Slovic, 2000; Dessai et al., 2004; Libarkin et al., 2018).

Climate change awareness has been closely investigated worldwide, and documented by Lorenzoni and Pidgeon (2006), Upham et al. (2009), Lee et al. (2015) among others.

Figures 1 and 2 about here

Figure 1 shows the geographic distribution of climate change awareness mapped in five color classes. The greener countries exhibit the highest levels of concern. It is easy to see that it widely varies round the world and that it is generally very high in advanced economies such as Australia, the countries of Europe and the USA. In a similar manner, Figure 2 highlights that these economies, together with some developing Asian countries, also show the highest levels of carbon dioxide emissions, which are widely held to be mainly responsible for global warming and climate change. Furthermore, despite the greater awareness of climate change in developed countries (Veisten et al., 2004; Hidano et al., 2005; Franzen and Vogl, 2013), emissions by the rich worldwide are much higher than those of the poor. Figure 3 shows that about half of the total growth in absolute emissions came from the richest 10 per cent of the world population, and over a third from the richest 5 per cent in the years 1990-2015 (Kartha et al., 2020).

Figure 3 about here

These stylized facts have important consequences in terms policy decisions. On one hand, policymakers require stronger efforts to reduce greenhouse gas emissions.[1] This is a key step to contrast the rise in the global average temperature (UNFCCC, 2015). At the same time, on

[1] For example, the Paris Climate Conference in December 2015 committed the 195 signatory countries to keeping the rise in global temperature to less than 2° C, and the '2030 Climate & Energy Framework' recommends cutting at least 40 per cent of greenhouse gases emissions by 2030 compared to 1990.

the other hand, citizen concern about climate change is the driver for the successful realization of this process, and is a critical component of the sociopolitical context in which policymakers operate (Leiserowitz, 2005, Leiserowitz et al., 2017).

The aim of this study is to summarize findings and to bring coherence and structure to the growing body of empirical papers analyzing climate change awareness, in order to provide a comprehensive overview of the state of knowledge at the time of writing. The main goal of this survey is first to provide a guide to the most popular variables used to measure climate change awareness, with a peculiar attention to the question wording when the analysis is performed at individual level. Second, this survey aims to identify factors such as socio-economic conditions, political values, trust in institutions, and extreme weather events which affect public opinion. These latter are currently particularly worrying, as Fisher et al. (2021) recently show that record-shattering events could come in *sharp bursts* and so totally unexpected, as demonstrated by the recent dramatic floods in Germany and the disastrous forest fires in Sardinia (Italy) during the summer of 2021. It also asks why, despite the scientific consensus that climate change is a byproduct of human activity and the urgency of stricter regulatory controls for environmentally-friendly behaviors, public opinion shows weak support for climate policies, and, is sometimes even skeptical of climate change and related risks.

This can have severe repercussions in terms of policy implementation. Climate change awareness is a key driver to take actions to preserve the environment and heavily influences public support or opposition to climate policies (Leiserowitz, 2005). This is particularly important in the light of the severe obstacles facing climate policies, as their effectiveness is often highly uncertain especially in the long run, and yet they can bear heavy costs in the short-run.

The rest of the paper is structured as follows. Section 2 provides a historical overview of climate change awareness. Section 3 describes the datasets most frequently employed and shows how climate change awareness and pro-environmental behaviours are measured in the empirical literature. Section 4 discusses the most common determinants of climate change awareness included in the empirical models. Section 5 discusses the intrinsic connection between climate change awareness and policy decisions. Section 6 concludes.

2. Climate change awareness: a historical overview

According to a study on "climatological research as it pertains to intelligence problems" realized by Central Intelligence Agency in the early seventies, '*the climate change began in 1960, but no one, including the climatologists, recognised it*' (Central Intelligence Agency, 1974, p.1). As a consequence, the world ignored this warning, and intensive investments in energy, technology and medicine were performed for many years, without considering their impact on the environment.

Public perception of climate change has received increasing attention only in recent decades, especially since the 1992 Kyoto Protocol, the first global attempt to reduce human impact on the environment. Moreover, climate change awareness is influenced by country- and culture-specific issues, implying that it is difficult to generalize across a geographically, economically and culturally diverse planet (Lee et al., 2015).

However, it is possible to identify common patterns in the evolution of climate change awareness all over the world, and they can be summarized into three phases as follows:

i) consciousness (1980s and 1990s);

ii) scepticism (2000s – first part of the 2010s);

iii) opinion leader influence (2016 – to today).

Individual attitudes on this phenomenon were sparse during the 1980s (Dunlap and Scarce, 1991; Nisbet and Myers, 2007; Whitmarsh and Capstick, 2018), and only after the Kyoto Protocol in 1992 a growing awareness has been observed (Lorenzoni and Pidgeon, 2006; Upham et al., 2009). In those years, scientific evidence of climate change as a by-product of human activities began to be reported by mainstream media, with a consequent higher public attention to this topic (Boykoff and Yulsman, 2013). However, national policymakers reacted differently to the Kyoto guidelines: on one hand, the European Union supported and promoted them while, on the other, the USA often did not (Leiserowitz, 2005).

Then, a phase of scepticism started during the 2000s especially in the USA, where the debate on climate change was particularly politicized and polarized (Guber, 2013; Dunlap et al., 2016), and then spread to the rest of the world. The majority of scientists in the climate research community stated that there had been an increase in temperatures due to human activities, but others disagreed: the debate between the Nongovernmental International Panel on Climate Change (NIPCC) in opposition to the assessment reports of the Intergovernmental Panel on Climate Change (IPCC) is probably the best-known international example of the fairly widespread scepticism.[2] Moreover, in this period, public scepticism about the severity

[2] The NIPCC is the climate change denial advocacy organization set up in 2003 by S. Fred Singer's Science & Environmental Policy Project, later supported by the Heartland Institute lobbying group. The IPCC is instead the United Nations body for assessing the science related to climate change in order to provide policymakers with regular scientific

of climate change was also fomented by uncertainty among scientists about how much temperatures would rise and the potential impact on human systems. For example, the IPCC Fourth Assessment Report claims that: '*Effects of climate change on human and some natural systems are difficult to detect due to adaptation and non-climatic drivers*' (IPCC 2007, p. 72) and '*Projections of climate change and its impacts beyond about 2050 are strongly scenario- and model-dependent, and improved projections would require improved understanding of sources of uncertainty and enhancements in systematic observation networks*' (IPCC 2007, p. 73). As noted by Whitmarsh (2011), the analysis of mass media and internet communication of climate change reveals denial, doubt and apathy towards the existence and causes of climate change and how to tackle it. This tendency was further emphasized by the *climategate controversy* in 2009, which reflected the politicization of climate change in Western European countries (McCright et al., 2015).

This trend was exacerbated after the election of President Trump in 2016, which opened the third phase in the evolution of climate change awareness. President Trump defined the problem as 'mythical', 'non-existent', and 'an expensive hoax' perpetrated by the enemies of the USA, but he also subsequently stated that it is a 'serious' and 'very important' subject. At the same time, the international 'Fridays for Future' movement led by Greta Thunberg, became an important focus for demands on preventing actions to fight global warming, especially among young people. The movement involved about 3.6 million people across 169 countries in August 2019.

This evidence suggests that opinion leaders influence climate change awareness (Baiardi and Morana, 2021). In the USA, various studies show that climate change awareness is highly dependent on the increasing partisan and ideological polarization in American public life, and Liberals and Democrats are more likely to express concern about climate change than are Conservatives and Republicans (Lee et al., 2015). In Europe, on the other hand, about 93 per cent of citizens think that climate change is a serious problem, and almost a quarter (23 per cent) retains that climate change is the single most serious problem facing the world today (Special Eurobarometer 490, 2019).

3. Measuring climate change awareness

3.1. Climate change awareness at individual level

assessments on global warming, its implications and potential future risks, and proposing adaptation and mitigation options.

Psychologists classify individual reactions to problems into three different but complementary components of mind: affect, cognition and conation. Affect refers to the emotions associated with knowledge, in this case, about climate change. Cognition is the process of thinking rationally and understanding the phenomenon through the acquisition and processing of information. Conation refers to the personal actions taken (Tallon, 1997). The literature on environmental attitudes has explored all three components, including a focus on mass media, which are fundamental to the cognition process (Whitmarsh, 2011). The main topics investigated are principally perceptions and opinions of:

i. the seriousness of climate change, its threats and perceived danger, and severity compared to other global problems;
ii. the prioritization of economic growth versus environmental protection;
iii. the responsibility of international and national governments and business and industry in fighting climate change;
iv. personal actions taken in order to mitigate climate change or, more generally, improve the environment;
v. the willingness to pay (including in terms of higher taxes) for fighting climate change.

Note that point (*i*) refers to affect, points (*ii*) and (*iii*) to cognition and points (*iv*) and (*v*) to conation.

The most frequently used datasets, covering a large set of countries, are the Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change, the Gallup World Poll, the International Social Survey Programme (ISSP), the Life in Transition Study, the World Value Survey, and the surveys provided by the PEW Institute.

Table 1 about here

As shown by Table 1, the two most complete databases, which cover all the above points with the sole exception of (*v*), are the Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change and the Gallup World Poll, together with the ISSP, which omits only climate change awareness (point *i*). Some datasets, like the World Value Survey, Life in Transition Study and the surveys provided by the PEW Institute, focus only on specific issues such as topics (*ii*), (*iii*) and (*v*). A description of the three most complete surveys (i.e. the Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change, the Gallup World Poll and the ISSP) is provided in Appendix.

In the case of the USA, data have been often retrieved from the Gallup World Poll, the General Social Survey, a nationally representative survey of adults in the United States

conducted since 1972, or from the New Hampshire Granite State Poll, a quarterly telephone interviews with random samples of about 500 New Hampshire residents. Some other papers analyse climate change attitudes using data from *ad hoc* surveys commissioned from private research companies.

Techniques for measuring climate change attitudes are principally based on qualitative approaches, such as face-to face or telephone interviews, through either pen-and-paper or computer-assisted personal interviewing techniques (CAPI or PAPI, respectively), with open-ended questions, and/or multiple-choice, true-false, or Likert type questions (see also Libarkin et al., 2018).

These various sources of data make it possible to carry out empirical research using pooled cross-sectional as well as country-specific cross-sectional datasets, and to analyse trends in attitudes by exploiting the time dimension of the data.

Lastly, it is worth noting that new and unconventional approaches for polling will probably revolutionize interview techniques in the future. An example is the Peoples' Climate Vote, launched in 2020 by the United Nations Development Programme and conducted at world level, where poll questions are distributed through adverts on popular mobile gaming apps. This innovative approach has allowed to obtain a random sample of 1.22 million people of all ages, genders and educational backgrounds, including individuals who are typically difficult to contact using standard techniques.

3.2. The most frequently investigated questions for each component of mind

Empirical analyses are generally made on either samples including a wide range of countries or specific countries or groups of countries. Advanced economies, such as the European countries, the USA and Australia, are the most widely investigated. However, policymakers and public opinion are currently shifting attention to developing countries, such as China and the Middle East,[3] given their crucial role in curbing greenhouse gases and reaching a cleaner energy era globally.

In the following subsections we review the most frequently investigated questions under the assumption that individuals react in three distinct ways to environmental problems, corresponding to the three components of mind affect, cognition and conation. In other words,

[3] The most recent Arab Barometer Wave V for the years 2018-2019 introduced for the first time a specific question on the environment: '*How serious a problem do you think the following issues are: Is [INSERT ITEM] a very serious problem, a somewhat serious problem, not a very serious problem, not at all a serious problem*', where the items are: '*climate change*', '*air pollution*', '*water pollution*' and '*trash*'.

it is assumed that they are emotionally affected by climate change, they have rational insight into the problem, and they are willing to act.

3.2.1. Being emotionally affected by climate change

In this subsection we review the most frequently investigated questions used to capture the emotional component of individual perceptions of climate change, i.e. how far the problem is perceived as serious and dangerous, its severity compared to other global problems, and its threats.

The extent to which climate change is serious, including in comparison to other global problems and other environmental issues, is the core question in many empirical analyses. Sandvik (2008) analyses a cross-national dataset, based on data collected by an online global survey on consumer attitudes towards global warming in 46 countries in 2007. Individuals were asked to express their perception of the seriousness of climate change on a scale from 1 to 5. The question used was '*Have you heard or read anything about the issue of global warming?*' and the author considers only those respondents who define global warming to be either '*a fairly serious problem'* or '*a very serious problem'*. A similar approach is adopted by Diekkman and Franzen (1999) who collected data from face-to-face or telephone interviews in 24 countries in 1993, and by Shao et al. (2014), who used answers to the question '*Do you think global warming is an environmental problem that is causing a serious impact now, or do you think the impact of global warming won't happen until sometime in the future, or do you think global warming won't have a serious impact at all?*'. Responses were retrieved from the CBS News and CBS News/New York Times surveys and from the Pew Research Centre in the years 2001-2010 in the USA.

Lee et al. (2015) analyze data collected by the Gallup World Poll in 2007-2008 in 119 countries, which is currently the most representative sample analyzed in the empirical literature. In order to identify the relative influence of socio-demographic characteristics, geography, perceived well-being, and beliefs on public climate change awareness and risk perceptions on a national scale, they use this question as a measure climate change awareness: '*How much do you know about global warming or climate change?*'. Individual responses '*I know something about it*' and '*I know a great deal about it*' are classified as '*aware*', and responses '*I have never heard of it*' or '*Don't know*' as '*unaware*'.[4] Moreover, *aware* participants were also asked: '*How serious a threat is global warming to you and your*

[4] Starting from this classification, Lee et al. (2015) build a binary variable used in the empirical analysis, assigning the value of 1 to aware respondents and 0 otherwise.

family?', and the response used as a measure of risk perception.[5] A similar question wording was used by Leiserowitz in various surveys of risk perception of climate change in the USA, for example: '*Which of the following are you most concerned about? The impacts of global warming on (1) you and your family; (2) your local community; (3) the U.S. as a whole; (4) people all over the world; (5) non-human nature; or (6) not at all concerned*' (Leiserowitz, 2005).

Lo and Chow (2015) note that it is important to distinguish *the perception of the importance* of climate change compared to other problems, from the *perception of danger*, which is correlated with the sense of insecurity and risk associated to climate change. Starting from the publicly available dataset 'Environment Module' managed by the ISSP Research Group (2012) which covers 34 countries worldwide, the perceived *importance* of climate change is obtained by means of a dummy variable which codes as '1' (otherwise '0') those respondents indicating climate change as the most important of nine distinct environmental problems. This is a *relative* rather than an *absolute* measure, since these individuals recognize climate change as a priority compared to other environmental problems. The second variable capturing the perception of risk associated with climate change relates to the belief that rising temperature is a result of the dangers of climate change and is measured on a five-point scale, ranging from '*Not dangerous at all*' to '*Extremely dangerous*'.

Other papers analyse this issue using data provided by *ad hoc* surveys commissioned from private research companies. Andor et al. (2018) use all survey waves conducted in 2012 and 2015 by the German institute *forsa*.[6] Their sample accounts includes over 6,000 respondents (6,404 households in 2012, 6,522 in 2013, 6,602 in 2014 and 7,077 in 2015), which are representative of the population of German speaking households aged 14 and above. The surveys are updated regularly. Interviewees are asked to complete the questionnaire at home using either a television or the internet. The key variable is the following: '*There are plenty of challenges that people all around the world are faced with. Please indicate how important combating climate change is to you'*, with response options ranging from (1) 'Very unimportant' to (5) '*Very important'*.

Looking at China, Dai et al. (2015) use data from a survey run by the Horizon Research Consultancy Group, one of the leading market research companies in the country. A total of 1,054 Chinese adults aged 18 - 60 were interviewed in December 2012 in the five cities of Beijing, Guangzhou, Chengdu, Wuhan, and Shenyang. The questionnaire consists of various

[5] Also in this case, the authors compute a binary variable by assigning the value of 1 to those who state that the problem is either 'Somewhat serious' or 'Very serious' and 0 otherwise.
[6] For details, see www.forsa.com.

parts, and Dai et al. (2015) examine respondent's experience with extreme weather events and their assessments of global warming, as well as their socio-demographic and socioeconomic characteristics. They then build a binary dependent variable, the key variable of their empirical analysis, which takes the value of 1 (otherwise zero) if respondents believe that global climate change is already taking place today or will take place in the future.

Climate change awareness has also been widely investigated in advanced economies such as the USA. Often individual perceptions are identified by questions such as: "*Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future, and that the world's climate may change as a result. What do you think? Do you think that global warming is happening?*" (See Leiserowitz et al., 2010). Similarly, Zaval et al. (2014) proxy climate change concerns by considering to what extent American respondents are convinced *'that global warming (climate change) is happening*' and to what extent they are '*personally worried about global warming (climate change)*'. Zaval et al. (2014) recruited respondents from the website Amazon Mechanical Turk and from Columbia University's Center for Decision Sciences national panel. Hamilton and Saito (2015) use data collected from the Granite State Poll. They proxy climate change concerns using responses to the question: '*Which of the following three statements do you personally believe?*'. Response options are: '*Climate change is happening now, caused mainly by human activities*'; '*Climate change is happening now, but caused mainly by natural forces*'; '*Climate change is not happening now*'. Konisky et al. (2016) consider the following question, retrieved from the CCES, a web-based survey conducted by YouGov in the USA since 2006: '*From what you know about global climate change or global warming, which one of the following statements comes closest to your opinion?*' The response categories are on a 5-point scale, ranging from '*Global climate change is not occurring*'; '*This is not a real issue*' to '*Global climate change has been established as a serious problem, and immediate action is necessary*'.

3.2.2. Rational insight into climate change problems

In this subsection we review the questions most frequently used to identify the cognition component of mind, which corresponds to rational insight into climate change problems. In this context, public debate focuses on the controversial relationship between economic growth and environmental protection, i.e. on preferences for prioritizing environmental protection or

economic growth when the two interests are in conflict. However, the empirical literature shows that attitudes on this topic are inconsistent and contradictory, and question wording and format can lead to significantly different responses. Moreover, increasing attention is also being given to the responsibilities of international and national governments, and business and industry in fighting climate change.

Looking at the prioritization of economic growth versus environmental protection, Drews et al. (2018) use data from three Special Eurobarometer surveys (2008, 2011 and 2014 Editions) on European citizen attitudes to the environment to study how public perception of environmental problems affects the growth debate. They also analyse the case of the USA, using data from the International Social Public Program, the World Value Survey and surveys by the PEW Institute and Gallup World Poll. They first analyse whether the aims of economic growth and environmental protection are compatible, using the following statements: '*Economic growth always harms the environment*', and '*In order to protect the environment, [COUNTRY] needs economic growth*'. These data, related to the 2010 and 2011, are retrieved from the International Social Survey Program. Respondents can express agreement or disagreement on a 5-point Likert scale. For the Eurobarometer surveys, respondents were divided into two groups, each of them receiving one of the following two statements: '*The protection of the environment can boost economic growth in the European Union*' or '*Protecting the environment is an obstacle to economic growth in the European Union*'. Drews et al. (2018) then investigate whether economic growth or environmental protection are the priority for respondents, using answers to the question: '*Here are two statements people sometimes make when discussing the environment and economic growth. Which of them comes closer to your own point of view? Protecting the environment should be given priority, even if it causes slower economic growth and some loss of jobs OR Economic growth and creating jobs should be the top priority, even if the environment suffers to some extent*', which is retrieved from the World Value Survey (2010 Edition).

Similar questions are used in the PEW Research Center surveys and the Gallup World Poll, and in the periodical surveys by the Yale Program on Climate Change Communication, which have been widely used to analyse the evolution of this debate especially in the USA. For example, Leiserowitz et al. (2012) and Kaplowitz et al. (2013) consider the binary variable obtained from the answers to the following question: '*When there is a conflict between environmental protection and economic growth, which do you think is more important?*'.

However, these investigations highlight that respondents do not always realize that the two issues conflict, and question wording can bias their answers. Some studies thus employ different options. For example, Drews and van den Bergh (2016) use: '*considering economic growth as compatible with environmental sustainability*', '*ignoring economic growth as a policy aim*', '*stopping pursuing economic growth*' and '*pursuing economic growth in spite of its environmental impacts*', while Jagers (2009) looks at opinions on '*working towards an environmentally friendly society even if it means low or no economic growth*'.

The responsibility of international and national governments and business and industry in fighting climate change is investigated by both the Eurobarometer Special Survey on Climate Change and by the Gallup World Poll. In the Eurobarometer survey, participants are asked to provide an answer to the following question: '*In your opinion, who within the EU is responsible for tackling climate change?*' by choosing among '*National governments*', '*the European Union*', '*Regional and local authorities*', '*Business and industry*', '*You personally*', '*Environmental groups*' or '*Others*' or '*All of these possibilities*'. With regard to Gallup World Poll, instead, the question wording is more closely focused on the responsibility of national government: '*Do you think that [COUNTRY] government is doing too much, too little, or about the right amount in terms of protecting the environment?*'. These answers have provided matter for discussion especially in the USA since 1992. Often advocating more action by elected officials, corporations and citizens themselves, the survey reveals that Americans perceive that their government is doing too little to protect the environment and that global warming and clean energy should be among the nation's priorities (Leiserowitz et al., 2012). Moreover, this issue is particularly divisive especially among Republicans and Democrats, since perceptions are sometimes in turn influenced by respondents' expectations of the Presidents' performance on the environment. These latter are investigated by means of this question '*Do you think [INCUMBENT PRESIDENT] will do a good job or a poor job in handling each of the following issues as president?*', whose possible answers are the following: '*Protecting the nation's environment*', '*Improving the nation's energy policy*' and '*Making America prosperous*'.

3.2.3. Willingness to act to fight climate change

This subsection focuses on the conative component of the mind, and describes personal actions to fight climate change, together with individual willingness to pay in order to ameliorate environmental conditions.[7]

Wicker and Beckern (2013) perform a cross-sectional analysis based on a final sample of 26,840 respondents. Data are retrieved from the Eurobarometer 75.4, reporting a survey conducted from 4 to 19 June in 2011 (GESIS, 2012). They consider individuals indicating climate change as the most serious problem facing the world as a whole, together with their concerns regarding energy availability and the economic situation. They also study actions among eleven listed possibilities personally taken by each respondent in order to fight climate change during the six months before the interview. Respondents are asked whether they have, for example, bought a new low fuel consumption car or a low-energy home, whether they buy locally produced and seasonal food, whether they walk, bike or take public transport or car-share instead of using private cars, whether they have insulated their home to reduce energy consumption or have installed solar panels, whether they separate waste for collection, etc. The same set of variables are analysed by Meyer (2015) in investigating the influence of education on pro-environmental behaviours. In this paper, data are retrieved from Eurobarometer 68.2 in the period November 2007 - January 2008 and Eurobarometer 75.2 April - May 2011.

In the same way, D'Amato et al. (2019) analyse the impact of different sources of information, and trust in information, on the following behaviours: waste reduction, waste recycling, water saving and energy saving. Data are collected from three Special Eurobarometer surveys on attitudes of European citizens towards the environment in the years 2008, 2011 and 2014. Respondents are asked: '*Have you done any of the following actions for environmental reasons in the past month? 1. Reduced the consumption of disposable items (for example plastic bags, certain kind of packaging, etc.); 2. Separated most of your waste for recycling; 3. Cut down your water consumption (for example not leaving water running when washing the dishes or taking a shower, etc.); 4. Cut down your energy consumption (for example turning down air conditioning or heating, not leaving appliances on stand-by, buying energy saving light bulbs, buying energy efficient appliances, etc.)*'.

Smith and Mayer (2018) consider the role of risk perception and social and institutional trust in encouraging actions to fight climate change. Data from 35 countries are supplied by the Life in Transition II Study, conducted by the World Bank and the European Bank for Reconstruction and Development in 2010. Face to face interviews were conducted in the

[7] There is currently increasing attention to the attitude towards the adoption of alternative energy sources and thus consumer willingness to pay for renewable energy and related policies (Longo et al., 2008; Corner et al., 2011).

respondent's home, utilizing either computer assisted or pen-and-paper interview techniques. Different variables are examined. Personal actions taken to fight climate change are first captured by the question '*Have you personally taken any action aimed at helping to fight climate change?*', and the willingness to pay variable is derived from the question: '*Would you be willing to give part of your income, or pay more taxes, if you were sure the extra money was used to combat climate change?*'. The measure of institutional trust is obtained by combining response categories ranging from 1 (complete distrust) to 5 (complete trust) for the following institutions: the presidency/monarchy, the government/cabinet ministers, local government, the parliament, courts and political parties. Risk perception related to climate change is derived using the following question: "*As a result of climate change, do you think people in our country will be better off, worse off, or about the same?*'. Lastly, variables capturing how much respondents know about the causes of climate change, the consequences of climate change, ways to slow down climate change, and ways to adapt to climate change are used as control variables.

Household data from the Life in Transition Survey conducted in 2010 in 35 countries, are also investigated by Dienes (2015). Various dependent variables are considered in order to study the relationship between individual concern about climate change and the actions and intentions to pay for mitigating it. The variable capturing the intention to pay to fight climate change is a dummy taking the value of one if the individual intends to pay, and zero otherwise. Individual actions taken against climate change are similarly captured by a dummy equal to one if the respondent has taken such actions, and zero otherwise.

Schwirplies (2018) introduces the problem of climate change using the statement: '*Climate change is understood to be a rise in the average global temperature over the past 150 years or in the future, resulting in weather and climate changes*'. Using a scale with five ordered categories ranging from 'very weakly' to 'very strongly', respondents are then asked to indicate their acceptance of '*mitigation of climate change*' (e.g. advancement of renewable energy or energy-efficient technologies) and '*adaptation measures relating to the consequences of climate change*' (e.g. protection against natural events like the building of dams, safeguarding of traffic routes etc.). Data are obtained from almost identical web-based surveys conducted simultaneously in Germany and the USA, where about 1,000 respondents were invited via email to complete a self-administered questionnaire in a web-based online environment. In China, on the other hand, respondents are invited to centrally located test studios because of the lack of internet access in many rural areas of the country.

Lastly, individual actions to fight climate change are the core of the Peoples' Climate Vote, the most recent survey of public opinion on climate change and the largest ever, run conducted in 50 countries in the last months of 2020. This survey focuses on 18 different climate policies in the following fields: Energy, Economy, Transportations, Farm and Food, Protecting People and Nature.[8]

The issue of how climate change attitudes influence personal efforts to do something about it is also studied in terms of willingness to pay for ameliorating environmental quality. In this framework, Torgler and García-Valiñas (2007) consider the following item: '*I would agree to an increase in taxes if the extra money were used to prevent environmental damage (0=strongly disagree, 3=strongly agree)*' retrieved from the World Values Survey for years 1990, 1995, 2000 and the 1999 European Values Survey, with a specific focus on the case of Spain. Franzen and Vogl (2013) base their empirical analysis on the following items: '*I do what is right for the environment, even when it costs more money or takes more time*', '*How willing would you be to accept cuts in your standard of living in order to protect the environment?*', '*How willing would you be to pay much higher prices in order to protect the environment?*' and '*How willing would you be to pay much higher taxes in order to protect the environment?*'. Data are collected from three waves of the ISSP environmental module for the years 1993, 2000, and 2010 on a sample of 33 countries.

The main shortcoming of this type of question is that they do not specify the level of improvement or the degree of tax increase, and they provide no information about the type of tax to apply. This may give a misleading picture of willingness to pay (Hidano et al., 2005). In order to overcome this problem, Meyer and Liebe (2010) consider not only the answer to the usual question '*It is not normally possible to increase environmental protection for free. Would you be prepared to pay higher taxes or duties for improved environmental protection?*' but they also follow it up with a request for detail: '*Could you please tell me the amount in Swiss francs that you would be prepared to pay per month in addition to your taxes for*

[8] With regard to Energy, respondents are asked which of the following policies they would like their country to pursue to address climate change: '*using solar, wind and renewable power*', '*wasting less energy in homes, buildings, and factories*', '*stopping burning fuels that pollute*', for the Economy, the policies suggested are: '*investing more money in green businesses and jobs*', '*requiring more information on how products are made*', and '*making companies pay for their pollution*'. With regard to Transportations, the actions suggested are: '*using more clean electric cars and buses, or bicycles*', '*transporting good on planes, ships, trains and trucks that run on clean energy*', and '*improving the design of cities and rural communities*', and for Farms and Food they are: '*using climate-friendly farming techniques*', '*reducing food waste*', and '*promoting plant-based diets*'. With regard to Protecting People from extreme storms, flooding, droughts, forest fires, and other climate impacts, the options suggested are: '*installing more early warning systems for disasters*', '*providing good and affordable insurance*', '*building infrastructure and conserve nature to protect lives and livelihoods*', and for Nature they are: '*conserving forests and land*', '*keeping the ocean and waterways healthy*' and '*supporting local communities, indigenous peoples, and women that are environmental stewards*'.

improved environmental protection in Switzerland?', in order to capture the appropriate willingness to accept an increase in taxes.

Finally, some authors consider willingness to pay for environmental protection jointly with the other aspects of environmental concern analysed in the previous subsections. Xiao et al. (2013) for example include in their empirical analysis the perceived seriousness of local environmental problems (local problems), the perceived seriousness of national environmental problems (national problems), the economic-environmental trade-off, and a measure of environmental worldview as well as more general variables capturing environmental activism and the willingness to pay for environmental protection.

3.3. Climate change awareness at the aggregate level

All the studies reviewed in the previous subsections use data disaggregated at individual level, but the empirical literature also works with quantitative and qualitative data to proxy climate change awareness at aggregate level. To the best of our knowledge, there are few papers using aggregate figures about climate change awareness (Howe et al., 2015; Lo and Chow, 2015; Carmichael and Brulle, 2016; Bergquist and Warshaw, 2019; Baiardi and Morana, 2021), although studying the aggregate dynamics of public opinion is particularly meaningful in terms of government decisions (Bergquist and Warshaw, 2019).

3.3.1. Quantitative aggregate data

A basic proxy of climate change at the aggregate level is the emission of carbon dioxide (CO2), which, together with methane (CH4) and nitrous oxides (N2O), is the major component of overall greenhouse gas emissions and thus the main cause of global warming. This explains why many industrial and developing countries, from the Kyoto Protocol to the recent Paris Agreement, emphasize curbing CO2 emissions globally. Data are principally available at national level and retrieved from free datasets like World Bank Development Indicators, OECD Statistics, the Paris Reality Check: PRIMAP-hist and the Climate Data Explorer.

CO2 emissions are widely used in the environmental economic literature as a proxy of the level of pollution in a specific geographic area (generally a country or a region), i.e. as a proxy of the negative externality due to human activities on the environment (see, among

others, Wang, 2012, Alberini et al., 2018; Lægreid and Povitkina, 2018). In a broader sense, they have also been considered as an indirect or implicit proxy of climate change concern at the aggregate level (Sandvik, 2008; Lo and Chow, 2015; Bu et al., 2016). However, it is important to note that the use of this variable to proxy climate change *concern* is improper, as CO2 emissions represent the *objective* level of this greenhouse gas in a specific geographic area and only implicitly refer to the *subjective* attitudes and perceptions of citizens of a country on climate issues.

The Notre-Dame Global Adaptation Index (ND-GAIN) is used to measure the ability and the preparedness of a country to face climate change (Lo and Chow, 2015). This annual indicator is computed by the University of Notre-Dame, within the Notre-Dame Global Adaptation Initiative, and ranges on a scale from 0 to 100. It measures the difference of an index of country's *readiness* to mobilize financial resources to mitigate its exposition to climate change and an index of country's *vulnerability* or *inability* to face the potential adverse effects of climate change.

Lastly, the Climate Change Performance Index is an annual composite indicator, covering 57 countries and the European Union, which evaluates and compares the climate protection performance of each country. The index is built using fourteen distinct variables from four different categories: Greenhouse Gas Emissions, Renewable Energy, Energy Use and Climate Policy. Quantitative data, retrieved from the International Energy Agency, the Paris Reality Check: PRIMAP-hist, the Food and Agriculture Organization and the national GHG inventories, refer to the first three categories, while climate policy data are based on qualitative measures indicating government decisions in terms of climate issue. However, both the ND-GAIN and the Climate Change Performance indicators are affected by the same shortcomings as the proxies of air pollution.

3.3.2. Qualitative aggregate data

The Eurobarometer Special Surveys on Climate Change also provide aggregate figures indicating perceptions on climate change on a national scale for European countries. These data are contained in Volume C (Country/Socio-Demographics). To the best of our knowledge, only Baiardi and Morana (2021) use these aggregate data by considering the Special Eurobarometer surveys 322, 372, 409, 435, 459 and 490, collected in the years 2009, 2011, 2013, 2015 and 2019, respectively.

Witzle and Urfei (2001), using individual data from a survey on Environmental Consciousness and Behavior run by the Federal Environmental Agency, apply a two-step procedure to estimate an indicator of environmental willingness to pay for Germany at regional level (NUTS3). They first estimate an order probit model in order to identify the main socio-economic determinants of environmental preferences at an individual level. They then combine this model with regional data in order to obtain an indicator of regional willingness to pay for conserving the environment.

With reference to the USA, Brulle et al. (2012) and Carmichael and Brulle (2016) compute a time-series measure of public opinion on climate change by pooling data on climate change perceptions between 2002 and 2010 and 2001 and 2013, respectively.[9] These data are retrieved from 74 different surveys, administered to 84,086 respondents, and the attention has been focused on 14 distinct questions related to the emotional component of mind of climate change. They thus build an aggregate measure capturing how much the interviewees worry about this problem, to what extent the issue is serious and important for them, whether they are personally affected by climate change and consider global warming as a threat to themselves or to their way of life. Similarly, Bergquist and Warshaw (2019) put forward a comprehensive index of the mass public's latent concern about climate change for each of the fifty states of the USA in the years 1999-2017. Qualitative data, collected from all publicly available survey data on climate change in the USA (about 400,000 survey respondents in 170 polls), are aggregated by means of the general framework of Item-Response Theory, which is commonly used for pooling responses to different survey questions about the issue of interest. Specifically, this index captures responses to questions about belief that climate change is occurring and/or caused by human activities, concern about global warming, and support for prioritizing policies to address climate change, thus principally focusing on the cognitive and conative components of mind.

4. Determinants of climate change awareness

Determinants of climate change awareness depend on the socio-economic features of the country where people live as well as their individual characteristics. To provide a structured overview of the existing studies, the following subsections review the literature based on the variables often included in the model specifications.

[9] In both papers, data have been pooled by using the algorithm developed by Stimson (1999).

4.1. Gender, age, education and personal income

Gender, age, race (mainly in the USA), education and personal income are the most investigated determinants of climate change attitudes. According to literature on risk perception, women are generally more risk averse than men, and consequently they exhibit a higher environmental awareness. This is consistent with their traditional role of caregiver and nurturer in the household. Moreover, as shown by Hunter and Hatch (2004), the fact that they traditionally work at home is an implicit incentive to engage privately in behaviours aiming environmental conservation. Nevertheless, the literature on the relationship between environmental attitudes and gender is inconsistent (Van Liere and Dunlap, 1980; Mohai, 1997; Zelezny et al., 2000).[10]

On the other side of the coin, men present higher risk acceptance, probably due to their dominant role in the society, and are thus less concerned about climate change (Hamilton and Keim, 2009; Andor et al., 2018). Similar conclusions also hold for elderly people. Specifically, Franzen and Vogl (2013) find that American women show slightly higher environmental concern than men and that the age effect is concave, i.e. environmental concern first increases and then decreases with increasing age. In line with these findings, Wickern and Beckern (2013) and Meyer (2015) show that women and young people exhibit a higher willingness to act in environmental protection than men and older people,[11] while Andor et al. (2018) find that older people are not likely to take personal action or support policy measures for fighting climate change. This appears to be because they are more concerned about other global challenges, such as stabilizing the financial system and fighting terrorism, and that the existence of children or grandchildren does not alter their perception on environmental problems. In the USA, race is an additional factor to take into consideration. Findings show that non-white women are more concerned about climate change than their white male counterparts (O'Connor et al., 1999; Leiserowitz, 2006; Wood and Vedlitz, 2007; Brody et al., 2008; Hamilton, 2008; Malka et al., 2009; McCright, 2010; McCright and Dunlap, 2011).

With regard to education, Lee et al. (2015) demonstrate that it is the strongest predictor of climate change awareness. It is generally positively correlated with the respondent's knowledge about environmental problems, and better educated individuals are expected to be

[10] For example, the meta-review by Zelezny et al. (2000) shows that of 13 studies, 9 found that women are significantly more active in pro-environmental behaviors than men, 3 found no statistically significant difference between males and females and one study reports greater participation of men.

[11] As noted by Franzen and Vogl (2013), younger people are more concerned than older people because global warming has received stronger media coverage in their lives.

more willing to engage pro-environmental behaviours and to exhibit stronger climate change beliefs (Klineberg et al., 1998; O'Connor et al., 1999; Tobler et al., 2012). The literature shows that formal education is effective (Israel and Levinson, 2004; Veisten et al., 2004), but also that informal education is important in terms of higher preferences in environmental protection (Torgler and García-Valiñas, 2007).

Reschovsky and Stone (1994) find a positive relationship between different indicators of the level of education (i.e., beyond high school, degree, bachelor's degree, and graduate or professional degree) and five distinct household recycling behaviours by running a natural experiment conducted in the Finger Lakes region of upstate New York. Similar results are discussed by Rowlands et al. (2003) and Kriström and Kiran (2014), who show a positive association between education and the individual willingness to pay premium for green electricity in Canada and in the OECD countries, respectively.[12] Wicker and Becken (2013) and Meyer (2015) estimate a logistic regression model and an instrumental variable analysis, respectively, in order to capture the effect of education on pro-environmental actions. Their findings demonstrate that education may increase the respondents' perceptions of environmental issues. Similar results are obtained by Franzen and Vogl (2013), who measure education by means of the highest schooling achievement for each respondent in the USA, by De Silva and Pownall (2014) using a survey of over 1,400 households in the Netherlands, and by Smith and Mayer (2018) in a sample from 35 countries. Xiao et al. (2013) and Dai et al. (2015) show that higher education is also positively associated with climate change concern in China.

However, the empirical literature casts some doubts about the robustness of this positive evidence, as highlighted by Smith (1995) and Torgler and García-Valiñas (2007) when individual attitudes towards collective environmental conservation and damage prevention initiatives are considered. Berk et al. (1993), Gilg and Barr (2006) and Grafton (2014) find mixed results about the role of education in various water saving behaviors, while D'Amato et al. (2019) find that lower education reduces the propensity towards recycling and water saving, but that education has no effect on other pro-environmental actions. Ek and Söderholm (2008) analyze the main determinants of Swedish households' choice to pay a price premium for 'green' electricity and find that it does not seem to be affected by education and gender. Kahan et al. (2011, 2012) identify in cultural polarization and conflict of interests, together with cognitive bias, elitist cultural worldviews and self-denial campaigns, the reason of the existence of a negative linkage between higher education and climate change

[12] Rowlands et al. (2003) investigate 2000-2001 survey responses from large Canadian cities (Waterloo and Ontario) by means of a Spearman's correlation analysis.

awareness. In line with this evidence, Baiardi and Morana (2021) find a positive link between secondary education and climate change awareness, but a negative effect when tertiary education is considered, thus suggesting that the higher the percentage of citizens with tertiary education is, the higher the national level of scepticism on climate change.

Lastly, among the social demographic characteristics linked to individuals' environmental awareness, personal income, or more generally, the economic situation of an individual, are an additional significant factor. In fact, wealthier people are expected to have a higher demand for a cleaner environment and for less environmental damage, although they are responsible for higher emissions than poorer individuals worldwide, as shown by Figure 3. As described by Franzen and Vogl (2013), two mechanisms are at work in this context: firstly, wealthier individuals have fewer economic problems and are therefore freer to consider other issues, and secondly, their willingness to pay for better public goods is higher (Franzen, 2003). This implies that personal income is expected to positively affect climate change awareness, i.e. that a higher personal income is correlated with a higher willingness to prevent environmental damage (Torgler and García-Valiñas, 2007). This hypothesis is generally verified, as shown, among others, by Israel and Levinson (2004), Veisten et al. (2004), Hidano et al. (2005), Franzen and Vogl (2013) and Schwirplies (2018).

It is worth noting that it is very difficult to capture the overall economic situation of each respondent. Personal income is an incomplete and partial measure of personal wealth, because respondents tend to underreport personal income in surveys, and inherited wealth or other properties are often not declared (Franzen and Vogl, 2013). For this reason, the inclusion in the empirical analysis of a macroeconomic variable measuring the stage of development of the country where the respondent lives would be crucial. Richer countries tend to provide more and better quality public goods, and this sort of GDP effect contributes to individuals' wealth in addition to their personal incomes (See also Subsection 4.5).

To conclude, Table 2 provides a detailed summary of the literature related to the socio-economic determinants of climate change awareness reviewed in this subsection. It indicates data sources, the countries investigated and the methodology used in the empirical analysis.

Table 2 about here

4.2. Political interest and political orientation

Political interest and political orientation are significant individual level predictors of environmental awareness. With regard to political interest, it is assumed that politically

interested people are also well-informed and have the objectivity to understand environmental issues. Their willingness to act to conserve the environment is expected to be very high. This is investigated by Torgler and García-Valiñas (2007), using three survey questions 'W*hen you get together with your friends, would you say you discuss political matters frequently, occasionally or never?*', '*How interested would you say you are in politics?*' and '*How important is politics in your life?*'. These questions capture whether the respondent discusses about politics, her/his interests on the topic and to what extent the issue is important for her/him.

Membership of a voluntary environmental organization is also a relevant factor. As underlined by Whitehead (1991), Blomquist and Whitehead (1998), Carlsson and Johansson-Stenman (2000) and Torgler and García-Valiñas (2007), members of this type of association tend to be more aware of environmental problems and exhibit stronger preferences for reducing environmental harm and fighting climate change.

Political orientation is another aspect analyzed frequently in the literature. Proxies of political orientation are generally obtained by means of specific survey questions where participants are asked to self-identify their ideology or political party. For example, the Eurobarometer survey invites respondents to express their political views on a Likert scale, where 1 is '*Being on the left*' and 10 '*Being on the right*'. Findings show that, in developed countries, people with more accentuated right-wing ideology are less interested in protecting the environment than left-wing voters (Franzen and Vogl, 2013), perhaps reflecting their stronger preference for economic development (Witzke and Urfei, 2001).

Literature on the role of political ideology in belief in anthropogenic climate change has flourished especially in the USA. Surveys generally ask individuals to express their political orientation among Democrat, Independent or Republican, sometimes with the additional qualification of '*strong Democrat*' or '*strong Republican*', or alternatively '*extremely liberal*' or '*extremely conservative*'. Empirical evidence shows that political ideology dominates other individual characteristics in determining environmental views in the USA (Borick and Rabe, 2010; Hamilton et al., 2015). Liberals and Democrats are more likely to express concern about climate change than Conservatives and Republicans (Malka et al., 2009; Brulle et al., 2012; Lee et al., 2015), who are more sceptical about the phenomenon and its features (Dunlap, 2014). Specifically, Guber et al. (2020) make a textual analysis of speeches published in the Congressional Record between 1996 and 2015, and show that the two main political parties differ in terms of the language they use. Democrats base their communications on scientific evidence, while Republicans prefer a narrative based on

anecdotes and storytelling.[13] McCright and Dunlap (2011), by using data from the Gallup World Poll and by means of a multivariate logistic regression model, demonstrate that being a conservative white male is crucial in terms of climate change denialism and in terms of the defence of the current socio-economic system in the USA.

Recent political divisions in the USA have taken on new relevance to environmental issues in the USA. Hamilton and Saito (2015) examine the case of the Tea Party movement which started in 2009, where supporters are more likely to be older, middle-class, male, and more educated than mainstream Republicans. Using an *ad hoc* survey question inserted into the Granite State Poll aiming to identify Tea Party supporters, they find that these supporters are less likely than other Republicans to trust scientists for information about environmental issues, accept human evolution, or believe either the physical reality or the scientific consensus on anthropogenic climate change. They show greater (misplaced) confidence in their own understanding of climate change.

Political ideology can also interact with education. The empirical literature shows that more educated people develop stronger arguments to support their views on climate problems, as in the case of Liberals and Democrats in the USA (Lee et al., 2015; Whitmarsh and Capstick, 2018). This evidence is generally explained by *elite cu*es and *party sorting*, according to that people's preferences align with the views of politicians and media that they follow (Guber, 2013). Moreover, more educated and informed individuals exhibit a higher capability to collect information supporting their beliefs and prejudices, as demonstrated by the *assimilation* and *motivated skepticism biases* (Borick and Rabe, 2010; Corner et al., 2011b; McCright and Dunlap, 2011; Hamilton and Saito, 2015). The consequence is that people believe that they are well informed about climate change, but their knowledge is biased by their political ideology and may not be based on scientific evidence (Hamilton et al., 2015). This also implies that elite views impact more strongly on public opinion than do scientific research and mass media coverage (Brulle et al., 2012; Carmichael and Brulle, 2016).[14]

Similar evidence holds in many other developed countries, i.e. left-identifying individuals are more concerned about climate change than their right-identifying counterparts. This is the case of Australia, where Tranter (2011, 2013) analyze the issue using data from the Australian

[13] James G. Watt, the head of the Department of the Interior during Ronald Reagan's presidency, distinguished for its hostility about environmental issues. A popular word pun at the time was 'How much power does it take to stop a million environmentalists? One Watt'.

[14] However, Ripberger et al. (2017), when considering political predispositions in data from the Meso-Scale Integrated Socio-geographic Network (M-SISNet), a longitudinal (panel) survey conducted in Oklahoma, find that political predispositions imply biased assimilation and confirmation bias in the cognitive process, and thus affect climate change awareness. But the influence is not strong enough to completely counteract feedback from the climate system.

Survey of Social Attitudes and from the Australian Election Study for the years 2007, 2010 and 2011. Tranter (2011) also shows that supporters of the Labor Party and the Greens exhibit a higher willingness to pay for renewable energy. Looking at climate change skepticism in Grain Britain, Poortinga et al. (2011), Whitmarsh (2011) and Clements (2012a,b) find that political affiliation is a very important predictor, and Conservative Party voters are more skeptical than Labour, Liberal Democrat or other party voters. A similar conclusion is reached by Lachapelle et al. (2012) in Canada, and by Tjernström and Tietenberg (2008), Kvaløy et al. (2012), Tranter and Booth (2015) and McCright et al. (2015) in other different samples of countries. However, it is worth noting that the evidence is weaker in developing countries. Dai et al. (2015), when testing whether education interacts with ideological and political beliefs, find that political factors do not seem to be crucial in terms of climate change attitudes in China. Moreover, McCright et al. (2015), in line with Chaisty and Whitefield (2015), find that there is no clear-cut ideological divide on climate change awareness in the former Communist countries of Eastern Europe.

Table 3 provides a summary of the literature on political values influencing climate change awareness reviewed in this subsection, showing the countries investigated, data sources and the estimation methods used.

Table 3 about here

It is worth noticing that Table 3 also reports some other *external* political factors, independent of individual ideology and political effort, which can affect environmental views and which should thus be included in the analysis. Such factors include armed conflicts (like war deaths in Iraq and Afghanistan), terrorist attacks, greater attention to foreign than to internal affairs, oil price shocks and the 2008 financial and economic crisis (Gelpi et al. 2009; Brulle et al., 2012; Dienes, 2015; Carmicheal and Brulle, 2016).

4.3. Experience of extreme weather events and weather conditions

Weather conditions and extreme weather events indicate in the literature *direct experience* of climate change, i.e. direct experience with heatwaves, heavy rainfall or floods, drought, sandstorms, windstorms and avalanches or the damage and/or financial loss due to extreme weather episodes (Konisky et al., 2016; Baiardi and Morana, 2021). In general, people experiencing extreme weather are more concerned about global warming (Borik and Rabe, 2010; Howe et al., 2013; Dai et al., 2015; Whitmarsh and Capstick, 2018).

Spence et al. (2011) use data from a 2010 national survey of 1,822 participants in the UK, and show that individuals with personal experience of flooding are more aware of climate change, and also exhibit greater willingness to save energy to mitigate climate change. Dai et al. (2015) find that climate change awareness is stronger for people who experience extreme weather events like heatwaves, heavy rainfall or floods, droughts, sandstorms, windstorms, or avalanches, independently of the occurrence of physical or financial damage. The relationship is very strong in the case of physical and financial damage caused by extreme weather events. Moreover, heatwaves are more strongly associated with climate change than floods or droughts. Similar conclusions are reached by Frondel et al. (2017), considering personal risk perception of three adverse natural events in Germany: heat waves, storms, and floods. In this survey, the key item in the empirical analysis is: '*With respect to the next few decades, how likely is an increase in future personal financial or physical damages caused by …*', and the blank is completed with one of the following events: heat waves, storms, or floods (Frondel et al., 2017, p. 174).[15] Explanatory variables indicate respondents' experience of such natural events as well as financial or physical damage caused. Using a generalized ordered logit approach, they find that risk perception is positively related to personal experience with adverse natural events, and if this experience involves personal damage, the effect on risk perception is even stronger. These results confirm findings in the literature from different countries. See, for example, Keller et al. (2006) and Siegrist and Gutscher (2006) for Switzerland and Whitmarsh (2008) for the UK. Baiardi and Morana (2021) use two variables for the monetary impact of climate change together with the number of cooling and heating degree days and the negative component of the Southern Oscillation Index, corresponding to El Niño episodes.

The incidence of *local weather conditions*, especially rising temperatures, on climate change awareness has been studied given their importance in raising awareness. Recent papers in fact show that *current* temperature increases amplify the perception that climate change is happening, since individual perceptions are generally the result of personal experience (Egan and Mullin, 2012; Zaval et al., 2014; Kaufmann et al., 2017). Zaval et al. (2014) investigate how local temperature abnormalities influence global warming attitudes in the USA, and find that they lead to an overestimation of the frequency of similar past events, thereby increasing belief in and concern about global warming. This sort of 'local warming effect' depends on the fact that local temperature changes, as well as perceived temperature changes, are easily interpreted by individuals as evidence of climate change, although they

[15] Frondel et al. (2017) consider the role of risk perception associated to climate change by using two surveys conducted in 2012 and 2014 by the German institute *forsa*.

provide little information about global warming from a scientific point of view (Li et al., 2011; Hamilton and Lemcke-Stampone, 2014).

However, conflicting results have been found in the empirical literature on this issue. Some papers, especially focusing on the USA, highlight that only fluctuations in temperature induce higher salience in climate change in the long run (Deryugina, 2013) and that they do not have any effects on climate change awareness (Carmicheal and Brulle, 2016). Konisky et al. (2016) consider micro-level geospatial data on extreme weather events from NOAA's Storm Events Database, and analyse extreme weather events that are predicted to increase in frequency and severity because of climate change, such as warmer temperatures, more heat waves and drought, higher rainfall, more serious tropical storms, and rise in sea-level (IPCC, 2013). They conclude that there is little evidence of a positive relationship between experiencing extreme weather and climate change awareness, especially if these weather events occurred recently. Carmichael and Brulle (2016) also find a weak result investigating five distinct measures of extreme weather events (extremes in high and low temperature, extremes in 1-day precipitation, drought levels, and land-falling hurricanes and major storms) as did Hamilton et al. (2015) with regard to daily temperature and weather disasters.

Goebbert et al. (2012) combine observed data on weather conditions with individual perceptions. Using an ordered logit model, they investigate to what extent and whether observed deviations in local temperatures and precipitation from long term averages affect individual perceptions of local weather changes. They ask three questions related to temperature, drought and floods: '*In your personal experience, over the past few years have average temperatures where you live been rising, falling, or staying about the same as previous years?*', '*In your personal experience, over the past few years has drought where you live been more frequent, less frequent, or stayed about the same as previous years?*' and '*In your personal experience, over the past few years has flooding where you live been more frequent, less frequent, or stayed about the same as previous years*'.[16] Their findings show that the relationship between perceptions of weather changes and actual changes in local weather is affected by cultural and political biases.

Table 4 provides a summary of the literature related to the perceptions and personal experience of weather conditions affecting climate change attitude reviewed in this subsection. It shows data sources, the countries investigated and the empirical methodology used.

Table 4 about here

[16] Data retrieved from two 2008 USA surveys; online interviews with independent cross sections and a nationwide telephone survey.

4.4. Trust

Trust is a particularly important issue in terms of climate change awareness because the information about the risk relating to climate change cannot usually be verified. There are various definitions of trust, but it can generally be defined as the assumption that '*other people, or institutions, are acting in a mutually beneficial manner informed by broadly shared social norms*' (Smith and Mayern, 2018, p. 141). However, trust may also constitute a 'social trap', since higher it may amplify the effect of risk perception (Rothstein, 2014).

The level of trust that citizens place in their institutions is very important in the discussion of climate change awareness (Smith and Mayer, 2018, Baiardi and Morana, 2021). Trust in government is particularly important, since it has a key role in the development of institutions and implementation of public policy (Sullivan and Transue, 1999). As a consequence, lack of trust in government, because of corruption, for example, can be detrimental in terms of pro-environmental efforts. Furthermore, the environment can be interpreted as a public good, which is characterized by non-excludability and non-rivalry of consumption, and environmental conservation may offer potential opportunities for 'free riding' behaviour (Kollock, 1998). This implies that greater trust in others indicates greater concern for public goods, and thus incentivises pro-environmental behaviors (Franzen and Vogl, 2013; Harring, 2014; Smith and Mayer, 2018).

Meyer and Liebe (2010) study the impact of generalized trust, measured by means of an additive index derived from the answers to the following three questions '*Generally speaking, would you say that most people can be trusted, or that you cannot be too careful in dealing with people?*', '*Do you think that most people would try to take advantage of you if they had the chance, or would they try to be fair?*' and '*Would you say that most of the time people try to be helpful or that they are mostly looking out for themselves?*', which are taken from the 2007 Swiss Environmental Survey, a nationwide general population survey of 3,369 individuals. In this way, they analysed the effectiveness of perceived trustworthiness, opportunism, and helpfulness as a determinant of individuals' willingness to pay for public environmental goods. They find that generalized trust is associated with a stronger willingness to contribute, also in terms of higher taxes, to environmental protection, and this suggests that trust in other people encourages more efforts toward environmental protection. Similar conclusions are reached by Torgler and García-Valiñas (2007), who show that the

more citizens trust their society, the higher their willingness to conserve the environment, which also favours membership of environmental organizations.

Franzen and Vogl (2013) investigate two dimensions of trust: trust in people and trust in governmental institutions. General trust in people is measured by means of the following question, taken from the ISSP survey: '*Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?*', and the possible five responses range from '*You cannot be too careful*' to '*Most people can be trusted*'. General trust in the government is measured by the item '*Most of the time we can trust people in government to do what is right*'. Franzen and Vogl (2013) find that while trust in other people has a positive impact on environmental awareness, trust in institutions has no significant effect.

Smith and Mayer (2018) distinguish three different dimensions of trust: social trust, particular trust and trust in institutions. Social trust is the most general definition, involving trust in others within a society, linking individuals with other people (Delhey and Newton, 2005). Particular trust is that between members of an individual's in-group. Trust in institutions, such as the government, the legal system, labour unions, business or organized religion, is a predictor of the individual's propensity to provide policy support. Smith and Mayer (2018) build two variables: the first proxies social trust, and respondents are asked to express their trust in the following groups: neighbourhood, people you meet for the first time, people of another religion, and people of another nationality. The second variable captures institutional trust and respondents are asked about their trust in the following institutions: the presidency/monarchy, the government/cabinet ministers, local government, the parliament, courts and political parties. By means of a multilevel binary logistic regression analysis, they find that individual-level social trust is positively correlated with climate behaviour, and that its estimated effects are stronger and more consistent than those of institutional trust.

A similar conclusion is reached by D'Amato et al. (2019), who find that institutions such as governmental agencies do not affect pro-environmental behaviours, with the sole exception of water saving. This suggests that public campaigns play a key role in water consumption. D'Amato et al. (2019) also analyse the role of eco-information sources and trust in environmentally relevant behaviours, and find that internet access can be considered as an effective source of eco-information in stimulating specific pro-environmental actions, while

traditional media are an important source of information only in the case of decisions on energy saving and, less significantly, waste reduction.[17]

The acquisition and processing of information are crucial, as climate change attitudes and actions are influenced by how people interpret and understand the available information (Franzen and Vogl, 2013; Smith and Mayer, 2018). It is however the case that individuals tend to use only information which confirms their beliefs, ignoring news which conflicts with them (Kunda, 1990). Education plays a central role in the fruition of printed and online media, magazines and newspapers, blogs, etc., since the media have sometimes been guilty of providing biased information and even denying the existence of climate change, showing doubt and encouraging apathy on this topic (Whitmarsh, 2011).

Table 5 provides a list of the papers related to the different types of trust investigated in the empirical literature reviewed in this subsection. It shows data sources, countries analysed and the methodological framework.

Table 5 about here

4.5. The stage of development of the country where people live

Climate change awareness is closely connected to the stage of development of the country where people live (Brulle et al., 2012; Carmicael and Brulle, 2016). Sandvik (2008) makes an analysis of covariance between climate change awareness, two proxies of economic wealth (2005 per capita GDP based on purchasing power parity in 1,000 USD and its annual growth rate in the years 2000–2004) and a variable capturing the responsibility for global warming (2003 national per capita emission of carbon dioxide from fossil fuels in metric tons of carbon). Countries are grouped into different geographical areas (Africa, Asia, Europe, Latin America, North America and Oceania), and also according to their stage of development. Sandvik (2008) finds that climate change awareness is negatively, or even non-linearly, correlated with GDP.

Kim and Wolinsky-Nahmias (2014) reach a similar conclusion on this correlation using a comprehensive cross-national dataset of data retrieved from the 2007 Pew Global Attitude Project, the 2005 World Values Survey, the 2008 HSBC Climate Change Confidence

[17] Information was captured by the question: '*From the following list, which are your three main sources of information about the environment?*', whose possible answers are: internet, publications, brochures or information materials, events (conferences, fairs, exhibitions, festivals, etc.), social media, TV films and documentaries, conversations with relatives, family, friends, neighbors or colleagues, books, magazines, newspaper, television news, the radio. Trust in the following information providers has also been considered: institutions (national and international), companies, environmental and consumers' organizations, and scientists.

Monitor, and the BBC World Service Poll on Climate Change for the years 2006 and 2007. The finding implies that individuals more exposed to adverse local climate conditions, like farmers in developing countries, may be much more concerned about climate change than people in advanced economies (Basannagari and Kala, 2013; Whitmarsh and Capstick, 2018).

This evidence suggests that, although climate change is a well-recognized threat to human wellbeing, the richest economies are "*better equipped and more capable of mitigating risks and coping with its consequences than the rest of the world*" (Lo and Chow, 2015, p. 346). People living in advanced economies are thus less concerned about the risks of climate change, and tend to see it as an important but not very dangerous threat. Moreover, from a temporal and spatial perspective, they perceive climate change as distant, with negative consequences only in the long run (Frondel et al., 2017).

However, the debate about the relationship between climate change awareness and GDP is still an open question. Lo and Chow (2015) use per capita GDP (constant 2005 prices in USD) and tonnes of per capita CO2 emissions as generic indicators of national wealth and of responsibility for climate change, respectively. They also include in their estimates energy consumption, as a robust alternative to CO2 emissions, and the Notre Dame Global Adaptation Index as an indicator of preparedness for global climate change. Their results, obtained by means of a bivariate correlation coefficient analysis and a generalized linear regression model, show that per capita GDP, like all the other variables described here, correlates negatively with the perceived *risk* associated with climate change. Unlike Sandvik (2008), however, they find that it correlates positively with climate change *concern*. Franzen and Vogl (2013), Smith and Mayer (2018) and Baiardi and Morana (2021) all reach the same conclusions, showing the existence of a positive relationship between per capita GDP and climate change awareness in different time periods and in different samples of countries.

This positive relationship is also found when other sets of variables are used. For example, Lo and Chow (2015) show that empirical estimations obtained by models using the ND-GAIN index are statistically more robust than models using GDP per capita. Similar conclusions are reached by Diekkman and Franzen (1999), who perform a correlation analysis using data from the 1992 Health-of-Planet Survey on 21 countries and per capita GNP, and by Franzen and Vogl (2013), who find that the positive effect of national wealth on environmental concern holds using cross-sectional data for the years 1993 and 2000, and also when fixed effects panel regressions are computed.

5. Climate change awareness and policy responses

The findings described above have important implications in terms of public policy, which is of course intrinsically linked to individual behaviour. Policy affects human behaviour towards the environment, while at the same time, individual awareness of climate change is a sufficient condition for supporting costly adaptation and a necessary condition for implementing mitigation policies (Dai et al., 2015). Moreover, greater concern about global warming is a determinant factor for individual voluntary actions in protecting and conserving the environment. It has repercussions also on consumption and production patterns, and in fact incentivizes greener consumption habits and firm innovation activities (Carraro and Lévêque, 2013; EEA, 2016; Costantini et al., 2017).

However, the implementation of climate policies faces severe obstacles, as '*the costs of these measures are known and arise today, while the benefits are uncertain and might only emerge in the distant future'* (Andor et al., 2018, p.173). This implies that the effectiveness of climate policies is subject to great uncertainty especially in the long run, which conflicts with the certain costs to be paid in the short run. In this context, population aging in industrialized countries is relevant for the implementation of climate policies. In fact, the combination of certain short-term costs and uncertain long-term benefits is weakly supported by older people, which are less likely to approve climate-friendly policies, agree with allocating public resources to climate policies and also have a lower willingness-to-pay for them, given their shorter individual planning horizons (Andor et al., 2018). Women exhibit greater willingness to contribute to a better environment than men (Torgler and García-Valiñas, 2007), reflecting their higher propensity to take private adaptation measures (Schwirplies, 2018). Another important individual characteristic is personal income, although its influence varies across countries. For example, acceptance of adaptation policies is positively correlated with income in China, and higher income German respondents seem to be more inclined to autonomous climate-friendly and adaptation activities (Grothmann and Reusswig, 2006, Lange et al., 2017).

This is just part of the story. People widely perceive climate change as a serious problem which is however distant in time and space, with potential impact on human wellbeing only in the future. This myopia is also identified in behavioural economics literature (Thaler and Benartzi, 2004), and implies that risks of climate change are often underestimated, with negative consequences in terms of public support for climate policies. In this context, personal experience with adverse natural events become crucial. Higher individual risk perceptions of climate change generally go hand in hand with personal experience of adverse

natural events, where personal loss or damage is involved, risk perception is even more pronounced (Zaalberg et al., 2009; Frondel et al., 2017). The existing literature thus shows that an important policy question is the following: '*Will the predicted increasing frequency and severity of extreme weather events lead citizens to reassess climate change risks, possibly increasing pressure on governments to invest more resources in mitigation and adaptation?*' (Konisky et al., 2016, p. 534). Generally, respondents more aware of climate change show a higher willingness to pay for mitigation policies and are more likely to take actions to preserve the environment (Wicker and Becken, 2013; Dienes, 2015; Osberghaus, 2015).

Wicker and Beckern (2013) and Smith and Mayern (2018) also find that climate change awareness is closely connected to direct and indirect pro-environmental behaviours supporting cross-national climate change policies. However, Wicker and Beckern (2013) note that this does not hold for actions entailing substantial personal or financial costs, while Smith and Mayern (2018) emphasize the importance of risk perception and trust in the promotion of climate change policies especially at the individual level. More specifically, they find that environmental-friendly behaviours are more likely in countries where social trust is high, while a high level of trust and climate change concern lead people to endorse climate policy more easily. In other words, lack of trust and corruption are associated with a lower perceived effectiveness of environmental policy (Harring, 2014), while high quality of political institutions encourages collective actions to conserve the environment (Duit, 2011). In this context, living in a country characterized by low levels of corruption is an implicit determinant of individual support for climate intervention. Adaptation and mitigation policies on climate change generally require huge financial outlay and the coordination of public-private partnerships (IPCC, 2014). In fact, these policies work only when corruption is low and political institutions show a high level of democratic or procedural fairness (Davenport et al., 2007).

Moreover, as shown by Tjernström and Tietenberg (2008) and Drews et al. (2018), institutions and structural conditions play an important role in translating climate change concern into policy, given that '*in democratic countries, the legitimacy of political decisions depends on the extent they reflect public opinion*' (Drews et al., 2018, p. 265). This implies that, in democracies, it can be difficult to implement policies which conflict with the public wishes. So in the trade-off between economic growth and environmental degradation, if economic growth takes priority over the environment in public opinion, growth-enhancing policies will be promoted at the expense of environmental protection. On the other hand, if

the environment is the priority in public opinion, the policymaker will promote environmental rather than growth-enhancing policies.[18]

Nowadays, fostering economic development and environmental preservation jointly is possible thanking to *sustainable development*, which has become mandatory in many countries worldwide. In the European Union, sustainable development is achieved through coordinating policies of the economic, environmental and social pillars, which are required to work together and support each other. In particular, economic development policies take account of high environmental standards. A similar trend is observed by the New Climate Economy initiative, which emphasizes the importance of 'green growth'. The study finds that '*there is a deepening understanding that climate action is not only necessary, but it can also be good for development and growth*' (New Climate Economy, 2015). This is confirmed by the 2020 Peoples' Climate Vote, the largest survey of public opinion regarding climate change ever conducted. It shows that respondents in Western Europe and North America strongly support environmentally-friendly economic policies, such as investment in green businesses and jobs and fines for companies responsible for pollution (61 and 58 per cent, respectively). Respondents especially in Canada, Australia, the United Kingdom and France (56, 55, 54, 53 per cent, respectively) also say that in order to make climate-friendly consumption choices they need to be better informed on how products are made.

Interestingly, the effectiveness of climate policies in a country is also influenced by the analogous measures applied in other countries (Andor et al., 2018). Therefore, even if the relationship between climate change awareness and individual environmentally-friendly efforts appears to be stable in developed economies (Dienes, 2015), official national government responses to climate issues depend on political values, financial constraints and psychological co-benefits, which have been very different worldwide in the last thirty years. Negative effects of climate change are also perceived to be less dangerous in countries which are better prepared for climate change, and can thus lower the sense of danger associated to this problem and the cautiousness in the face of climate uncertainties (Lo and Chow, 2015).

This implies that a global alliance is necessary to fight climate change (Andor et al., 2018).[19] And there are many initiatives in this direction: in fact, according to the Climate

[18] For example, in Spain, in a survey presented by Drews and van den Bergh (2016), percentages of 15 and 21 per cent of respondents respectively state they are in favour of supporting environmental sustainability and ignoring growth.
[19] The Paris Climate Conference in December 2015, the first-ever legally binding global climate agreement, goes in this direction. It was signed by 196 countries with the goal of limiting global warming to under 2 degrees Celsius, compared to pre-industrial levels (UNFCCC, 2015).

Policy Database,[20] about 5,204 national mitigation-related policies have been applied by 196 countries around the world. With regard to climate strategy and greenhouse gases reduction target interventions, Figure 4 maps their geographic distribution worldwide.

Figure 4 about here

In particular, Figure 4 shows that only the European Union countries apply two types of interventions, i.e. political and non-binding climate strategy and greenhouse gases reduction target interventions and formal and legally binding climate strategy and greenhouse gases reduction target policies (blue). The remaining countries at best are only implementing political and non-binding climate strategy and greenhouse gases reduction target interventions (in light blue). Understanding the cross-country differences in terms of climate change concern is a key element for efficiently realizing coordinated environmental programs. The somewhat ambitious aim of tailored climate communication strategies for individual nations would be the tool to reach this goal (Sandivik, 2008; Lee et al., 2015). Unfortunately, as documented by the Climate Policy Database, only Argentina, France, Germany, Korea, Japan, Sweden, Turkey, the United Kingdom and the USA have put in place information or education policies on the climate and energy since the late 1990s.

Conclusions

Nowadays, climate change is a priority for policymakers worldwide. In this context, assessing which factors influence individual perceptions, which actions should be taken and the willingness to pay for mitigating the effects of climate change is key for better understanding the nature of individual support for governmental environmental and climate policies. The success of such policies in turn depends to a great extent on public opinion.

This study first described the evolution of climate change awareness during the last thirty years. It identified three distinct phases: the growing worldwide awareness of climate change during the 1980s and 1990s, a subsequent phase of scepticism during the 2000s and the increasing importance of opinion leaders on environmentally-friendly behaviours in more recent years.

The study then reviewed the data sources most widely used in the empirical literature. It focused on the different variables used to proxy climate change awareness, taking account of studies using both individual and aggregate data. With regard to empirical papers

[20] The Climate Policy Database is a comprehensive policy package to mitigate the effects of climate change developed by the New Climate Institute together with PBL Netherlands Environmental Assessment Agency and Wageningen University and Research. See https://climatepolicydatabase.org/.

investigating individual perceptions, the most popular question wordings capturing the emotional, cognitive and conative components of mind were analyzed. It is important to note that question wording is a thorny topic (Whitmarsh, 2009; Schuldt et al., 2015; Drews et al., 2018), as biases due to the response process can clearly affect survey data results (Bertrand and Mullainathan, 2001; McFadden et al., 2005).

Third, this study provided an overview of the most widely investigated determinants of climate change awareness, and reviewed variables often included in the model specifications in the literature. Individual characteristics like age, gender, education, political values, experience with extreme weather conditions and trust appear to be crucial for understanding climate change, as does the stage of development of the country where people live. With regard to political values, specific attention was given to the USA, given the existence of a huge body of papers on this topic.

Finally, the study concluded with some policy implications detached from the most significant results in terms of the determinants affecting individual preferences. This latter step is crucial since public policies and individual attitudes are intrinsically connected. In fact, on one hand, policymaker decisions affect human behaviour toward the environment, while on the other hand, individual awareness of climate change is both a sufficient condition for supporting costly adaptation activities and a necessary condition for implementing mitigation policies.

References

Alberini, A., Bigano, A., Ščasnýd, M., Zvěřinovád, I., (2018). Preferences for energy efficiency vs. renewables: What is the willingness to pay to reduce CO2 emissions? Ecological Economics, 144, 171–185.

Andor, M., Schmidt C., M., Sommer, S., (2018). Climate change, population ageing and public spending: Evidence on individual preferences. Ecological Economics, 151, 173–183.

Baiardi, D., Morana, C., (2021). Climate change awareness: Empirical evidence for the European Union. Energy Economics, 96, 105163.

Basannagari, B., Kala, C., P., (2013). Climate change and apple farming in Indian Hymalayas: A study of local perceptions and responses. Plos ONE, 8(10), e77976.

Berk, R., Schulman, D., McKeever, M., Freeman, H., (1993). Measuring the impact of water conservation campaigns in California. Climatic Change, 24, 233–248.

Bergquist, P., Warshaw, C., (2019). Does global warming increase public concern about climate change? The Journal of Politics, 81, 686-691.

Bertrand, M., Mullainathan, S., (2001). Do people mean what they say? Implications for subjective survey data. American Economic Review, 91, 67-72.

Blomquist, G.C., Whitehead, J.C., (1998). Resource quality information and validity of willingness to pay in contingent valuation. Resource and Energy Economics, 20, 179–196.

Borick, C., Rabe, B., (2010). A reason to believe; Examining the factors that determine individual views on global warming. Social Science Quarterly, 91, 777–800.

Boykoff, M., T., Yulsman, T., (2013). Political economy, media, and climate change: Sinews of modern life. Wiley Interdisciplinary Reviews: Climate Change, 4, 359-371.

Brody, S.D., Zahran, S., Vedlitz, A., Grover, H., (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. Environment and Behavior, 41, 72-95.

Brulle, R.J., Carmichael, J., Jenkins, J.C., (2012). Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U.S., 2002–2010. Climatic Change, 114, 169–188.

Bu, M., Lin, C-L., Zhang, B., (2016). Globalization and climate change: new empirical panel data evidence. Journal of Economic Survey, 30, 577–595.

Carlsson, F., Johansson-Stenman, O., (2000). Willingness to pay for improved air quality in Sweden. Applied Economics, 32, 661–669.

Carraro, C., Lévêque, F., (2013). Voluntary Approaches in Environmental Policy. vol. 14 Springer Science & Business Media.

Central Intelligence Agency (1974). A Study of Climatological Research as it Pertains to Intelligence Problems, August 1974.

Chaisty, P., Whitefield, S., (2015). Attitudes towards the environment: are post-communist societies (still) different? Environmental Politics, 24, 598–616.

Clements, B., (2012a). Exploring public opinion on the issue of climate change in Britain. British Politics, 7, 183–202.

Clements, B., (2012b). The sociological and attitudinal bases of environmentally related beliefs and behaviour in Britain. Environmental Politics, 21, 901–921.

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., Pidgeon, N., (2011a). Nuclear power, climate change and energy security: exploring British public attitudes. Energy Policy, 39, 4823–4833.

Corner A., Whitmarsh L., Xenias D., (2011b). Uncertainty, scepticism and attitudes towards climate change: Biased assimilation and attitude polarisation. Climatic Change, 114, 463–478.

Costantini, V., Crespi, F., Palma, A., 2017. Characterizing the policy mix and its impact on eco-innovation: a patent analysis of energy-efficient technologies. Research Policy, 46, 799–819.

Dai J., Kesternich M., Löschel A., Ziegler A., (2015). Extreme weather experiences and climate change beliefs in China: An econometric analysis. Ecological Economics, 116, 310–321.

D'Amato, A., Giaccherini, M., Zoli, M., (2019). The role of information sources and providers in shaping green behaviours. Evidence from Europe. Ecological Economics, 164, 106-292.

Delhey, J., Newton, K., (2005). Predicting cross-national levels of social trust: global pattern or nordic exceptionalism? European Sociological Review, 21, 311–327.

De Silva, D.G., Pownall, R.A.J., (2014). Going green: does it depend on education, gender or income? Applied Economics, 46, 573–586.

Davenport, M.A., Leahy, J.E., Anderson, D.H., Jakes, P.J., (2007). Building trust in natural Resource management within local communities: a case study of the midewin national tallgrass prairie. Environmental Management, 39, 353–368.

Diekkman, A., Franzen, A., (1999). The wealth of nations and environmental concern. Environment and Behavior, 31, 540-549.

Dienes, C., (2015). Actions and intentions to pay for climate change mitigation: environmental concern and the role of economic factors. Ecological Economics, 109, 122–129.

Deryugina, T., (2013). How do people update?: the effects of local weather fluctuations on beliefs about global warming. Climatic Change, 118, 397–416.

Drews, S., van den Bergh, J.C.J.M., (2016). Public views on economic growth, the environment and prosperity: results of a questionnaire survey. Global Environmental Change, 39, 1–14.

Drews, S., Antal, M., van den Bergh, J.C.J.M., (2018). Challenges in Assessing Public Opinion on Economic Growth Versus Environment: Considering European and US Data. Ecological Economics, 146, 265–272.

Duit, A., (2011). Patterns of environmental collective action: some cross-national findings. Political Studies, 59, 900–920.

Dunlap, R.E., Scarce, R., (1991). Poll trends: environmental problems and protection. Public Opinion Quarterly, 55, 651-672.

Dunlap, R.E., (2014). Clarifying anti-reflexivity: Conservative opposition to impact science and scientific evidence. Environmental Research Letters, 9, 021001.

Dunlap, R.E., McCright, A.M., Yarosh, J.H., (2016). The Political Divide on Climate Change: Partisan Polarization Widens in the U.S. Environment, 58, 4-23.

EEA, (2016). Communication, Environment and Behaviour. Technical Report No 13/2016.

Egan, P.J., Mullin, M., (2012). Turning personal experience into political attitudes: the effect of local weather on Americans' perceptions about global warming. The Journal of Politics, 74, 796–809.

Ek, K., Soderholm, P., (2008). Norms and economic motivation in the Swedish green electricity market. Ecological Economics, 68, 169–182.

Eurobarometer, (2019). Climate change, special Eurobarometer 490.

Fischer, E. M., Sippel, S., Knutti, R., (2021). Increasing probability of record-shattering climate extremes. Nature Climate Change, 1-7.

Franzen, A., (2003). Environmental attitudes in international comparison: an analysis of the ISSP Surveys 1993 and 2000. Social Science Quarterly, 84, 297-308.

Franzen, A., Vogl, D., (2013). Two decades of measuring environmental attitudes: a comparative analysis of 33 countries. Global Environmental Change, 23, 1001-1008.

Frondel, M., Simora, M., Sommer, M., (2017). Risk perception of climate change: empirical evidence for Germany. Ecological Economics, 137, 173-183.

Gelpi, C., Feaver, P., Reifler, J., (2009). Paying the human costs of war: American public opinion and casualties in military conflicts. Princeton N.J.: Princeton University Press.

GESIS, (2012). ZA5564: Eurobarometer 75.4 (2011). Available at (24/09/2012). http:// info1.gesis.org/dbksearch19/Docs.asp?no=5564.

Gilg, A., Barr, S., (2006). Behavioural attitudes towards water saving? Evidence froma study of environmental actions. Ecological Economics, 57, 400-414.

Grafton, R.Q., (2014). Household behaviour and water use. Organisation for Economic Co-operation and Development, pp. 149-181.

Goebbert, K., Jenkins-Smith, H.C., Klockow, K., Nowlin, M.C., Silva, C.L., (2012). Weather, climate, and worldviews: the sources and consequences of public perceptions of changes in local weather patterns. Weather Climate and Society, 4, 132-144.

Grothmann, T., Reusswig, F., (2006). People at risk of flooding: why some residents take precautionary action while others do not. Natural Hazards, 38, 101-120.

Guber, D.L., (2013). A cooling climate for change? Party polarization and the politics of global warming. American Behavioral Scientist, 57, 93–115.

Guber, D.L., Bohr, J., Dunlap, R.E. (2020). 'TIME TO WAKE UP': Climate change advocacy in a polarized Congress, 1996-2015. Environmental Politics, 1-21.

Hamilton, L.C., (2008). Who cares about polar regions? Results from a survey of U.S. public opinion. Arctic, Antarctic, and Alpine Research, 40, 671-678.

Hamilton, L.C., Keim, B.D., (2009). Regional variation in perceptions about global climate change. International Journal of Climatology, 29, 2348-2352.

Hamilton, L.C., Lemcke-Stampone, M., (2014). Arctic warming and your weather: public belief in a connection. International Journal of Climatology, 34, 1723-1728.

Hamilton, L., Saito, K., (2015). A four-party view of US environmental concern. Environmental Politics, 24, 212–227.

Hamiltion, L., Hartter, J., Lemcke-Stampone, M., Moore, D.W., Safford, T.G., (2015). Tracking public beliefs about anthropogenic climate change. PLOS One, Online Open Access, 10, e0138208.

Harring, N., (2014). Corruption, inequalities and the perceived effectiveness of economic pro-environmental policy instruments: a European cross-national study. Environmental Science & Policy, 39, 119-128.

Hidano, N., Kato, T., Aritomi, M., (2005). Benefits of participating in contingent valuation mail surveys and their effects on respondent behaviour: a panel analysis. Ecological Economics, 52, 63-80.

Howe, P.D., Markowitz, E.M., Lee, T.M., Ko, C-Y, Leiserowitz, A., (2013). Global perceptions of local temperature change. Nature Climate Change, 3, 352-356.

Howe, P.D, Mildenberger, M., Marlon, J.R., Leiserowitz, A., (2015). Geographic variation in opinions on climate change at state and local scales in the USA. Nature Climate Change, 5, 596-603.

Hunter, L.M., Hatch, A., (2004). Cross-national gender variation in environmental behaviors. Social Science Quarterly, 85, 677-694.

Israel, D., Levinson, A., (2004). Willingness to pay for environmental quality: testable empirical implications of the growth and environmental literature. Contributions to Economic Analysis and Policy 3 (1) (art.2).

IPCC, (2007). Fourth Assessment Report: Climate Change 2007: Synthesis Report, IPCC.

IPCC, (2013). Climate change 2013: the physical science basis contribution of working group I to fifth assessment report of the intergovernmental panel on climate change. Chapter summary for policymakers. Cambridge University Press.

IPCC, (2014). In: Core Writing Team, Pachauri, R.K., Meyer, L.A. (Eds.), Climate Change 2014. Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Jagers, S.C., (2009). In search of the ecological citizen. Environmental Politics, 18, 18-36.

Kahan, D.M., Jenkins-Smith, H., Braman, D., (2011). Cultural cognition of scientific consensus. Journal of Risk Research, 14, 147-174.

Kahan, D.M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L.L., Braman, D., Mandel, G., (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. Nature Climate Change, 2, 732-735.

Kaplowitz, M.D., Lupi, F., Yeboah, F.K., Thorp, L.G., (2013). Exploring the middle ground between environmental protection and economic growth. Public Understanding of Science, 22, 413-426.

Kartha, S., Kemp-Benedict, E., Ghosh, E., Nazareth, A., Gore, T., (2020). The Carbon Inequality Era: An assessment of the global distribution of consumption emissions among individuals from 1990 to 2015 and beyond. Joint Research Report. Stockholm Environment Institute and Oxfam International.

Kaufmann, R.K., Mann, M.L., Gopal, S., Liederman, J.A., Howe, P.D., Pretis, F., Tang, X., Gilmore, M., (2017). Spatial heterogeneity of climate change as an experiential basis for skepticism. PNAS, 114, 67.

Keller, C., Siegrist, M., Gutscher, H., (2006). The role of the affect and availability heuristics in risk communication. Risk Analysis, 26, 631-639.

Kim, S.Y., Wolinsky-Nahmias, Y., (2014) Cross-national public opinion on climate change: the effects of affluence and vulnerability. Global Environmental Politics, 14, 79-106.

Klineberg, S.L., McKeever, M., Rothenbach, B., (1998). Demographic predictors of environmental concern: it does make a difference how it's measured. Social Science Quarterly, 79, 734-753.

Kollock, P. (1998). Social dilemmas: The anatomy of cooperation. Annual Review of Sociology, 24, 183-214.

Konisky, D.M., Hughes, L., Kaylor, C.H., (2016). Extreme weather events and climate change concern. Climate Change, 134, 533-547.

Kriström, B., Kiran, C., (2014). Greening household behaviour and energy. Organisation for Economic Co-operation and Development.

Kunda, Z., (1990). The case for motivated reasoning. Psychological Bulletin, 108,480-498.

Kvaløy, B., Finseraas, H., Listhaug, O., (2012). The publics' concern for global warming: a cross-national study of 47 countries. Journal of Peace Research, 49, 11–22.

Lachapelle, E., Borick, C.P., Rabe, B., (2012). Public attitudes toward climate science and climate policy in federal systems: Canada and the United States compared. Review of Policy Research, 29, 334-357.

Lægreid, O.M., Povitkina, M., (2018). Do political institutions moderate the GDP-CO2 relationship? Ecological Economics, 145, 441-450.

Lange, A., Schwirplies, C., Ziegler, A., (2017). On the interrelation between the consumption of impure public goods and the provision of direct donations: theory and empirical evidence. Resource and Energy Economics, 47, 72-88.

Lee, T. M., Markowitz, E. M., Howe, P.D., Ko, C.Y., Leiserowitz, A.A., (2015). Predictors of public climate change awareness and risk perception around the world. Nature Climate Change, 5, 1014-1020.

Leisenrowitz A., (2005). American Risk Perceptions: Is Climate Change Dangerous? Risk Analysis, Vol. 25, No. 6, 2005.

Leiserowitz, A., (2006). Climate change risk perception and policy preferences: the role of affect, imagery, and values analysis. Climatic Change, 77, 45–72.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Smith, N., (2010). Climate Change in the American Mind: American's Global Warming Beliefs and Attitudes in June 2010. Yale University and George Mason University, Yale Project on Climate Change Communication, New Haven CT.

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Hmielowski, J.D., (2012). Climate change in the American Mind: Public support for climate & energy policies in March 2012. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. http://environment.yale.edu/climate/files/Policy-Support-March-2012.pdf

Leisenrowitz A., Maibach, E., Roser-Renouf, C., Cutler, M., Rosenthal, S., (2017). Trump Voters & Global Warming. Yale Program on climate Change Communication, Yale University and George Mason University.

Li, Y., Johnson, E.J., Zaval, L., (2011). Local warming: daily temperature change influences belief in global warming. Psychological Science, 22, 454-459.

Libarkin J.C., Gold A.U., Harris S.E., McNeal K.S., Bowles, R.P., (2018). A new, valid measure of climate change understanding: associations with risk perception. Climatic Change, 150, 403-416.

Longo, A., Markandya, A., Petrucci, M., (2008). The internalization of externalities in the production of electricity: willingness to pay for the attributes of a policy for renewable energy. Ecological Economics, 67, 140-157.

Lorenzoni, I., Pidgeon, N.F., (2006). Public views on climate change: European and USA perspectives. Climatic Change, 77, 73-95.

Malka, A., Krosnick, J.A., Langer, G., (2009). The association of knowledge with concern about global warming: trusted information sources shape public thinking. Risk Analysis, 29, 633–647.

McCright, A.M., (2010). The effects of gender on climate change knowledge and concern in the American public. Population and Environment, 32, 66-87.

McCright, A., M., Dunlap, R., E., (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. The Sociological Quarterly, 52, 155-194.

McCright, A.M., Dunlap, R.E., (2011). Cool dudes: the denial of climate change among conservative white males in the United States. Global Environmental Change, 21, 1163-1172.

McCright, A.M., Dunlap, R.E., Marquart-Pyatt, S. (2015). Political ideology and views about climate change in the European Union, Environmental Politics, 1-21.

McFadden, D., Bemmor, A.C., Caro, F.G., Dominitz, J., Jun, B.H., Lewbel, A., Matzkin, R.L., Molinari, F., Schwarz, N., Willis, R.J., Winter, J.K., (2005). Statistical analysis of choice experiments and surveys. Marketing Letters, 16, 183–196.

Meyer, A., (2015). Does education increase pro-environmental behaviour? Evidence from Europe. Ecological Economics, 116, 108-121.

Meyer, R., Liebe, U., (2010). Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in Switzerland. Population and Environment, 32, 42-65.

Mohai, P., (1997). Gender differences in the perception of most important environmental roblems. Race, Gender & Class, 5, 153-169.

New Climate Economy, (2015). Positive social media discussion on climate action and economic growth up by 700% in last 3 years, analysis finds. URL: http://newclimateeconomy.net/content/positive-social-media-discussion-climate-actionand-economic-growth-700-last-3-years.

Nisbet, M.C., Myers, T., (2007). The polls – Trends twenty years of public opinion about global warming. Public Opinion Quarterly, 71, 444-470.

O'Connor, R.E., Bord, R.J., Fisher, A., (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Analysis, 19, 461-471.

Osberghaus, D., (2015). The determinants of private flood mitigation measures in Germany-evidence from a nationwide survey. Ecological Economics, 110, 36-50.

Poortinga, W., Spence, A., Whitmarsh, L., Capstick, S., Pidgeon, N.F., (2011). Uncertain climate: an investigation into public scepticism about anthropogenic climate change. Global Environmental Change, 21, 1015–1024.

Reschovsky, J.D., Stone, S.E., (1994). Market incentives to encourage household waste recycling: paying for what you throw away. Journal of Policy Analysis and Management, 13, 120–139.

Ripberger, J.T., Jenkins-Smith, H.C., Silva, C.L., Carlson, N., Gupta, K., Carlson, D.E., Dunlap, R.E., (2017). Bayesian versus politically motivated reasoning in human perception of climate anomalies. Environmental Research Letters, 12, 114004.

Rothstein, B., (2014). Social Traps and the Problem of Trust. Cambridge University Press, Cambridge, UK.

Rowlands, I.H., Scott, D., Parker, P., (2003). Consumers and green electricity: profiling potential purchasers. Business Strategy and the Environment, 12, 36-48.

Sandvik, H., (2008). Public concern over global warming correlates negatively with national wealth. Climate Change, 90, 333-341.

Schuldt, J.P., Roh, S., Schwarz, N., (2015). Questionnaire design effects in climate change surveys implications for the partisan divide. The Annals of the American Academy of Political and Social Science, 658, 67–85.

Schwirplies, C., (2018). Citizens' Acceptance of Climate Change Adaptation and Mitigation: A Survey in China, Germany, and the U.S. Ecological Economics, 145, 308–322.

Shao, W., Keim, B.D., Garand, J.C., Hamilton, L.C., (2014). Weather, climate, and the economy: explaining risk perceptions of global warming, 2001-2010. Weather, Climate, and Society, 6, 119–134.

Siegrist, M., Gutscher, H., (2006). Flooding risks: a comparison of lay people’s perceptions and expert’s assessments in Switzerland. Risk Analysis, 26, 971–979.

Smith, V.K., (1995). Does education induce people to improve the environment? Journal of Policy Analysis and Management, 14, 599.

Spence, A., Poortinga, W., Butler, C., Pidgeon, N.F., (2011). Perceptions of climate change and willingness to save energy related to flood experience. Nature Climate Change, 1, 46–49.

Stimson, J.A., (1999). Public opinion in America; Moods, cycles and swings. 2nd ed. Boulder Co; Westview Press.

Sullivan, J.L., Transue, J.E., (1999). The psychological underpinnings of democracy: a selective review of research on political tolerance, interpersonal trust, and social capital. Annual Review of Psychology, 50, 625-650.

Tallon, A., (1997). Head and heart: Affection, cognition, volition as triune consciousness. Fordham University, New York.

Thaler, R.H., Benartzi, S., (2004). Save more tomorrow: using behavioral economics to increase employee saving. Journal of Political Economy 112 (S1, Papers in Honor of Sherwin Rosen: A Supplement to Volume 112), S164–S187.

Tobler, C., Visschers, V., Siegrist, M., (2012). Addressing climate change: determinants of consumers' willingness to act and to support policy measures. Journal of Environmental Psychology 32, 197–207.

Torgler, B., García-Valiñas, M.A., (2007). The determinants of individuals' attitudes toward preventing environmental damage. Ecol. Econ. 63 (2–3), 536–552.

Tranter, B., (2011). Political divisions over climate change and environmental issues in Australia. Environmental Politics, 20, 78–96.

Tranter, B., (2013). The great divide: political candidate and voter polarisation over global warming in Australia. Australian Journal of Politics and History, 59, 397–413.

Tranter, B., Booth, K., (2015). Scepticism in a changing climate: a cross-national study. Global Environmental Change, 33, 154–164.

Tjernström, E., Tietenberg, T., (2008). Do differences in attitudes explain differences in national climate change policies? Ecological Economics, 65, 315–324.

UNFCCC, (2015). Paris agreement. U. Nations Framew. Conv. Clim. Change, (FCCC/CP/ 2015/L.9/Rev.1).

Upham, P., Whitmarsh, L., Poortinga, W., Purdam, K., Darnton, A., McLachlan, C., Devine-Wright, P., (2009). Public attitudes to environmental change: a selective review of theory and practice. A Research Synthesis for the Living with Environmental Change Programme. Research Councils UK.

Van Liere, K., Dunlap, R., (1980). A review of studies that measured environmental attitudes and behaviors. Environment and Behavior, 11, 22–38.

Veisten, K., Hoen, H.F., Navrud, S., Strand, J., (2004). Scope insensitivity in contingent valuation of complex environmental amenities. Journal of Environmental Management, 73, 317–331.

Wang, K.M., (2012), Modeling the nonlinear relationship between CO2 emissions from oil and economic growth, Economic Modelling, 29, 1537–1547.

Whitmarsh, L., (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. Journal of Risk Research, 11, 351–374.

Whitmarsh, L., (2009). What's in a name? Commonalities and differences in public understanding of “climate change” and “global warming.”. Public Understanding of Science, 18, 401–420.

Whitmarsh, L., (2011). Scepticism and uncertainty about climate change: Dimensions, determinants and change over time. Global Environmental Change, 21, 690–700.

Whitmarsh, L., Capstick, S., (2018). Perceptions of climate change. Psychology and Climate Change, pp. 13-33. Elsevier Masson.

Wicker, P., Becken, S., (2013). Conscientious vs. ambivalent consumers: Do concerns about energy availability and climate change influence consumer behaviour? Ecological Economics, 88, 41–48.

Whitehead, J.C., (1991). Environmental interest group behaviour and self-selection bias in contingent valuation mail surveys. Growth and Change, 22, 10–21.

Witzke, H.P., Urfei, G., (2001). Willingness to pay for environmental protection in Germany: coping with the regional dimension. Regional Studies, 35, 207–214.

Wood, B.D., Vedlitz, A., (2007). Issue definition, information processing, and the politics of global warming. American Journal of Political Science, 51, 552–568.

Xiao, C., Dunlap, R.E., Hong, D., (2013). The nature and bases of environmental concern among Chinese citizens. Social Science Quarterly, 94, 672-690.

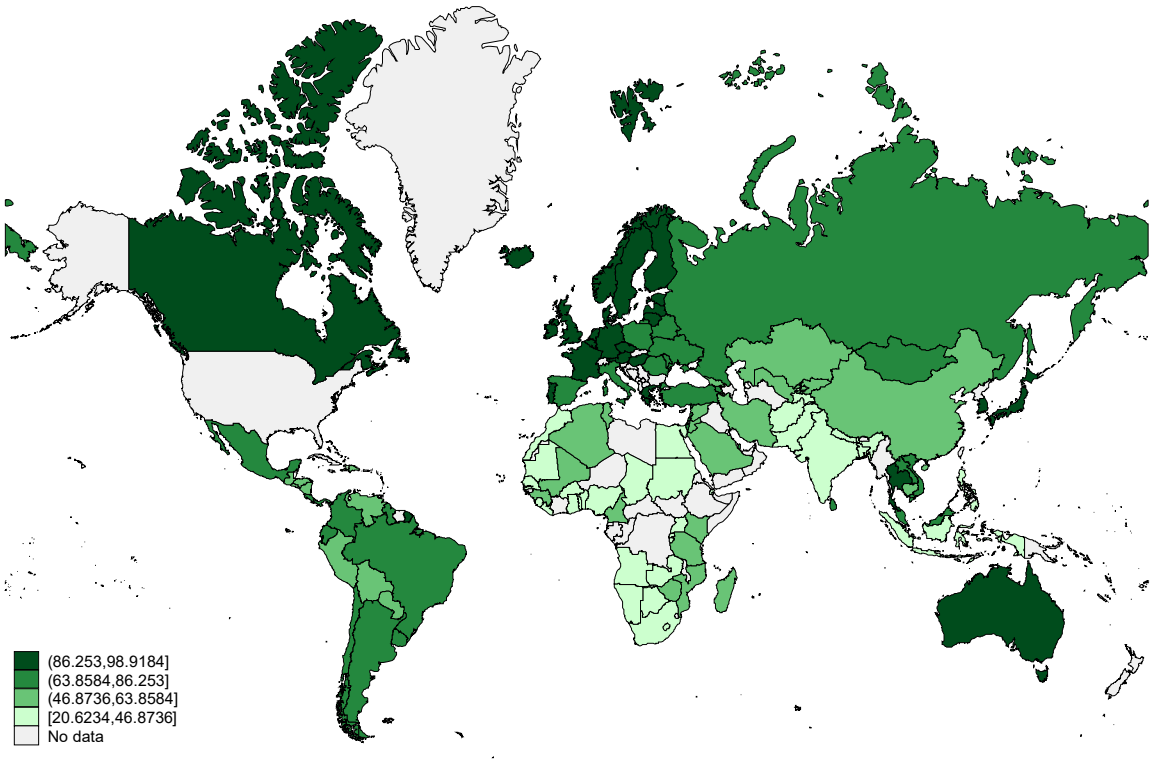
Zaalberg, R., Midden, C., Meijnders, A., McCalley, T., (2009). Prevention, adaptation, and threat denial: flooding experiences in The Netherlands. Risk Analysis, 29, 1759–1778.

Zaval, L., Keenan, E.A., Johnson, E.J., Weber, E.U., (2014). How warm days increase belief in global warming. Nature Climate Change, 4, 143.

Zelezny, L.C., Chua, P.-P., Aldrich, C., (2000). Elaborating on gender differences in environmentalism. Journal of Social Issues, 56, 443–457.

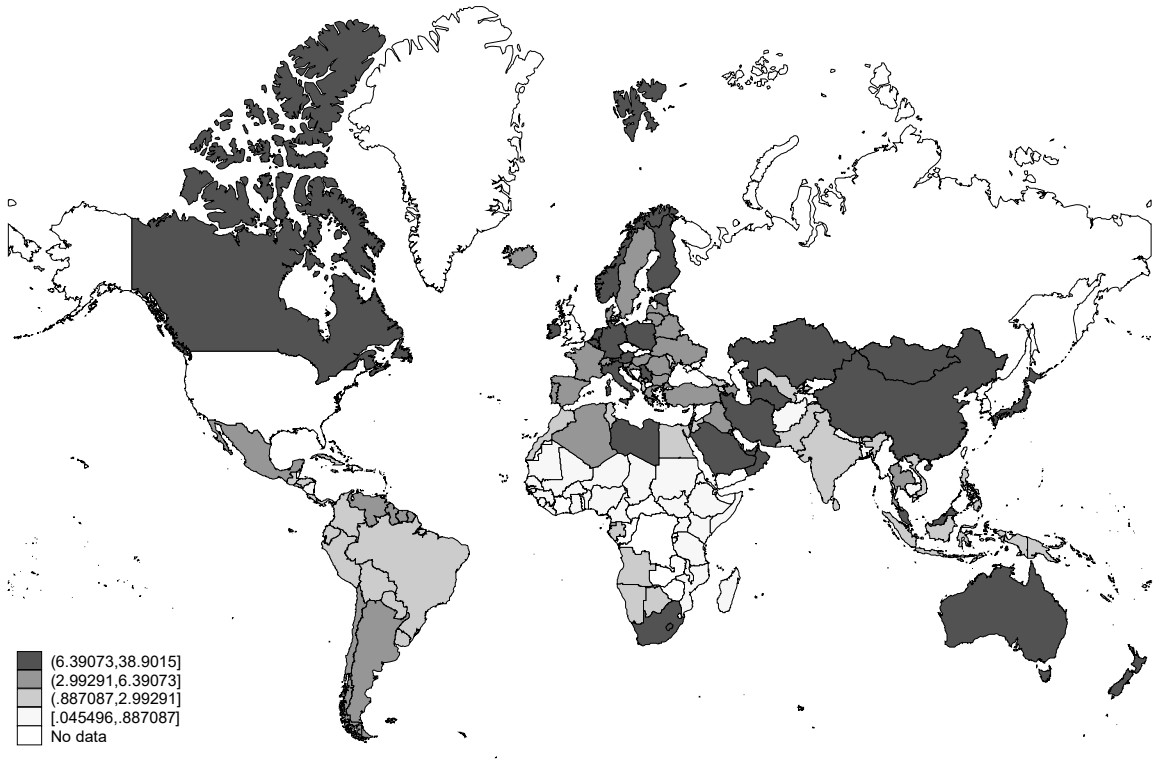
Figures

Figure 1 – Geographic distribution of climate change awareness



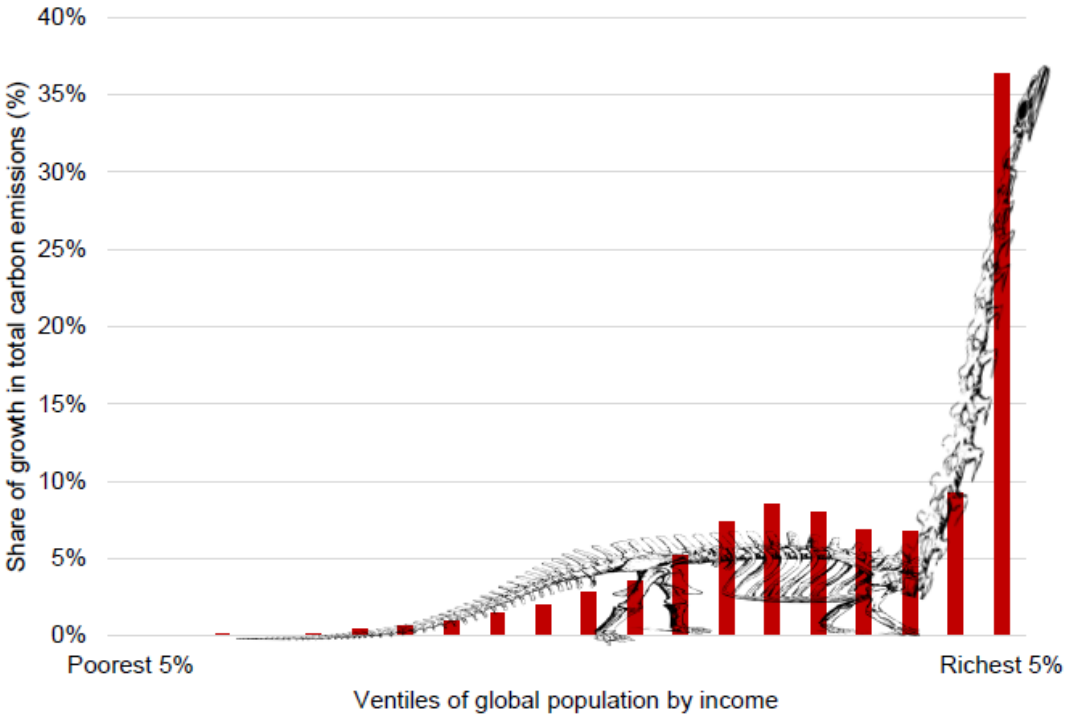
Notes: Author's elaboration on Lee et al. (2015) data retrieved from the Gallup World Poll. Specifically, citizens in 119 countries in 2007-2008 have been asked to answer to the following questions: '*How much do you know about global warming or climate change?*' and *'How serious of a threat is global warming to you and your family?*'

Figure 2 – Geographic distribution of per capita carbon dioxide emissions



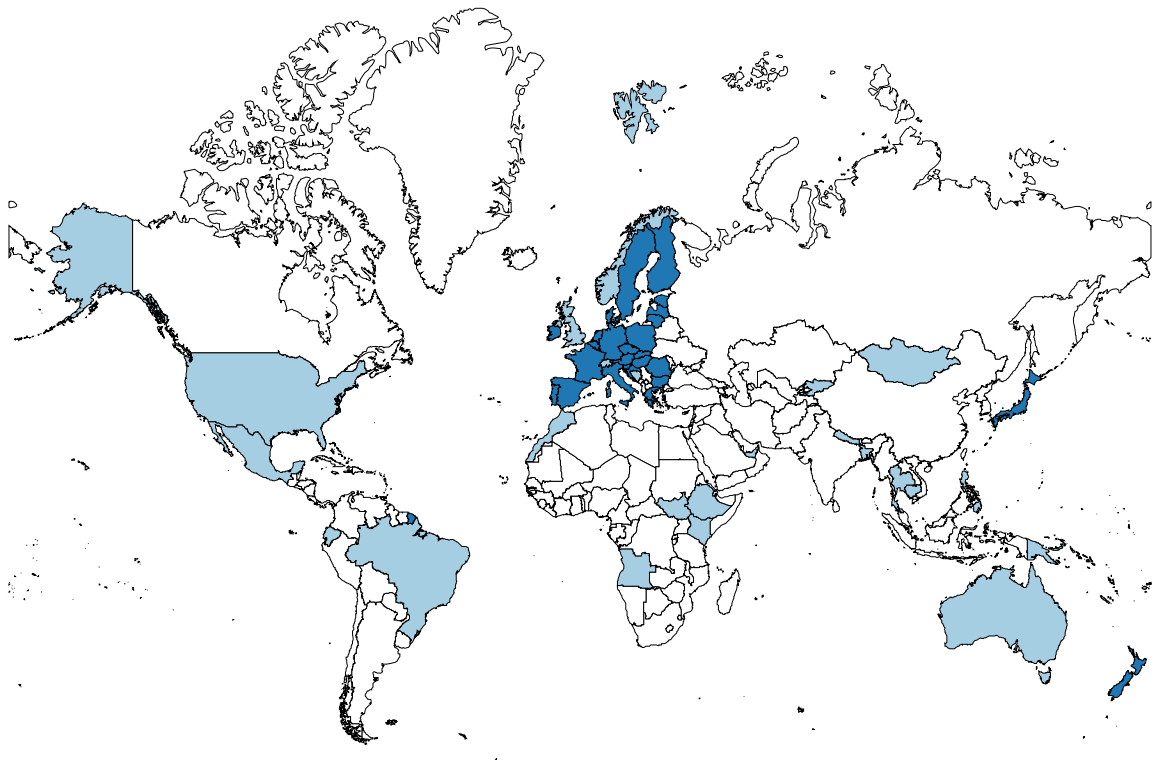
Notes: Author's elaboration on World Bank data. Reference year: 2016

Figure 3 – The carbon inequality 'dinosaur' of emissions growth in the years 1990-2015



Notes: The plot has been retrieved from Kartha et al. (2020, p. 7). The line shows each ventile's increase in per capita emissions (as a percentage of its 1990 per capita emissions), while the bars show each ventile's increase in total emissions (as a percentage of total global emissions increase).

Figure 4 – Geographic distribution of climate strategy and greenhouse gases reduction target policies



Notes: Author's elaborations on data retrieved from Climate Policy Database. Specifically, the following two types of policies have been mapped: political and non-binding climate strategy and greenhouse gases reduction target interventions (light blue) together with formal and legally binding climate strategy and greenhouse gases reduction target policies (blue).

Tables

Table 1: The main dimensions of climate change awareness investigated in the most popular databases

Topic	**Reference**
i) The seriousness of climate change, its threats and perceived danger, and severity compared to other global problems	Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change Gallup World Poll
ii) Prioritization of economic growth versus environmental protection	Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change Gallup World Poll ISSP The World Value Survey
iii) The responsibility of international and national governments and business and industry in fighting climate change	Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change Gallup World Poll ISSP The World Value Survey PEW Institute
iv) Personal actions taken in order to mitigate climate change or, more generally, improve the environment	Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change ISSP
v) The willingness to pay (including in terms of higher taxes) for fighting climate change	ISSP Life in Transition Study

Table 2 – Socio-economic determinants of climate change awareness reviewed in Subsection 4.1, by country

Country	Data sources	Socio-economic determinant	Methodology	Author(s)
119 countries	Gallup World Poll	Education, Income	Recursive partitioning methods and non-metric multidimensional scaling	Lee et al (2015)
35 countries	Life in Transition II study (LITS II, 2010)	Education	Multilevel binary logistic regressions	Smith and Mayer (2018)
33 countries	World Value Survey	Income	International contingent valuation study	Israel and Levinson (2004)
33 countries	ISSP (2010 Edition)	Gender, Age, Education, GDP	OLS regressions	Franzen and Vogl (2013)
27 European Member States	Eurobarometer #75.4 (2011 Edition)	Gender, Age, Education	Logistic regression analyses	Wickern and Beckern (2013)
27 European Member States	Eurobarometer #68.2 and #75.2 (2008 and 2011 Editions)	Gender, Age, Education	OLS and 2SLS regressions	Meyer (2015)
27 European Member States	Eurobarometer #295, #365 and #416 (2008, 2011 and 2014 Editions)	Education	Multivariate linear regression model	D'Amato et al. (2019)
27 European Member States	Eurobarometer #322, #372 (2011), #409, #435, #459 and #490 (2009, 2011, 2013, 2015, 2017 and 2019 Editions) and different databases	Education	OLS regressions	Baiardi and Morana (2021)
26 countries	ISSP (2010 Edition)	Wealth	Descriptive statistics	Franzen (2003)
20 countries	ISSP (2010 Edition)	Gender	OLS regressions	Hunter and Hatch (2014)
Canada	Ad-hoc survey	Gender, Age, Education	Spearman's correlation analysis	Rowlands et al. (2004)
China	Chinese General Social Survey	Gender, Age, Education, Income	Structural equation model	Xiao et al. (2013)
China	Ad-hoc survey	Gender, Age, Education	Probit regression analyses	Dai et al. (2015)
China, Germany, and the USA	Ad-hoc survey	Education, Income	Bivariate ordered probit models and multinomial logit models	Schwirplies (2018)
Germany	forsa	Gender, Age	OLS Multivariate Regression Model	Andor et al. (2018)
Japan	Ad-hoc survey	Income, Information sources of global warming	Logistic regression models	Hidano et al. (2005)
Neitherlands	Ad-hoc survey	Education	OLS and quantile regressions	De Silva and Pownall (2014)
Norway	Ad-hoc survey	Income	Contingent valuation study	Veistein et al. (2004)
Spain	World Values Survey and European Values Survey	Education, Income	Order probit regression	Torgler and García-Valiñas (2007)

Sweden	Ad-hoc survey	Gender, Age, Education	Random effects binary probit model	Ek and Söderholm (2008)
Switzerland	Ad-hoc survey	Gender, Education	Principal component analysis and multivariate regression model	Tobler et al. (2012)
United Kingdom (Davon)	Ad-hoc survey	Education	Descriptive statistics	Gilg and Barr (2006)
USA (California)	Telephone survey of households in the Los Angeles area by UCLA's Center for the Study of the Environment and Society	Education	Descriptive statistics	Berk et al. (1993)
USA (Michingan)	University of Michigan's 1990 Detroit Area Study	Gender	Descriptive statistics	Mohai (1997)
USA (Texas)	Texas Environmental Survey	Gender, Race, Education	Logistic regression models	Klineberg et al. (1998)
USA	Email survey	Gender, Race, Education	Multivariate regression models	O'Connor et al. (1999)
USA	Ad-hoc survey	Gender, Race	Descriptive statistics and OLS regressions	Leiserowitz (2006)
USA	Ad-hoc surveys	Gender, Political ideology	Ordered logistic model	Malka et al. (2009)
USA	Ad-hoc survey	Gender, Race	Descriptive statistics	Wood and Vedlitz (2007)
USA	Ad-hoc survey	Gender, Race	Descriptive statistics	Brody et al. (2008)
USA	Ad-hoc survey	Gender	Descriptive statistics	Hamilton (2008)
USA	Community and Environment in Rural America	Gender, Education	OLS regressions	Hamilton and Kleim (2009)
USA	Gallup World Poll	Gender, Age, Race	Logistic regression models	McCright and Dunlap (2011)
USA	Gallup World Poll	Gender, Race, Education, Political ideology, Income	OLS regressions	McCright (2010)
USA	Ad-hoc survey	Gender, Age, Education	Probit estimates	Reschovsky and Stone (1994)
USA	1993 General Social Survey	Education	Probit estimates	Smith (1998)
USA	Ad-hoc survey	Education	Multinomial logistic regression analyses	Kahan et al. (2011)
USA	Ad-hoc survey	Education, Cultural values, Information	OLS regressions	Kahan et al. (2012)

Table 3 – Political values reviewed in Subsection 4.2, by country

Country	Data sources	Political values	Methodology	Author(s)
119 countries	Gallup World Poll	Political ideology	Recursive partitioning methods and Non-metric multidimensional scaling	Lee et al (2015)
47 countries	World Values Survey	Political interest	Linear regressions analysis	Kvaløy et al. (2012)
35 countries	Life in Transition Study (2010 Edition)	External political factors (2008 economic and financial crises)	Probit estimations	Dienes (2015)
33 countries	ISSP 2010	Party affiliation	OLS Multivariate Regression Model	Franzen and Vogl (2013)
26 countries	International Social Survey (2000 Edition)	Liberal political views	Descriptive Statistics and Probit regressions	Tjernström and Tietenberg (2008)
25 European countries	Eurobarometer #69.2 survey (2008)	Political ideology	OLS regressions	McCright et al. (2015)
14 countries	International Social Survey Programme (2010 Edition)	Political affiliation	Ordered logit models	Tranter and Booth (2015)
Australia	Australian Survey of Social Attitudes	Political ideology	Ordered logistic model	Tranter (2011)
Australia	Australian Electiom Study	Political ideology	Multivariate analyses	Tranter (2013)
Canada and USA	Different databases	Political affiliation	Descriptive statistics	Lachapelle et al. (2012)
China	Ad-hoc survey	-	Descriptive statistics and maximum likelihood estimates in binary probit models,	Dai et al. (2015)
Germany	Ad-hoc survey	Income distribution	Ordered probit model	Witzke and Urfei (2001)
Great Britain	Ad-hoc survey	Party affiliation	Logistic and linear regressions	Poortinga et al. (2011)
Great Britain	Ad-hoc postal survey	Political affiliation	Linear regressions analysis	Whitmarsh (2011)
Great Britain	Eurobarometer #71.1 (2009); Department for Environment, Food and Rural Affairs (DEFRA) Survey 2009; British Social Attitudes Survey 2009	Political affiliation and discussion	Linear regressions analysis	Clements (2012a)
Great Britain	British Household Panel Survey 2008-2009	Political affiliation	Linear regressions analysis	Clements (2012b)
Post-Communist European countries	ISSP (1993, 2000, and 2010 Editions)	Political parties	OLS regressions	Chaisty and Whitefield (2015)
Spain	World Values Survey and European Values Survey	Environmental organizations, Political ideology	Order probit regression	Torgler and García-Valiñas (2007)

Sweden	Ad-hoc survey	Environmental organizations	Contingent Valuation Method	Carsson and Johansson-Stenman (2000)
United Kingdom	Ad-hoc survey	Voting preference	Descriptive statistics and linear regressions	Corner et al. (2011)
USA	Mail survey	Environmental Interest Group Behaviour	Contingent Valuation Method	Whitehead (1991)
USA	Email survey by the University of Kentucky Survey Research Center	Environmental organization	Logistic regression models	Blomquist and Whitehead (1998)
USA	Different databases	External political factors (Military conflicts)	Multivariate analyses	Gelpi et al. (2009)
USA	Ad-hoc surveys	Party affiliation, Trust in scientists	Ordered logistic model	Malka et al. (2009)
USA	Ad-hoc survey	Party affiliation	Descriptive statistics and ordered logistical model	Borick and Rabe (2010)
USA	Gallup World Poll	Political ideology	Multivariate logistic regression model	McCright and Dunlap (2011)
USA	Different databases	Elite Cues, Scientific information, Media advocacy, External political factors (business cycles, oil price shocks, arm conflicts)	Time-series regression estimates	Brulle et al. (2012)
USA	Gallup World Poll	Party affiliation, Party sorting, Elite cues	Descriptive statistics and OLS regression model	Guber (2013)
USA	Various national and rural surveys	Party affiliation	Descriptive statistics and logistic regression model	Hamilton et al. (2015)
USA	Granite State Poll	Political ideology, Scientific information	Descriptive statistics and weighted logistic regressions	Hamilton and Saito (2015)
USA	Different databases	Elite cues, Social movement efforts on climate change, Availability of scientific information, and mass media coverage, External political factors (business cycle)	SEM model	Carmichael and Brulle (2016)
USA	-	Person's worldviews and ideology	-	Whitmarsh and Capestick (2018)
USA	Floor speeches published in the *Congressional Record* between 1996 and 2015	Political ideology	Quantitative text analysis	Guber et al. (2020)

Table 4 – Perceptions and personal experience about weather conditions reviewed in Subsection 4.3, by country

Country	Data sources	Perceptions and personal experience about weather conditions	Methodology	Author(s)
89 countries	Gallup World Poll	Temperature anomalies	Kruskal–Wallis one-way analysis of variance and multilevel binary logistic regressions	Howe et al. (2013)
27 European Member States	Eurobarometer #322, #372 (2011), #409, #435, #459 and #490 (2009, 2011, 2013, 2015, 2017 and 2019 Editions) and different databases	Extreme weather events (monetary loss and cooling degree days)	OLS regressions	Baiardi and Morana (2021)
Australia and USA	Ad-hoc survey and different databases	Perceived local temperature changes	2SLS regressions	Li et al. (2011)
China	Ad-hoc survey	Physical or financial damages due to extreme weather events (heatwaves, heavy rainfalls or floods, droughts, sandstorms, windstorms, and avalanches)	Descriptive statistics and maximum likelihood estimates in binary probit models,	Dai et al. (2015)
Germany	Ad-hoc survey	Perceptions about three kinds of natural hazards: heat waves, storms, and floods	Ordered logit regressions	Frondel et al. (2017)
Switzerland	Ad-hoc survey	Perception and personal experience with floods	Descriptive statistics	Keller et al. (2006)
Switzerland	Ad-hoc mail survey	Perceptions and personal experience with flood risks	Descriptive statistics	Siegrist and Gutscher (2006)
United Kingdom	Ad-hoc surveys	Personal experiences of flooding	Qualitative analysis	Whitmarsh (2008)
United Kingdom	Ad-hoc survey	Extreme weather events (floods)	Product of-coefficients approach	Spence et al. (2011)
USA	Ad-hoc survey	Local temperature changes and extreme weather events (hurricanes)	Descriptive statistics and ordered logistical model	Borick and Rabe (2010)
USA	Pew Research Center (June, July, and August 2006, January 2007, and April 2008)	Extreme weather events (local weather)	Ordered logit regressions	Egan and Mullin (2012)
USA	Different databases	Perceived changes in local temperatures, floods and droughts	Ordered logit regressions	Goebbert et al. (2012)
USA	Gallup World Poll	Local temperature abnormality	Bayesian and heuristics updating	Deryugina (2013)
USA	Granite State Poll	Perceived temperature changes (Arctic/weather question) and two temperature indicators	Logit regression model	Hamilton and Lemcke-Stampone (2014)
USA	Different databases	Perceived temperature and temperature abnormalities	OLS, 2SLS and hierarchical multiple regressions	Zaval et al. (2014)
USA	Various national and rural surveys	Temperature anomaly	Descriptive statistics and logistic regression model	Hamilton et al. (2015)

USA	Different databases	Extreme Weather Events (excessive hot and cold temperature, droughts, flooding, storms and hurricanes)	SEM model	Carmichael and Brulle (2016)
USA	NOAA's Storm Events Database and Cooperative Congressional Election Study	Extreme weather events (excessive heat, droughts, flooding, and hurricanes)	OLS and logistic regression models	Konisky et al. (2016)
USA	Different databases	Local temperature changes and temperature abnormalities	OLS and spatial regression models	Kaufmann et al. (2017)
USA	-	Weather condition and weather events	-	Whitmarsh and Capestick (2018)

Table 5 – Different kinds of trust reviewed in Subsection 4.4, by country

Country	Data sources	Trust	Methodology	Author(s)
60 countries	Different databases	Social trust	Descriptive statistics and OLS regressions	Delhey and Newton (2005)
35 countries	Life in Transition Study (LITS II, 2010)	Social trust; Institutional trust	Multilevel binary logistic regressions	Smith and Mayer (2018)
33 countries	ISSP (2010 Edition)	General trust in people; General trust in government	OLS regressions	Franzen and Vogl (2013)
27 European Member States	Eurobarometer 68.2 (2008)	Corruption	Multilevel logistic regression:	Harring (2014)
27 European Member States	Eurobarometer #295, #365 and #416 (2008, 2011 and 2014 Editions)	Trust in information providers	Multivariate linear regression model	D'Amato et al. (2019)
27 European Member States	Different databases	Institutional trust	OLS regressions	Baiardi and Morana (2021)
Great Britain	Ad-hoc postal survey	Trust and distrust in information sources	Linear regressions analysis	Whitmarsh (2011)
Spain	World Values Survey and European Values Survey	Generalized trust	Order probit regression	Torgler and García-Valiñas (2007)
Switzerland	Swiss Environmental Survey (2007 Edition)	Generalized trust	Multivariate analyses	Meyer and Liebe (2010)
-	-	Interpersonal trust, membership in voluntary associations, and norms of reciprocity	Qualitative analysis	Sullivan and Transue (1999)

Appendix

A.1. The Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change and the Gallup World Poll

The Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change is a periodical survey, authored by the European Commission and produced by TNS Opinion & Social and the Leibniz Institute for the Social Sciences (GESIS). The data constitute the main source of statistical information on the pro-environmental attitudes and behaviours of European Union citizens. Questionnaires are administered by means of a face-to-face interview conducted in people's homes in the 27 countries of the European Union, and the final sample size is composed of about 27,000 respondents. Specifically, 1,000 individuals are interviewed in each country, with the exception of the smaller ones (Luxembourg, Cyprus, and Malta), where approximately 500 interviewees are performed. Data are gathered using computer assisted personal interviews (CAPI). The survey is repeated every two years. Currently, data are available for the years 2009, 2011, 2013, 2015 and 2019 in Special Eurobarometer surveys numbered 322, 372, 409, 435, 459 and 490, respectively.

The Gallup World Poll is a periodical survey of semi-annual, annual, or biennial frequency determined on a country-by-country basis, conducted by interviewing at least 1,000 individuals in more than 115 countries worldwide. Sample size can differ: for example, it is at least 2,000 for China and Russia, while, in a few cases, it is between 500 and 1,000. In some countries (e.g. USA, Canada, Western Europe, Japan, Australia), it covers at least 80 per cent of the population. The survey is conducted by means of a 30 minutes' telephone interview, and participants are selected by means a random-digit-dial method or a nationally representative list of phone numbers. Face-to-face interviews of about one hour of randomly selected households are carried out in developing countries, Latin America, the former Soviet Union countries, Asia, the Middle East, and Africa. With some exceptions, all samples are probability-based and nationally representative of the resident population aged 15 and older.

The strength of these databases is that the information collected is very rich, since participants are invited to express their opinions on the degree of severity they attribute to climate change compared to other major global problems or other environmental problems,[21]

[21] In the Special Eurobarometer survey on Europeans' attitudes towards climate change, the global problems listed are: international terrorism, poverty, hunger and lack of drinking water, the spread of infectious diseases, arm conflicts, the economic situation, the proliferation of nuclear weapons and the increase of global population. In the Gallup World Poll, climate change/global warming is compared with other environmental problems, such as pollution of drinking

and on other related topics as well. For example, the Gallup World Poll investigates whether individuals are satisfied with their country's efforts to preserve the environment, and the Eurobarometer Survey asks whether they have taken any personal action to fight climate change in the last six months, such as buying a new low fuel consumption car or electric car, whether they regularly use environmentally-friendly alternatives to their car, whether they have insulated their home better to reduce energy consumption, have bought a low energy house or have installed solar panels, and whether they try to reduce and regularly separate waste. Both surveys ask respondents their opinion of the responsibility of national governments and business and industry in fighting climate change, and about the relationship between economic growth and environmental problems.

A.2. The International Social Survey Programme (ISSP)

With reference to the years 1993, 2000 and 2010, the topics investigated by the Special Eurobarometer Survey on Europeans' Attitudes towards Climate Change (see Section A.1) are also taken into consideration in the 'Environment Module' by International Social Survey Programme (ISSP).[22] The ISSP Environment module series is a cross-national survey, which covers numerous European countries together with Argentina, Australia, Canada, Chile, Iceland, Israel, Japan, Mexico, New Zealand, Philippines, Russia, South Africa, South Korea, Switzerland, Taiwan, Turkey and the USA. It mainly deals with attitudes towards environmental issues, such as environmental protection and respondents' behaviour and preferences regarding governmental measures on environmental protection. The 1993 and 2000 surveys do not explicitly refer to 'climate change', but investigate individual attitudes towards the environment, by asking then to attribute air pollution to cars or industries, and asking whether pesticides and chemicals used in farming are possible causes of environmental degradation. Respondents are also asked about their perceptions of what increase in world temperatures caused by the greenhouse effect could be dangerous for the environment. The 2010 Edition substitutes the expression 'climate change' for 'greenhouse effect/global warming'. In all the editions there are specific questions aiming to reveal the individual willingness to pay to protect the environment (including through taxation), and questions on the role of individuals, business and government in environmental protection. These aspects are also present in the Life in Transition Study, a survey conducted by the World Bank and

water, pollution of rivers, lakes and reservoirs, air pollution, loss of tropical rain forests and extinction of plant and animal species.

[22] See https://www.gesis.org/en/issp/modules/issp-modules-by-topic/environment.

the European Bank for Reconstruction and Development. Lastly, participants are also asked to express their opinion about the trade-off between economic growth and the environment, and which is the main priority, and the role of developing and developed countries in determining climate change. This issue is also analysed in The World Value Survey and in the Gallup World Poll.