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Drivers of climate change opinion

Itxaso Ruiz[a*], Sérgio H. Faria[a,b], Marc B. Neumann[a,b]

Understanding how different socio-cultural groups think about climate change is crucial for the successful implementation of climate policies. Here we review the main drivers of climate change opinion. Regardless of the socio-cultural context, knowledge of climate change (influenced by exposure to media and education) and belief in anthropogenic climate change (influenced by ethnography and political orientation) appear to be the main predictors of opinion. However, for action to occur, opinion about climate change must be modulated by risk aversion (shaped by climate change risk exposure, vulnerability and poverty). We illustrate how these interactions work by examining the willingness to accept climate policies.

Keywords: climate change opinion, social dynamics, belief, knowledge, risk.

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1. Introduction

Public opinion on Climate Change (CC) has evolved considerably over the past few decades (e.g. European Commission, 2013; GlobeScan, Eurobarometer, and Gallup databases). Nonetheless, while awareness of impacts has recently increased, there are still significant misconceptions and addressing climate change appears to lack priority in society (Brechin, 2003; Leiserowitz, 2007; Lee et al., 2015; Corner and Clarke, 2017). Given the large impact of human activities on climate, it follows that a better understanding of the ways different socio-cultural groups think about CC is crucial for the development and implementation of effective climate policies. For effective climate action (mitigation and adaptation) to occur, CC has to be perceived as one of the greatest challenges for society today.

The objective of this paper is to summarize and better understand the structural roots of public opinion about CC. This matter is central for climate action, as behavioural change and willingness to support climate policies are strongly dependent on public opinion and awareness of the underlying causes (Leiserowitz, 2006; Lorenzoni and Pidgeon, 2006; McCright and Dunlap, 2011; Weber and Stern, 2011; Howe et al., 2015; Lee et al., 2015; Hornsey et al., 2016). Thus, there is a pressing need to understand how opinion is shaped.

Despite decades of action towards climate change mitigation, little data on CC opinion have been collected globally. Most of the existing studies focus on values and beliefs of individuals (Axelrod, 1997; Hegselmann and Krause, 2002; Castellano et al., 2009; Marquart-Pyatt et al., 2011). However, there is evidence that broader community-level processes may be the main drivers of public opinion (Brulle et al., 2012; Huxster et al., 2015). Some studies on this topic have considered "audience segmentation", in which groups are identified according to demographic and psychosocial variables (Kahan et al., 2012; Howe et al., 2015).

In this paper we review the main community-level educational, cultural, and political factors that drive CC opinion. Furthermore, we present a specific application where we analyse which additional factors, together with CC opinion, drive climate policy acceptance. We summarize meta-analyses and complement them with a review of polling and scientific studies. It should be noted that, due to the large amount of studies conducted in the United States of America (USA), our review contains an inevitable bias towards US-American traits.

The aim of this work is to promote a better understanding of the role of public opinion of CC as a key component for climate action. To this aim, we develop a review of variables that influence CC opinion and policy acceptance, including their relational network.

The paper is organized as follows. Section 2 describes the sources of information used in this study. Section 3 discusses the relational network of the key factors for CC opinion, while Section 4 presents the application of the developed relational network in view of climate polices acceptance. Section 5 offers some final remarks and lastly, Section 6 discusses some future steps.

2. Materials

Our review of key factors driving CC opinion (Table 1) and policy acceptance (Table 2) is based on:

- three international meta-analysis studies, conducted over the past eight years;
- fifteen polling studies;
- seventeen scientific papers.

For each study, a number of distinctive characteristics is recorded, including the survey time span and location, the main discipline conducting the study, key words, methodology, and main results. All reviewed publications derive from analyses of relevant climate-related data available from public databases (e.g. Roper iPoll Database, GlobeScan, Gallup Organization, Eurobarometer).

Table 1. Review of the key drivers that shape public opinion. Three types of studies are identified: polling studies (P), meta-analyses (M), and scientific papers (S).

Knowledge of CC		
Key factors	**Studies**	**Type**
Awareness of scientific work	Brulle et al., 2012	P
	Briggs, 2014	M
	Castell et al., 2014	S
Exposure to organic advocacy	Leas et al., 2016	S
Education on CC	Kahan et al., 2012	P
	Plutzer et al., 2016	P
Exposure to traditional media	Farrell, 2015	S
	Brulle et al., 2012	P
	Maibach, 2008	P
	Beder, 2014	S
	O'Neill et al., 2015	S
	Lee et al., 2015	S
	Stern, 2016	M
Belief in anthropogenic CC		
Key factors	**Studies**	**Type**
Ethnography	Bord et al., 1998	P
	Leiserowitz et al., 2007	S
	Meira-Cartea et al., 2009	S
	Brulle et al., 2012	P
	Hanemann et al. 2011	P
	Cook et al., 2013	S
	Leiserowitz et al., 2015a	P
	Leiserowitz et al., 2013	P
	Howe et al., 2015	S
Political orientation	Brulle et al., 2012	P
	Kahan et al., 2012	P
	Huxster et al., 2015	S
	Givens, 2014	S
	Stimson, 1991	S
	McCright et al., 2015	P
	Lee et al., 2015	S
	Leiserowitz et al., 2015a, b	P
	Hornsey et al., 2016	M
	Stern, 2016	M
Religious orientation	Hope and Jones, 2014	P
	Leiserowitz et al., 2015b	P

Table 2. Review of the key drivers that shape willingness to accept climate policies. Three types of studies are identified: polling studies (P), meta-analyses (M), and scientific papers (S).

Risk aversion		
Key factors	**Studies**	**Type**
CC risk exposure	Leiserowitz et al., 2007	S
	Hornsey et al., 2016	M
	Leiserowitz et al., 2015a	P
	Lee et al., 2015	S
	Brulle et al., 2012	P
Health impact perception	Patz and Olson, 2006	S
	Maibach et al., 2015	P
	Smith et al., 2014	S
	Patz et al., 2005	S
	Akerlof et al., 2010	P
Vulnerability and poverty	Leiserowitz et al., 2015a	P
	Brechin, 2003	P
	Leiserowitz et al., 2007	S
	Moyano et al., 2009	P
	Meira-Cartea et al., 2009	S
	Lee et al., 2015	S
Economic costs of climate policies	Bord et al., 1998	P
	Leiserowitz et al., 2013	P
	Leiserowitz et al., 2007	S
	Meira-Cartea et al., 2009	S
	Brulle et al., 2012	P
	Hanemann et al. 2011	P
	Leiserowitz et al., 2015a	P

The use of terminology changes across time and scientific communities. Scientific work is heterogeneous in its whole, and thus, uses different wordings to refer to the same phenomena. In this way, there has been an evolution of concepts such as "environment" (see e.g. Gómez-Baggethun and Naredo, 2015). There are also geographical differences in the use of key definitions of central concepts (e.g. the term "Global Warming" is frequently used in the USA with a meaning equivalent to the European "Climate Change"). In addition, the terminology also differs across domain narratives (e.g. communication sciences generally reframe the term "uncertainty" as "risk"). Owing to this diction diversity, we define below, in each section, the meaning of each key concept.

3. Identification of a conceptual model and review of mechanisms

We review in detail the *drivers* of CC opinion, which can be disaggregated into *influencers* (Figure 1). These *drivers* determine two *predictors:* "Knowledge of climate change" and "Belief in anthropogenic CC".

Criteria for selecting the different influencers, drivers and predictors are:

- number of occurrences across studies;
- transferability across scales- and sites;
- quantifiability.

3.1. Description of the Predictor "Knowledge of CC"

This predictor defines the level of information about CC within a group. Polarization of information (viz. biased information based on distorted, or even absent, scientific basis) is one of the key issues here. As such, exposure to traditional media plays a decisive role for this predictor, since traditional communication channels have historically been the most efficient tools to polarize opinion.

3.1.1. Exposure to Traditional Media. According to the Special Eurobarometer 401 (European Commission, 2013), people still tend to get most of their science news from traditional media such as radio, television, and the press. People tend to rely on media interpretations of scientific results to understand climate change research, governance, and decision-making. Traditional media, therefore, plays a decisive role in the communication of science. Traditional media coverages of major scientific advances and assessment reports have been found to generally have a positive effect on public knowledge and understanding of CC, raising also individual concern (Boykoff, 2011; Brulle et al., 2012; O'Neill et al., 2015).

However, as pointed out by O'Neill et al. (2015), traditional media have an influence that goes beyond delivery of information: they can also have a polarizing effect, by shaping, enhancing or inhibiting people's engagement. Greater exposure to polarized information can easily provoke confusion, and reduce risk perception. For instance, in a study examining the institutional and corporate structure of the climate change counter-movement and its influence on traditional media, Farrell (2015) concluded that polarization of CC opinion is higher in countries where organized influencers (e.g. the mining and fossil fuel industry) raise contrarian social movements doubting the scientific consensus (Stern, 2016).

From Maibach (2008) we highlight three aspects of traditional media that positively impact public perception: 1) volume of coverage, e.g. peaks of information after extreme weather events; 2) domain narrative, e.g. reformulation of "disaster/uncertainty" to "risk/opportunity" frames; and 3) marketing interventions, e.g. financial incentives to promote sustainability. However, in the words of the author, traditional media lacks the ability to "*influence potentially more important institutional, economic, and technologic drivers of behaviors"* (i.e. laws and regulations, etc.; Maibach, 2008). Moreover, as stated by Brulle et al., (2012), for those who are influenced, the effects do not last more than some weeks, ranging from one week for press coverage, to eight weeks for national television (McCombs, 2004; Sampei and Aoyagi-Usus, 2008).

3.1.2. Education on CC. Plutzer et al. (2016) assessed both, quantity and quality of CC knowledge in US-American classrooms by undertaking "*the first nationally representative survey of science teachers focused on climate change*". The authors collected data from 1500 public middle- and high-school teachers evaluating the direct influence of school education on the level of understanding. They found that although CC was included in most of the courses, time spent on it was little. Moreover, they also state that the quality of instruction was for most of the cases not rigorous and in some cases even confusing. In line with this study, Kahan et al. (2012) assert the need of addressing CC scientific causes in colleges and universities, avoiding political commitments and the promotion of particular views, which can lead to the adoption of an opposing position.

3.1.3. Exposure to organic advocacy. In contrast to the predominant top-down strategies of traditional media, online platforms are proving to be powerful for engaging individuals in a more effective manner. An example of this can be found in Leas et al. (2016), who reported the effects

of Leonardo DiCaprio's 2016 Oscars acceptance speech. DiCaprio's speech increased Google searches for "climate change" and "global warming" by 261 % and 210 % respectively, and reached record highs on Twitter with more than 250,000 tweets in one evening.

3.1.4. Awareness of scientific work. It has generally been reported that the communication from science to the wider public is weak. For instance, the European Commission (2010) provides evidence of insufficient effort in scientific communication, and states that the majority of Europeans think scientists do not put enough effort into informing the public about new developments. Evidence of this can also be found in diverse local/national reports, as for example, the United Kingdom (UK). Briggs (2014) reviewed more than 200 articles taken from six British newspapers and identified the need of a larger effort from the part of scientists to inform the public about CC. Likewise, the Ipsos MORI 2014 Poll (see Castell et al., 2014) shows that although 90 % of British citizens think that scientists play a valuable role in society, only around 15 % obtain scientific news directly from science websites, and the percentage that experience direct interactions with scientists is even lower. It is hence clear that exposure to scientific work (i.e. reading of scientific papers, participation in open-science conferences and face-to-face meeting with scientists, etc.) remains very low in the society.

Moreover, scientists that directly deal with CC often hesitate to communicate directly with the general public, as they are largely aware of the social and potentially politicized context of their research matter, the unavoidable and complex uncertainty related to this topic, and the role their research might play in policy making (Briggs, 2014).

Nonetheless, Brulle et al. (2012) observe a positive impact in the case of open access to major assessment reports and popular science magazines. The authors state that both these sources are shown to have a direct impact on public concern and understanding.

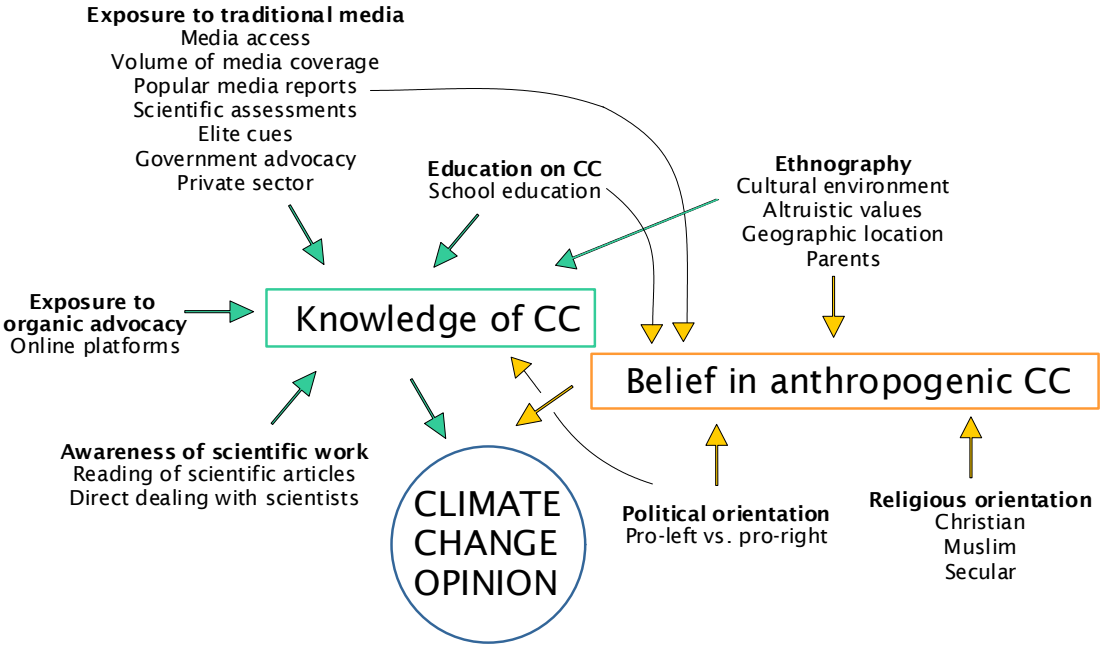

Figure 1. Conceptual model of CC public opinion. Drivers are displayed in boldface, with their respective influencers listed below them. Predictors are enclosed in rectangular boxes. The target variable (Climate change opinion) is within a circle.

3.2. Description of the Predictor "Belief in anthropogenic CC"

Belief in anthropogenic CC defines the convictions about CC based on social norms, cultural, religious, and moral values. As indicated above, anthropogenic climate change may be defined as a change of climate that can be attributed directly or indirectly to human activity. Despite the fact that 97 % of climate scientists currently agree that CC is happening and that it is at least partly anthropogenic (Cook et al., 2013), several studies indicate that the general public has a distorted vision of this reality. For instance, Cook et al. (2013) found that the vast majority of US-American citizens (90 % at the time of their study) believed that there is disagreement between scientists, and only about half of them believed that human activity was the predominant cause of CC (Leiserowitz et al., 2015a; Plutzer et al. 2016). These results suggest that more knowledge about CC does not necessarily imply a stronger belief in the anthropogenic cause of CC. The same facts reasoned under different believes or initial convictions can induce opposing tendencies that ultimately create polarization (Sharot and Sunstein, 2016). In this manner, the "Cultural environment" together with "Political orientation" appear to be the strongest influencers polarizing "Belief in anthropogenic CC".

3.2.1. Ethnography. Literature on aggregate public opinion suggests that some portions of the public hold stable opinions about CC determined by their social identity. Lee et al. (2015) found that people from the same community who share a relatively homogeneous cultural and economic environment tend to reason in similar ways. Howe et al. (2015) report on Hispanic/Latino adults from Southwestern Texas and majority-black communities of central Alabama showing a higher tendency to believe in CC than US-American whites on average. In the same way, Howe and colleagues state that the rural–urban divide is also reflected in CC beliefs, with stronger belief in CC observed in states with larger cities (e.g. New York, Chicago, Los Angeles).

3.2.2. Political orientation. Although differences in CC opinion exceed what political orientation alone can explain, it is consistently found that these orientations influence a wide range of beliefs (Givens, 2014). Many studies show that whenever CC polarization is high in the media, citizens rely on their political affiliation as a source of credibility to form an opinion (Brulle et al., 2012; Kahan, 2012; Huxster et al., 2015; Lee et al., 2015; Leiserowitz et al., 2015a,b; Hornsey et al., 2016; Stern, 2016).

In order to understand how political orientation affects public opinion, several polls have recently taken place in the USA. Huxster et al. (2015) examined this issue by gathering public opinion data available on the Roper iPoll Database between 2001 and 2013. The authors aggregated multiple polls and tracked the polarization of pro-right and pro-left parties' ideology with regard to CC opinion and awareness. They found that individuals from each political party had significantly different levels of awareness, and polarization between these two groups increased over the 13 years of the study. Likewise, Brulle et al. (2012) used time-series analysis to evaluate five possible factors (viz. extreme weather events, public access to accurate scientific information, media coverage, elite cues, and movement/countermovement advocacy) influencing CC opinion from 2002 to 2010 in the USA. They used Congressional press releases, as well as Senate and House votes on CC bills, and found that political mobilization by elites and advocacy groups were the most critical. They determined that pro-climate change action statements by Democrats, and especially anti-environmental voting by Republicans, are the main drivers. In line with both studies, Leiserowitz et al. (2015a) also reported that CC awareness in the USA is higher among Democrats or pro-left parties (57 %) than among Republicans or pro-right parties (19 %).

Similarly, although less pronounced, the division on CC attitudes related to political affiliation has been reported for several European countries in the Eurobarometer survey data

(McCright et al., 2015). It has been consistently found that CC polarized opinions are more effective among conservatives, and that liberals are more likely to support CC mitigation.

3.2.3. Religious orientation. Leiserowitz et al. (2015a) examined the connection between US-American political affiliation and religious orientation. They indicate that Christians are more likely to be politically conservative, with Evangelicals being the most conservative and Catholics the most liberal, respectively. In the same way, Leiserowitz et al. (2015b) stated that Evangelicals are the least likely to believe that CC is caused mostly by human activities while Catholics are the most likely (41 % versus 57 %). They explain this fact through Pope Francis' encyclical "Laudato Si': On Care for Our Common Home", where he urges the nations to work together on the CC issue, calling for moral action to protect the Earth and the world's poorest against the threat of climate change.

Hope and Jones (2014) investigated CC attitudes shaped by beliefs of UK Christian, Muslim, and secular (non-religious) communities. Their study reports an influence of religious orientation on CC belief in the following way: 1) Secular participants have the strongest pro-environmental orientation, urging for immediate action towards CC mitigation. 2) Muslim participants reveal strong concern for environmental conservation and for a human lifestyle in harmony with nature, but lack the urge regarding action towards CC mitigation and adaptation. 3) Christian participants place greater emphasis on human welfare and intergenerational justice, also lacking an urge towards CC action. Consequences of these findings are that, although Seculars alone push for CC action, Christians and Muslims favour lifestyles that indirectly support CC action.

4. Applying the CC opinion model in view of willingness to support climate policies

Opinion formation is a necessary, but not sufficient, condition to trigger climate engagement: additional drivers and predictors are often required to convert opinion into action. In this section we illustrate this phenomenon by applying our conceptual model of CC opinion to the process of acceptance of climate policies.

Based on the current literature, our working hypothesis is that climate change opinion together with attitude towards risk provides the sufficient combination of predictors that determine the willingness to accept climate policies. As presented in Section 3, "Knowledge of climate change" and "Belief in anthropogenic CC" emerge as the main *predictors* of "Climate change opinion". Here we propose that an additional *predictor* of "Risk aversion" modulates "Climate change opinion", and both together determine the "Willingness to accept climate policies". In the sequel we review the *drivers* and *influencers* that control this process (Figure 2).

4.1. Description of the Predictor "Risk Aversion"

This predictor defines the attitude towards risk. A number of studies have shown that the transformation of CC opinion into climate policy support depends on the way associated risks are perceived. "CC risk exposure" together with "Vulnerability and poverty" have been found to be the greatest influencers of "Risk aversion". Both are related to the natural, cultural, and economic environment shared by the community, which induces them to similar reasoning on strategies and perceptions (cf. "Ethnography").

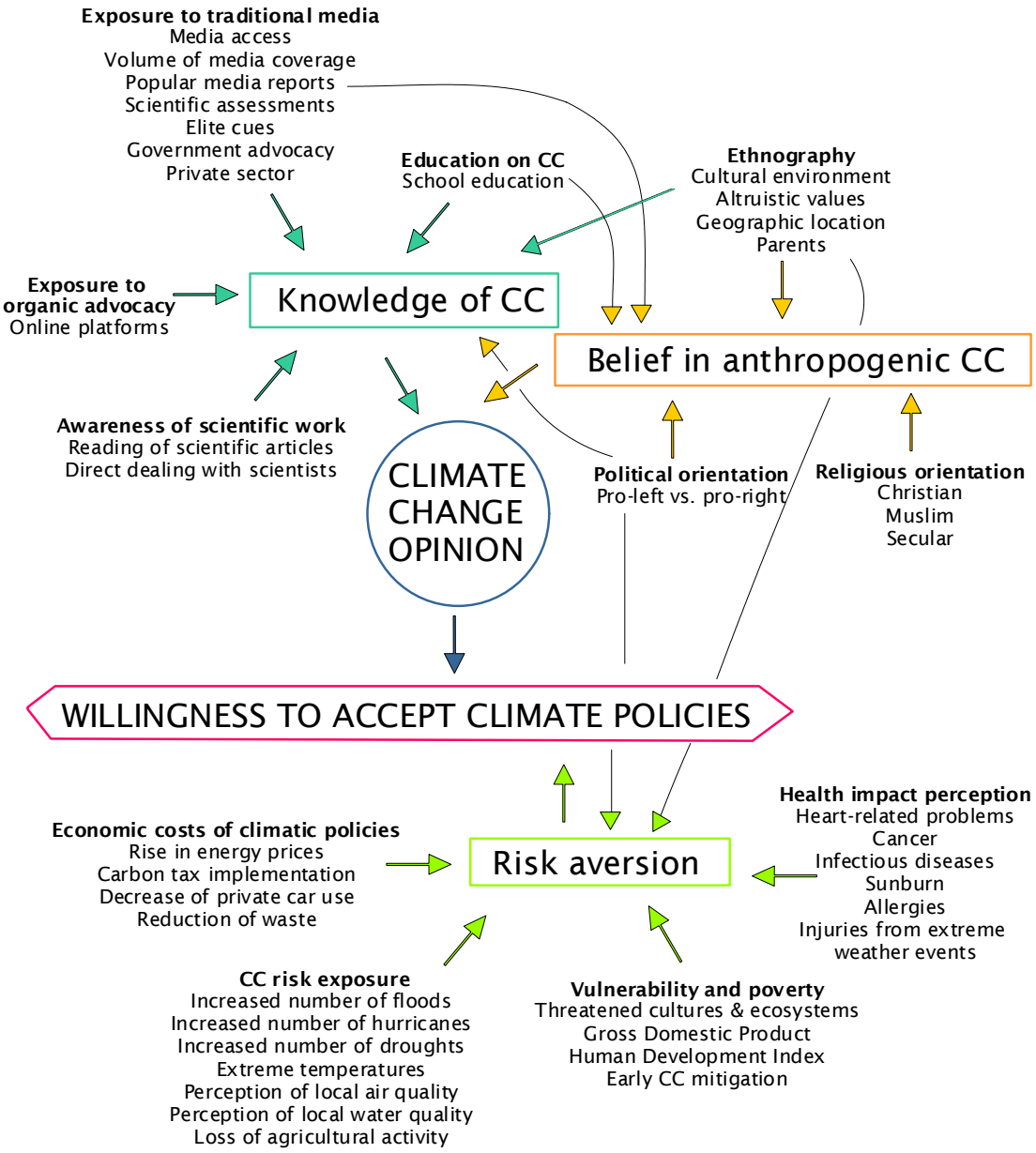

Figure 2. Conceptual model of CC public opinion and acceptance of climate policies. Drivers are displayed in boldface, with their respective influencers listed below them. Predictors are enclosed in rectangular boxes. The target variable (Climate change opinion) is within a circle, while the variable (Willingness to accept climate policies) is enclosed in a hexagonal box in the centre of the diagram.

4.1.1. Vulnerability and poverty. Regardless of the nature and degree of CC exposure, developed countries consistently perceive CC as a distant problem that ranks lower in priority than other concerns (e.g. Special Eurobarometer 340). Hence, persistent news on threatened cultures and ecosystems often cause a general state of disengagement. In contrast, exposed communities with lower wealth levels generally have a higher degree of risk awareness. Accordingly, Leiserowitz (2007) identified the community's wealth and development level (expressed as GDP: Gross Domestic Product, and HDI: Human Development Index) as key differentiating factors between levels of CC risk awareness. Similarly, Lee et al. (2015) used the Gallup's Financial Wellbeing Index to obtain similar results.

In this manner, wealth is largely responsible for shaping the specific mitigation and adaptation capacities of a community. While developed countries are as likely to experience high exposure to hazards as developing countries, the former exhibit lower vulnerability, which leads to a disengagement from CC action.

4.1.2. CC risk exposure. Leiserowitz (2007) and Lee et al. (2015) are two examples of studies reporting that more exposed nations are more aware about the impacts of CC. Leiserowitz (2007) conducted a global comparison between different nations in order to investigate the degree of CC risk perception (or awareness) using already existing surveys ranging from 1999 to 2007. On the other hand, Lee et al. (2015) used data from the largest cross-sectional international survey of CC perception so far conducted, the Gallup World Poll of 2007–2008, representing 90 % of the world's population (i.e. 119 countries).

Leiserowitz et al. (2015a) and Hornsey et al. (2016) agree that experiences of unusual environmental episodes (i.e. extreme weather events, increased number of floods, droughts, hurricanes, etc.) are cognitively associated with CC, leading to a rise in public awareness. In contrast, Brulle et al. (2012) found a very limited influence of this factor at a community level. It should be noted, however, that they used data collected solely in the USA, from the NOAA (National Oceanic and Atmospheric Administration) Climate Extremes Index. Thus, in contrast to the afore-mentioned studies, Brulle et al. (2012) analysed CC risk perception in a single developed country only (viz. the USA), leaving unresolved if experiences with extreme weather events affect CC awareness of vulnerable people living in developing countries. It seems that the results of Brulle et al. (2012) support the observations made by Leiserowitz (2007) and Lee et al. (2015), reporting a low CC risk perception among citizens of developed countries, such as the USA.

Besides extreme weather events, Lee et al. (2015) and Hornsey et al. (2016) conclude that the experience of recent local environmental changes increases the level of perceived risk, as people become aware of CC-related environmental threats to their communities. In this way, perceived changes in local air and water quality or temperature are strong predictors of CC risk aversion.

4.1.3. Economic costs of climatic policies. Quoting Bord et al. (1998), individuals "*tend to express support for virtually any abstract problem presented to them in surveys*". Such a bias is thus likely reflected in CC polls, usually indicating strong willingness to support climate policies. Therefore, here we focus only on the costs of climate policies.

Meira-Cartea et al. (2009) and Hanemann et al. (2011) are two of many studies that offer a detailed picture of the Spanish preferences regarding climate policy costs. Both studies point out that, although Spanish citizens are greatly concerned about CC and willing to support pro-environmental policies, they put their own economic interests first. In particular, they are against a rise in energy prices (i.e. electricity or oil) or reduction in the consumption of goods and services subjectively related to wellbeing (e.g. private car use or reduction of waste). This is partially explained by the fact that citizens generally transfer most of the climate responsibilities to industries and governments. According to the European Commission (2010), this same finding can be extrapolated to all of Europe. Nevertheless, Spanish citizens would support a green tax reform or pay a moderate extra-charge for goods and services like cleaner appliances, local food, etc. (see Meira-Cartea et al., 2009).

Leiserowitz et al. (2007) outline the same tendency at a global level. In their study, the authors inquired about the preferences between an early mitigation of CC in spite of uncertainty,

or a later response to an obvious need of action involving higher costs. They found a strong preference towards a precautionary approach for most of the countries, with the USA, South Africa, Dominican Republic and Nigeria being the exceptions. As in the European case, Brulle et al. (2012) and Leiserowitz et al. (2015a) found that citizens would attribute responsibility to corporations and governments. Further, these authors state that US-Americans do not support initiatives that threaten car use or home heating/cooling. However, they observe moderate-to-high levels of support (62 %) to reduce USA's own greenhouse gas emissions, regardless of actions taken in other countries, especially developing countries. Leiserowitz et al. (2013) report a high polarization in the case of India, where climate policies are seen by some as an obstruction to economic growth, while others state that environmental protection should be a priority.

4.1.4. Health impact perception. Similar to the experience of extreme weather events and environmental change perceptions, several studies describe a link between health and CC in developed countries (Patz et al., 2005; Patz and Olson, 2006; Smith et al., 2014). Akerlof et al. (2010) conducted a public health survey (2008–2009) inquiring about the belief of possible human health risks related to CC. Respondents from the USA, Canada and Malta related CC with the following health impacts: 78–91 % respiratory disease, 75–84 % heat-stress, 61–90 % cancer, and 49–62 % infectious diseases. Canadians also named sunburn (79 %), and injuries from extreme weather events (73 %), while Maltese cited allergies (84 %).

Respondents from developed countries judge negative impacts as more likely to occur for others than for themselves, viewing CC as a threat distant in space and time (Brechin, 2003; Leiserowitz et al., 2015a; Maibach et al., 2015). Further evidence of this can be found for Spain in Meira-Cartea et al. (2009) or Moyano et al. (2009), who reported how Spanish citizens expressed little concern about CC affecting local regions of Spain but much higher concern for impacts at the global scale.

5. Highlighted outcomes

- "Knowledge of CC" and "Belief in anthropogenic CC" are the two main predictors of "CC opinion", which together with "Risk aversion" shape the "Willingness to accept climate policies".
- Individuals tend to form opinions compatible with the values of the societal groups that they identify with.
- Initial beliefs about the anthropogenic role in climate change are reinforced by further media coverage, as same facts reasoned under different perspectives induce opposite opinions.
- Higher-level education does not necessarily mean higher perception of CC risk.
- There is an association between "Risk aversion" and "Belief in anthropogenic CC", with egalitarian and communitarian people being more risk aware and attributing a stronger role to the anthropogenic cause of CC.
- There are some drivers that impact multiple predictors implying potential interactions. "Ethnography" and "Political orientation" influence "Knowledge of CC", "Belief in anthropogenic CC" and "Risk aversion". "Education on CC" and "Exposure to traditional media" influence both "Knowledge of CC" and "Belief in anthropogenic CC".
- Media do not only transmit information, but also shape the nature of peoples' engagement. Polarization of CC opinion has been found to be higher in countries where influential lobbies

(e.g. the fossil fuel industry, etc.) raise contrarian social movements doubting the scientific consensus.

- Perceived local environmental change and experiences of extreme weather events are cognitively associated with CC.
- Mitigation and adaptation capacities are crucial to determine whether taking climate action is urgent for the community. Societies with high capacity tend to be less alarmed about CC. As a result, citizens in many developed countries perceive CC threats as distant problems without urgency.

6. Further remarks

Global climate change poses diverse challenges to countries with distinct capacities to implement mitigation and adaptation strategies. The omission of such strategies raises issues of security, health, wellbeing, equality, and fairness. Therefore, considering that CC is projected to increase risks for people, food provision, assets, economies, and ecosystems (IPCC, 2014), it is of interest to:

- Understand how contextual and cultural values of a community shape its environmental behaviour in view of climate action.
- Develop more effective communication strategies in order to engage society to take local action.
- Develop quantitative models to describe the drivers and the dynamics of public opinion, which may eventually help decision makers to formulate strategies that are more effective.

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References

Akerlof K., DeBono R., Berry P., Leiserowitz A.A., Roser–Renouf C., Clarke K.-L. and Maibach, E.W. (2010). Public Perceptions of Climate Change as a Human Health Risk: Surveys of the United States, Canada and Malta. International Journal of Environmental Research and Public Health, Vol. 7, Iss. 6, pp. 2559–2606. DOI: 10.3390/ijerph7062559.

Axelrod R. (1997). The dissemination of culture: a model with local convergence and global polarization. Journal of Conflict Resolution, Vol. 41, pp. 203–226.

Beder S. (2014). Lobbying, greenwash and deliberate confusion: how vested interests undermine climate change. In M. C–T. Huang and R. R-C. Huang (Eds.), Green Thoughts and Environmental Politics: Green Trends and Environmental Politics, pp. 297–328. Taipei, Taiwan: Asia-seok Digital Technology

Bord R.J., O'Connor R.E. and Fisher A. (1998). Public perceptions of global warming : United States and international perspectives. Climate Research, Vol. 11, pp. 75–84.

Boykoff M. (2011). Who Speaks for the Climate? Making Sense of Media Reporting on Climate Change. Cambridge University Press, Cambridge.

Brechin S. R. (2003). Comparative public opinion and knowledge on global climatic change and the Kyoto Protocol: the US versus the world? International Journal of Sociology and Social Policy, Vol. 23, Iss. 10, pp. 106–134.

Briggs H. (2014). The badgers moved the goalposts. Reporting science in the british media. Reuters Institute Fellowship Paper, University of Oxford, Oxford.

Brulle R.J., Carmichael J. and 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, Vol.114, Iss. 2, pp.169–188. DOI: 10.1007/s10584–012–0403–y.

Castellano C., Fortunato S. and Loreto V. (2009). Statistical physics of social dynamics. Reviews of Modern Physics, Vol. 81, pp. 591–646.

Castell S., Charlton A., Clemence M., Pettigrew N., Pope S., Quigley A., Shah J.N. and Silman T. (2014) Public attitudes to Science. Ipsos MORI, Social Research Institute. Department for Business, Innovation & Skills, London.

Cook J., Nuccitelli D., Green S.A., Richardson M., Winkler B., Painting R., Way R., Jacobs P. and Skuce A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. Environmental Research Letters, Vol. 8, Iss. 024024, pp.7–14. DOI: 10.1088/1748-9326/8/2/024024.

Corner A. and Clarke J. (2017). Taking Climate: From Research to Practice in Public Engagement. Palgrave Macmillan, London.

European Commission. (2010). Special Eurobarometer 340: Science and Technology Report. European Commission, Brussels.

European Commission. (2013). Special Eurobarometer 401: Responsible Research and Innovation (RRI), Science and Technology. European Commission, Brussels.

Farrell J. (2015). Network structure and influence of the climate change counter–movement. Nature Climate Change, Vol. 6, pp. 1–5. DOI: 10.1038/nclimate2875.

Givens J.E. (2014). Sociology: Drivers of climate change beliefs. Nature Climate Change, Vol. 4, pp. 1051–1052.

Gómez-Baggethun E. and Naredo J.M. (2015). In search of lost time: the rise and fall of limits to growth in international sustainability. Sustainability Science, Vol. 10, Iss. 3, pp. 385–395. DOI: 10.1007/s11625-015-0308-6.

Hanemann M., Labanderia X. and Loureiro M.L. (2011). Preferencias Sociales sobre políticas de cambio climático: evidencia para España. Economics for Energy, Working Paper 03/2011.

Hegselmann R. and Krause U. (2002). Opinion dynamics and bounded confidence: models, analysis and simulation. Journal of Artificial Societies and Social Simulation, Vol. 5, Iss. 3.

Hope A.L.B. and Jones C.R. (2014). The impact of religious faith on attitudes to environmental issues and Carbon Capture and Storage (CCS) technologies: A mixed methods study. Technology in Society, Vol. 38, pp. 48–59.

Hornsey M.J., Harris, E.A., Bain, P.G. and Fielding K.S. (2016). Meta-analyses of the determinants and outcomes of belief in climate change.Nature Climate Change, Vol. 6, pp. 622–626. DOI: 10.1038/NCLIMATE2943.

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

Huxster J.K., Carmichael J.T. and Brulle R.J. (2015). A Macro Political Examination of the Partisan and Ideological Divide in Aggregate Public Concern over Climate Change in the U.S. between 2001 and

2013. Environmental Management and Sustainable Development, Vol. 4, Iss. 1, pp. 1–15. DOI: 10.5296/emsd.v4i1.6531.

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

Leas E.C., Althouse B.M., Dredze M., Obradovich N., Fowler J.H., Noar S.M., et al. (2016). Big data sensors of organic advocacy: the case of Leonardo DiCaprio and climate change. PLoS ONE, Vol. 11, Iss. 8. e0159885. DOI:10.1371/journal.pone.0159885.

Lee M.T., Markowitz E.M., Howe P.D., Ko C.–Y. and Leiserowitz A.A. (2015). Predictors of public climate change awareness and risk perception around the world. Nature Climate Change, Vol. 5, pp. 1014–1020. DOI: 10.1038/NCLIMATE2728.

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

Leiserowitz A.A. (2007). International public opinion, perception, and understanding of global climate change. Human Development Report 2008/2007. United Nations Development Programme, New York.

Leiserowitz A.A., Thaker J., Feinberg G. and Cooper D. (2013). Global Warming's Six Indias. Yale Project on Climate Change Communication. Yale University. New Haven, CT.

Leiserowitz A.A., Maibach E., Roser-Renouf C., Feinberg G. and Rosenthal S. (2015a). Climate Change in the American Mind. Yale Project on Climate Change Communication. Yale University. New Haven, CT.

Leiserowitz A.A., Maibach E., Roser-Renouf C. and Smith N. (2015b). Climate Change in the American Christian Mind. Yale Project on Climate Change Communication. Yale University. New Haven, CT.

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

Maibach E. W., Roser–Renouf C. and Leiserowitz, A.A. (2008). Communication and marketing as Climate Change–Intervention Assets. American Journal of Preventive Medicine, Vol. 35, Iss. 5, pp. 488–500. DOI: 10.1016/j.amepre.2008.08.016.

Marquart-Pyatt S.T., Shwom R.L., Dietz T., Dunlap R.E., Kaplowitz S.A., McCright A.M. and Zahran S. (2011). Understanding Public Opinion on Climate Change: A Call for Research. Environment: Science and Policy for Sustainable Development, Vol. 53, Iss. 4, pp. 38−42.

McCombs M. (2004). Setting the Agenda: the Mass Media and Public Opinion. Polity, Malden, MA.

McCright A.M. and 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, Vol. 52, pp. 155–194. DOI:10.1111/j.1533- 8525.2011.01198.

McCright A.M., Dunlap R.E. and Marquart–Pyatt S.T. (2015). Political ideology and views about climate change in the European Union. Environmental Politics, Vol. 25, Iss. 2, pp. 338–358. DOI: 10.1080/09644016.2015.1090371.

Meira-Cartea P.A., Arto-Blanco M. and Montero-Souto P. (2009). La sociedad ante el cambio climático. Conocimientos, valoraciones y comportamientos en la población española. Fundación MAPFRE y Universidade de Santiago de Compostela, Santiago de Compostela.

Moyano E., Paniagua Á. and Lafuente R. (2009). Políticas ambientales, cambio climático y opinión pública en escenarios regionales. El caso de Andalucía. Revista Internacional de Sociología, Vol. 67, Iss. 3, pp. 681–699. DOI: 10.3989/ris.2008.01.23.

O'Neill S., Williams H.T.P., Kurz T., Wiersma B. and Boykoff M. (2015). Dominant frames in legacy and social media coverage of the IPCC Fifth Assessment Report. Nature Climate Change, Vol. 5, pp. 380–385. DOI: 10.1038/NCLIMATE2535.

Patz J.A., Campbell–Lendrum D., Holloway T. and Foley J.A. (2015). Impact of regional climate change on human health. Nature, Vol.438, pp.310–317.

Patz J.A. and Olson S.H. (2006). Climate change and health: global to local influences on disease risk. Annals of Tropical Medicine & Parasitology. Vol. 100, Iss. 5, 535–549.

Plutzer E., McCaffrey M., Hannah A.L., Rosenau J., Berbeco M. and Reid A.H. (2016). Climate confusion among U.S. teachers. Science, Vol. 351, Iss. 6274, pp. 664–665. DOI: 10.1126/science.aab3907.

Sampei Y, Aoyagi–Usui M. (2008). Mass-media coverage, its influence on public awareness of climate change issues, and implications for Japan's national campaign to reduce greenhouse gas emissions. Global Environmental Change, Vol. 19, pp. 203–212.

Sharot T. and Sunstein, C.R. 2016. Why facts don't unify us. Today's Paper, The New York Times edition, p.SR10. Available at: www.nytimes.com/2016/09/04/

Smith K.R., Woodward A., Campbell-Lendrum D., Chadee D.D., Honda Y., Liu Q., Olwoch J.M., Revich B. and Sauerborn, R. (2014). Human health: impacts, adaptation, and co-benefits. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp. 709–754.

Stern P.C. (2016). Sociology: impacts on climate change views. Nature Climate Change, Vol. 6, Iss. 4, pp. 341–342. DOI: 10.1038/nclimate2970.

Stimson J.A. (1991). Public opinion in America. Moods, cycles, & swings. Westview Press, Boulder, CO.

UNFCCC (1992). 1992 United Nations Framework Convention on Climate Change. UN Secretary General, New York, USA. Available at: https://unfccc.int/resource/docs/convkp/conveng.pdf

Weber E.U. and Stern P.C. (2011). Public understanding of climate change in the United States. American Psychologist, Vol. 66, pp. 315–328.

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