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HOW TO COMMUNICATE ABOUT CLIMATE CHANGE: AN INSIGHT INTO THE PERCEPTION OF SCIENCE COMMUNICATION IN SELECTED EUROPEAN COUNTRIES

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Abstract: *This paper examines how European citizens perceive the topic of climate change. It is based on qualitative research that involved gathering information from five (5) European countries (Portugal, Spain, Italy, Poland, and Slovakia) about their citizens' perception of science communication. The data were collected via public consultations using qualitative methods. The research aimed to provide qualitative knowledge gained through consultations with citizens on how they acquire science-related knowledge and how this knowledge influences their beliefs, opinions, and perceptions. This paper presents the findings of public consultations concerning science communication on climate change, in addition to presenting citizens' perception of scientific institutions and scientists working in the field of climate change. It also provides recommendations for improving science communication in terms of education systems and communication strategies. The analyzed data allowed us to look at several levels of science communication. The findings show citizens' various perspectives on communication preferences when it comes to climate change and present several science communication dimensions that could boost the effectiveness of science communication on the topic of climate change.*

Keywords: Climate change, Science communication, Public consultation, Science institutions, Communication dimensions.

Introduction

Climate change represents one of the greatest challenges of the 21st century. Currently, climate change mitigation, in addition to the process of adapting to it, brings with it large-scale local, regional, and global challenges for scientists, politicians, and the general public. Although climate change is often perceived as a global problem, the consequences of it can be seen more and more often on both national and local scales (Pittock, 2009). The Intergovernmental Panel on Climate Change (IPCC) has been issuing regular assessment reports since 1988 that address, among other things, the impact of human activities on global warming. The latest report published by the Intergovernmental Panel on Climate Change (IPCC, 2014) provided new scientific evidence that human activities are the cause of unprecedented climate change and confirmed (95-100% probability) that the global warming that has taken place since 1950 is due to human influence.

This scientific consensus has highlighted the urgency of developing both global and local strategies to adapt and mitigate global warming (Burton, Malone & Huq, 2005). Climate change, therefore, poses far-reaching challenges not only for ecosystems, but also for social and cultural systems and economic development. Consequently, adapting to climate change requires step-by-step actions of individuals, local communities, local and national governments, and international organizations. However, identifying the direct impact of climate change on people's daily lives is not entirely straightforward, and, as a result, it is often difficult to define the causes and the possible consequences for the everyday lives of the general population. However, a great deal of research suggests there is significant concern among EU citizens about the consequences of climate change (Papoulis et al., 2015; Moser, 2016).

The latest Eurobarometer survey (European Union, 2021) also found that many EU citizens remain very concerned about climate change and support EU-wide action in tackling it. European citizens identify climate change as the most serious problem we are currently facing. More than a quarter of EU citizens (29%) perceive climate change (18%), environmental degradation (7%), and health problems due to environmental pollution (4%) to be among the most serious problems. Up to 93% of EU citizens consider climate change to be a serious problem, and 78% consider it a very serious problem. At the same time, the findings confirm

that 96% of respondents have recently taken at least one specific measure to combat climate change, namely regularly sorting and recycling waste (75%) and reducing the consumption of disposable items (59%).

However, it is important to point out the significant discontinuity in citizens' concerns about climate change and their knowledge, beliefs, and perceptions about this issue as part of their individual commitment to climate change mitigation and adaptation. Understanding how the public perceives the effects of climate change is crucial for prompting successful adaptation and mitigation efforts through global and national policies on both public and individual levels. Therefore, several studies are focused on defining the main areas of the public perception of climate change in order to understand the extent of this phenomenon (Arnold et al., 2016; Muradova et al., 2020). This is where science communication on climate change can provide the opportunity to gain a more insightful perception on this issue and increase the involvement of the general public.

Science communication as a tool for effectively sharing scientific topics

Science communication is the important process of communicating scientific knowledge to the general public. It applies a model of the social communication of knowledge, which is focused on the process of information transfer and social interaction (Steinerová, 2018). At the same time, it ensures the interaction of scientists from various disciplines, whether by publishing, reviewing, scientific conferences, collaborations, or sharing resources (Brown 2010; Fry 2013). Science communication can be defined as the use of appropriate presentation skills, traditional and social media, dialogue, and social and scientific activities to create awareness and interest, form opinions and attitudes, and spread new knowledge on scientific topics among the general public (Burns, et al., 2003).

Science communication, as the basis of the information process, defines a set of interactions associated with scientific research. It develops and changes as an area of research, and so does the way it is communicated. Science communication in the field of climate change is a very important but very demanding area of expertise. It is a relatively young scientific and communication discipline that can be used in the field of climate change as a tool to better

understand the negative effects of global warming in the daily lives of the general public. It can also help to better understand the importance of public support for adaptation and mitigation strategies. Climate change is a collective problem, and a solution to it is only possible through the active participation of the public, as they can bring about political change as well as everyday changes in the individual lives of the general public.

The digital environment creates opportunities for new forms of science communication in the form of electronic journals, digital libraries, professional blogs, and scientific social networks (Haustein, 2016). When it comes to new technologies, climate change presents new challenges for science, the media, the public, and national and global policies. Thus, science communication has undergone profound and significant changes over the last decade. A survey of 6,000 American scientists that was carried out in the U.S. showed a serious interest in using science communication as a tool to increase confidence in the scientific community, but one that must be supported by institutions and policies (Rose, Markowitz, and Brossard, 2020). Science communication to the public is considered the responsibility of scientists (Greenwood & Riordan, 2001), and scientists can play an important role in supporting the effective development of adaptive and mitigating climate strategies (Pfisterer, Paschke, & Pasotti, 2019).

The increase in the speed of technological and social change also brings with it the increasing visibility of science communicators as mediators of professional scientific work in the field of climate change, and the size of the audience that receives this information is also growing. At the same time, this sharp increase in the amount of available information may bring about some communication misunderstandings on scientific topics, as they require more comprehensive coverage by those involved in science communication. According to some authors (Dunwoody, 2014), it will take longer for successful models to emerge that conform to the changes in the 21st century and provide scientific knowledge to the general public. New communication trends, therefore, require the involvement of science communicators in new roles that not only approach the topic by presenting scientific stories systematically, but mainly by using an interpretive approach (Fahy & Nisbet 2011). Science communication tends to be based on facts, while the public tends to combine facts and values. Hence, the interaction between science and society and the creation of research initiatives to involve the public in

shaping science communication are significant challenges. These initiatives represent various processes that open the possibility of involving the public in scientific discussions or even possibly participatory forms in facilitating science communication (van der Bles et al., 2020).

Science communicators are mainly scientific institutions, scientists, experts, scientific journalists, and public figures who have the opportunity to link scientific knowledge with the general public due to their impact on public action. Communication training for researchers is an important tool for improving the quality of interaction between scientists and the public (Besley et al., 2015). Experts in training people to improve and develop their communication skills agree that communication in modern sciences requires much more than just the ability to explain scientific topics in a comprehensive way. Researchers need to be able to approach communication more strategically, and their skills should include, in addition to media training, the ability to frame scientific information and link various activities that involve public engagement. These activities can include holding public debates, building partnerships between communities, and initiating mutual dialogue (Baram- Tsabari & Lewenstein, 2017; Yuan et al., 2017; Rodgers et al., 2018).

According to Kappel and Holmen (2019), we can divide science communication into two basic models. The first is a communication model based on one-way transmission, i.e., the dissemination of information from an expert or a science communicator to the public. The second is a model based on two-way transmission, i.e., a discussion by experts, the public, and mediators who can decide on the appropriateness and possibilities of public involvement in the formation of science communication. When employing a one-way model, we can define science communication as the successful transmission of information on climate change from scientists and science communicators to the public. This transmission can be provided through formal education or through the media, either traditional media in the form of popular science books and TV documentaries on climate change, or digital media in the form of science blogs and web-based professional portals (Ziman, 1991; Bauer et al, 2007 Druckman & Lupia, 2017). The two-way model is about communication between the public, climate change experts, mediators, and policy makers (Gastil, 2017). In practice, several approaches to two-way science communication are used, such as public hearings and consultations (Rowe-Frewer, 2000), science camps (Wachelder, 2003), science workshops, and international conference projects

such as Citizens Science, which make it possible to collect large amounts of data from a large number of participants from different countries over a longer period of time (Bonney et al., 2009). However, science communication alone and raising awareness about climate change are not entirely sufficient to stimulate the kind of individual action that can help mitigate and adapt to new changes in the climate. It is therefore important that scientific facts and data are presented in science communication in accordance with the values, beliefs, and interests of a particular audience.

Research design and research methodology

The aim of the study is to present the main findings about the European public's view on climate change. The data obtained and analyzed are part of the CONCISE¹ research project, which is aimed at examining the role of science communication in the perceptions and beliefs of EU citizens. The main objective of this project was to learn the role science communication plays on the origin of beliefs, perceptions and knowledge concerning scientific issues. The study was carried out under the EU - HORIZONT 2020 program. It was coordinated by the University of Valencia, and it included 9 partners from five European countries: Portugal, Spain and Italy – representing Southern Europe; Slovakia and Poland – representing Central Europe.

The public consultations were attended by 100 volunteers per each country (total 500 citizens) who discussed individual topics (climate change, vaccinations, alternative and complementary medicine, and GMOs) in small groups of 10 people. They were guided by moderator and recorded by an observer. The public consultations took place during September and November 2019 in all five countries and the data were analyzed during 2020. in September (Italy, Poland), October (Spain), and November (Slovakia, Portugal) of 2019. Public consultation is a qualitative research technique. It is a method of moderated group discussion

¹ The main objective of the CONCISE project was to gain insight into the origins of European citizens' beliefs, perceptions and knowledge in the field of science and technology. The promoter of the project was the University of Valencia (Universitat de Valencia). The project partners were three European universities in Portugal (University of Lisbon), Poland (University of Łódź), Slovakia (Trnava University) and the scientific association of Italian Universities Observa. Three professional institutions from Spain (FyG Consultores, Asociación Española de Comunicación Científica, Universitat Pompeu Fabra) and one from Poland (Danmark Coputers) also contributed to the development of the project.

that uses group interaction to obtain data on participants' views and perspectives on selected topics that might be more difficult to access outside of group interaction (Morgan 2001; Bloor & Wood 2006).

The study is based on public consultations using qualitative methods, which make it possible to better capture and analyze the attitudes of citizens who have had the opportunity to answer questions without predetermined variables and, above all, to explain their arguments and differing views in communication. Group discussions provided an overview of the knowledge, views, and perceptions of scientific topics by EU citizens. These discussions took advantage of group dynamics and interactions, which can help uncover the reasons behind attitudes towards scientific topics that can be more difficult to capture with quantitative research techniques. The public consultations also focused on gathering the views, suggestions, and critical views of EU citizens and provided an opportunity to consult and exchange different constructive views among the participants during the interactions. The role of the moderator in the discussion groups was to ensure that the discussions focused on the correct topics and to maintain a suitable atmosphere for mutual conversation for all the participants.

In order to properly implement the research process, it was necessary to ensure the close coordination of the five national teams and follow a common protocol that included detailed information on the choice of the discussion sites, the course of discussions, possible complications and how to prevent them, and how to effectively manage successful public consultations. At the same time, the research team sought to ensure diversity and that a variety of views were represented. To meet this goal, the teams consistently selected samples of nationals by gender, age, education, ethnicity, and occupation based on socio-demographic data for each participating country. The public consultations were audio-recorded, transcribed word for word, and content analyzed using NVivo software, which is used to analyze qualitative data. The textual analyses by NVivo software helped us to identify different dimensions of science communications as well as to find common patterns between discussed topics in each country. All partners involved in the research were using common coding grids which ensured that a large number of group discussions could be analyzed, and the findings systematized according to the required criteria for the analysis of the selected research questions. All the partners from

the countries where the research was conducted shared a common grid for coding the text corpus, which enabled the countries to be compared (Annex 1).

Our study details the findings of five public consultations on climate change. The aim of the study is to answer three main research questions:

1. How do citizens of the selected European countries perceive scientific institutions and scientists in the field of climate change?
2. What are the recommendations the citizens of the selected European countries have for improving science communication on climate change?
3. What communication models can we identify through public consultations on climate change?

The study presents the views of European citizens from selected countries on the science communication of climate change in more detail. In addition, it defines the main sources they use to obtain this information and assesses their credibility. It deals with the perception of scientific institutions and scientists working in the field of climate change and presents recommendations for improving science communication from the point of view of education systems and communication strategies. The analysis of the obtained data also allowed us to look at several levels of science communication. This was due to the interaction of science communicators and the general public, and we learned that with the right focus on target categories, better results for the presentation of scientific knowledge about climate change can be achieved. In the study, we present selected citations to illustrate the main identified topics and provide clearer answers to our research questions. The citations are illustrative and due to some other scientific papers presented from our CONCISE project some of them could be find in other publications and journals (Brondi et al. 2021; Delicado et al. 2021; Dziminska et al. 2021).

The perception of science communication on climate change

From the respondents' points of view, climate change is a widely discussed issue that is mainly covered by the media, for example, on television news or social media, and especially by climate activists. However, the information available in the media, whether traditional or digital, does not always provide enough relevant information. According to the respondents, the

media space is often overwhelmed by information on climate change, but the level and quality of this information is not sufficient. Some respondents evaluate information on climate change, especially in the digital environment of social networks, as misleading or insufficiently explaining professional topics to the general public. It is therefore more difficult for the general public to choose the most credible sources from such a huge amount of information. This can lead to an oversaturation of information on climate change, which often times causes people to get lost and renders them unable to select the information that is essential.

“Ordinary articles lack quality information on this topic. It would be good to set aside an appropriate space for information on climate change. If more quality articles are available, there may be more interest in this issue. In these articles, the information should be easily disseminated among people, but I don't think there are enough of them at the moment.”(Slovakia, male, 18-24 years old, secondary education)

“I think we are living in a paradoxical time. We have more and more information, but we feel less and less informed, which is a paradox.”(Portugal, female, 25-34, university education)

According to the respondents, it is therefore necessary to select information on climate change and take into account its credibility and verifiability. The scientific community, which is perceived by respondents as having two levels, plays an important role in the topic of climate change. The first level can be defined as institutional, which represents scientific institutions, state institutions, and international organizations that deal with climate change. The second level can be defined as personal, which takes the form of specific scientists, science journalists, and science communicators who deal with climate change in terms of disseminating scientific knowledge to the general public. The respondents often mentioned international institutions that deal with scientific knowledge in the field of climate change. These institutions are perceived as being more credible, and when it comes to the topic of climate change, they were reported by respondents as being more easily identifiable than local and national institutions.

“I must say that I often rely on some institutional resources, usually on some international institutions that deal with this topic, the UN and other similar organizations” (Slovakia, male, 25-34, higher education)

“I believe in institutions that play a significant role in this type of activity. So, if we are talking about the environment, then it is the Ministry of the Environment. And I think that is why these institutions are set up, to inform and support research in this area.” (Poland, male, 25–34, university education)

On a personal level, science communicators who have been identified by the respondents as an important part of presenting scientific information play an important role in spreading information about climate change. In countries with a tradition of science communication (Portugal, Italy, Spain), the respondents mentioned science journalists as important sources of information on climate change. Conversely, in countries where science communication on climate change has only developed as part of science in recent years (Poland, Slovakia), science communicators are more difficult to identify, and people are more aware of scientists from scientific institutions who are popularizing climate change for the wider public.

“Piero Angela (an Italian scientific journalist) was explaining the climate crisis, and he was quiet brief, saying things that everyone could understand. I was a child and I understood perfectly, even though he was talking about scientific topics. He used scientific language appropriately. He was neutral, and I didn't feel anxious about it.” (Italy, male, 25–34, high school education)

“There is a channel produced by the Copernicus Center (Centrum Nauki Koperni), and there is a scientist there roughly every week that discusses a new edition of Nature magazine. It's fantastic and it's great to listen to.” (Poland, female, 35-44 years old, university education)

In countries with a long tradition of science communication, communication is sensitively assessed by scientists who do not have experience directly in the field. They express

themselves outside their scientific field of work, and climate change is often not the main focus of their professional practice. The participants are critical of scientists who often get involved in various scientific topics outside their professional focus. This may create greater distrust with regard to science communication on climate change among the general public, as they may not be aware of the scientist's work and may perceive him as a representative of the scientific community on climate change.

“I recently heard a statement from a well-known scientist that works in the social sciences. He gave an incredible speech on television, stating that there was no scientific consensus on climate change.” (Italy, male, age 45-54, university education)

Suggestions for improving science communication on climate change

The public consultations also focused on identifying recommendations respondents made to the scientific community to more effectively disseminate scientific information on climate change to the general public and to increase the involvement of EU citizens in both the adaptation and mitigation processes. In our data analysis, we discuss two important levels of recommendations for science communication on climate change. They focus on communication strategies and education systems.

The level with the communication strategies points to recommendations aimed at streamlining communication on climate change by using simpler language that should not be highly technical, but understandable by the general public. It is important to emphasize the consequences climate change can have on people's daily lives to help them gain a better idea of how their daily lives could be affected on an individual level. The content of the information provided on climate change should therefore draw attention to specific actions and personal consequences in everyday life. The respondents perceive this as being a more relevant communication strategy than technical scientific language based only on data and scientific analysis.

“Information obviously must have a scientific basis, but the way it is presented must be put in a way that people can read it and it captures their attention. Because otherwise, if the texts are very scientific, people read a maximum of three lines and say it is not for me, I do not understand.” (Portugal, female, 55-64, university education)

“I think all reports on climate change should have at least three levels. A clear description of the developments with scientific information, a description of the consequences of how it will affect me in my daily life, and what I can do to make a positive contribution.” (Spain, male, 18-24, secondary education)

Respondents also stated that the general public is often lost in information on climate change that is presented using scientific data and analysis, as it is difficult to pay attention to it and focus on the essence of the information. In the recommendations, therefore, they propose not only approaching the general public with a certain style of language, but also presenting data and technical information in ways that allow it to be visualized. This could make science communication more attractive, more effective, and at the same time, attract more public attention.

“I think a lot of emphasis needs to be put into simplifying those reports, meaning that the information should have a visual side in order to have some effect, such as the felling of the Amazon rainforest.” (Italy, male, 45-54, university education)

“I am quite influenced by short videos that show specific things that happen to the planet. They influence me a lot, and they actually inspired me to gain a new perspective and approach to this topic.” (Slovakia, female, 18-24, secondary education)

Communication strategies also include popularizing scientific information on climate change among the general public. According to respondents, lay popularizers of science, who may be public figures, activists, celebrities, or bloggers, play an important role. The key is to

find a person who can gain the interest of the audience, work closely with the scientific community, and has the ability to pass on scientific information to a wide audience.

“I have this specific experience. It happened when I was still at school. The professor played a movie with Leo DiCaprio and it was about the field of environmental management. I think this was the first thing that opened this topic with people who had not realized it so much before, or those who considered him only to be a Hollywood star. People realized that this must be a serious thing if he was also an ambassador to the UN. And these are things that I, as a student, had no idea at all about.” (Slovakia, male, 25–34, university education)

“I think the latest film promoted by Greta Thunberg has just been released, and I think it’s a masterpiece ... talking to a scientist who talks about what’s going on and finally telling you what you can do. Three things: first, share information, second - alert your friends, third - if you can, change your behavior. I think these types of films are perfect.” (Poland, female, 35-44, university education)

The level with education systems points to proposals for improving science communication on climate change in the field of education in primary and secondary education as well as other educational programs, which can also be offered to the general public.

“The only way, in my opinion, is through school education and other educational projects. Teachers should be financially supported for the implementation of projects aimed at additional teaching in schools.” (Poland, female, 25-34, university education)

“I believe that is the way to go. It starts with kindergarten, with small children ... then educating citizens who will then be aware of these changes and will be able to better choose their representatives.” (Portugal, female, 55-64, university education)

At the same time, the respondents confirmed the importance of linking the education system and the family environment. This can help the flow of information on climate change go

both directions, from children who learn new things at school to parents, and vice versa, from parents who can gain knowledge in various areas related to climate change and integrate it into the upbringing of their children.

“I think that education is very important, but first it is the family and only then school ... children repeat what they see with their parents, and if it is connected with education, it brings a better result.” (Slovakia, female, 18-24, secondary education).

“For me, one of the ways information about climate change makes its way home is from school, because that’s where my daughter gets the information she brings home. And maybe it’s the same with some of your children, grandchildren, nephews. I think it is important for people who study this from an academic point of view to organize mini-discussion conferences in schools. When we started sorting our garbage at home, much of the stimulus to do so came from our children.” (Spain, female, 45-54 years old, university education)

According to the respondents, the education system should especially reflect the need to educate the young generation of children, as they will be those that are the most affected by the negative consequences of global warming. Therefore, the education system provides an important environment for disseminating scientific information on climate change.

“Start communicating science well with children, because they are future adults. I remember Rio in 1992 when I was in school, and my teacher was passionate about it and passed this information on to us with passion.” (Italy, female, 35-44, university education)

“It would be nice if there was a subject in the elementary education system in which young children could learn how to live more ecologically, educating them in ecology.” (Slovakia, female, 18-24, secondary education)

Dimensions of science communication in the field of climate change

A more detailed analysis of the data yielded several interesting findings pointing to three basic dimensions of the science communication of climate change. As mentioned above, science communication mostly works with two basic models, a one-way communication model and a two-way communication model (Kappel and Holmen, 2019). In the case of our public consultations, we identified three basic communication dimensions on the topic of climate change that represent the mutual relationship between the scientific community, which is represented by scientific institutions, scientists, science communicators, and science influencers, and the general public. Our findings point to the possibility of using three models of science communication focused on climate change: one-way communication, dialogue and participatory communication.

One-way communication is a type of communication based on mutual dialogue and participatory communication. It is the transfer of scientific information on climate change from the scientific community to the public, and the media, whether traditional or digital, play an important role. Science communication can thus be aimed at publishing popular science books, creating television documentaries on climate change, science blogs, and professional web portals that bring awareness about climate change to the general public. In our case, the respondents confirmed the importance of traditional media in one-way scientific communication, as they are given a higher level of trust. At the same time, however, respondents reflect the growing importance of digital media in the field of climate change. The possibilities social networks provide for the dissemination of scientific information, especially lectures and seminars from scientists and science communicators, enable the participation of the general public in the online environment.

“Every television station should have a program and interviews on these topics. That is the only chance we have. Not just superficial discussions, but expert conversations on these topics on television. To talk about these topics, which is very important. If such programs are not on television, they won’t make a difference.” (Spain, male, 55-64, secondary education)

“I think scientists, at least for me, are still people who are ultimately very fascinating because they can take a step back from society, and I think if you attend a conference of real experts, even if it’s only online, if these scientists speak in an influential way, I think it has a really big impact on the average listener.” (Portugal, female, 25–34, university education)

Dialogue as part of science communication on climate change plays a key role in creating an environment for mutual discussion between the scientific community and the general public. It is an environment in which it is possible to ask scientists and experts on climate change questions directly and create direct interaction between the scientific community and the public to identify possible communication gaps, unanswered questions, clarify public opinions and attitudes, as well as identify societal concerns. In the case of the communication dimension of the dialogue, the respondents confirmed, in particular, the importance of educational initiatives, which allow for direct discussions with climate change scientists and experts both on-site and virtually. According to the respondents, digital media could involve the public more in science communication. It could provide the general public, science communicators, and climate experts with interactive opportunities to discuss various topics on climate change. According to the respondents, efforts by scientists to engage in direct communication with citizens are very well received.

“I think it’s very important that scientists from different fields stop only thinking about publishing ... but start developing science in order to effectively educate and work with society. I also think that it is not just about lectures and workshops on a theoretical level. Communication should also include a practical part, working with people ... Adapt communication and working with different types of populations according to their reality.” (Spain, female 25–34, higher education)

“NGOs are holding meetings like these, some picnics, and discussing what is happening now among young people with this climate strike, giving these young people a very high level of awareness of the subject and, for example, children alerting their parents.” Poland, Female, 55-64, university education)

Participatory communication brings a new perspective on science communication, as it seeks to involve the public in activities aimed at mitigating the effects of global warming and adapting to climate change. Public participation in science communication represents an opportunity to actively participate in science as part of local scientific initiatives, science camps, workshops, and international scientific projects. The participants' communication was not identified to such an extent as being one-way communication and dialogue, but through the analysis of data from public discussions, we were able to observe the respondents' efforts to point out the possibility of being part of climate change solutions, especially at the local level.

“Maybe projects like this with the participation of ordinary people, projects where there will be different companies, research centers focused on this topic, where we can participate, meet to talk about these things, and there is an opportunity to commit to action.” (Spain, male, 55-64 years, university education)

“So, for example, more scientific initiatives. In this case, it is a public consultation, but is this type of thing typically done? There are people who do not normally take part, but these debates can draw them in more. For people like this, lectures are not interesting, but to be a part of a debate and a solution where you ask why do you think this, what do you think, how do you do it? And there is a person who knows how to deal with the situation and can engage the public to express their views and suggestions on the subject, to find out what is happening in people's perception, whether they know or do not know how to communicate with them.” (Portugal, female, 25-34 years, university education)

The participatory dimension of science communication also pointed to the interest of some respondents to be part of solutions that are focused on climate change. This is in addition to the opportunity to participate in possible proposals for changing everyday life, especially at the local and community levels to address climate change. The respondents confirmed the need for mutual cooperation between local governments and citizens to find appropriate solutions to mitigate climate change.

“As I said before, municipalities should play a more active role in this. They should report on climate change, which affects cities, and at the same time propose, together with citizens, a change in attitudes among their citizens. Point out specific examples of how to change people’s behavior while educating them.” (Italy, female, 45-54)

Conclusion

Knowledge about the perception of science communication on climate change by EU citizens can present an important impetus for scientists, climate experts and, in particular, science communicators and popularizers of scientific information. At the same time, the public consultation process can provide a new perspective on the possibility of using a participatory approach to climate change communication, where information is exchanged between science communicators and the general public, where both parties can communicate and share knowledge, answer questions, and possibly find common ground suggestions for possible solutions to this problem (Davies et al., 2009). Involving the general public in the participatory processes of science communication on climate change offers an opportunity to gain a better overview of the perception of scientific information, needs, and preferences in the ways to communicate scientific knowledge about climate change to the public as effectively as possible.

Based on the views of the respondents from the selected European countries, the perception of scientific institutions and scientists working in the field of climate change differs between countries with a long tradition (Portugal, Spain, Italy) and scientific countries with a slight delay (Poland, Slovakia). In countries with a long tradition of science communication on climate change, communicators play an important role, especially from the ranks of scientific journalists and popularizers of scientific topics, as they are more easily identifiable than knowledge bearers and mediators of scientific topics. In countries with a less developed tradition of science communication, international scientific institutions are, according to the respondents, the bearers of scientific information who play an important role in mediating information on climate change. The position of science communicators in these countries is therefore developing very slowly, and identifying them is more difficult for respondents due to their lower degree of anchoring knowledge in the public sphere.

The proposals for improving science communication on climate change from the perspective of citizens of the five chosen European countries focused mainly on the area of communication strategies, which should focus on using a more accessible language of communication with regard to different age categories and levels of education. Related to this, there are proposals aimed at the visualization side of science communication on climate change, which, from the citizens' point of view, can often have a greater effect than communication based on scientific data when passing on information to a wider audience. The position of the communicator also plays an important role in communication strategies on climate change. This person may come from the ranks of scientists, journalists, or celebrities, but they must meet the criteria of being consistent, effective with, and attractive to the general public. At the same time, the presentation of scientific facts should include the opportunity to talk about the issue of climate change in the context of everyday life, to point out its effects on the individual, whether in an individual, local, national, or global context. The recipient of this information would thus have the opportunity to reflect on the consequences of climate change for their own daily lives, life in their neighborhood, their community, as well as in the country where they live. An important dimension of science communication on climate change is the need for active dialogue between scientists and the general public. According to our findings, the participants propose developing scientific educational initiatives that would support direct communication between citizens and the scientific community and, at the local level, the direct involvement of citizens in the search for effective solutions to climate change.

Participatory science communication enables the public to be involved in scientific discussions, and at the same time, it enables citizens to be perceived as active people with an interest in participating in the development of adaptation solutions and climate change mitigation processes, especially at the local level. Science communication on climate change should thus perceive the demands of the public to change one-way communication to two-way communication on climate change, and the perspective of the active public should be taken into account. Our study provides insight into the perception of science communication in the field of climate change from the perspective of European citizens. It presents their proposals for streamlining science communication, which according to our analysis should lead to greater involvement of the active public in finding possible adaptation solutions. The public

consultations focused on a participatory approach to communication brought forth interesting findings. Additionally, the nature of the methodology used enabled the active participation of citizens and brought several benefits with it. Firstly, it made it possible to qualitatively ascertain the views of non-experts on public dialogue while discussing proposals to improve science communication for experts, communicators, and policy makers, all of whom often face obstacles in successfully communicating about climate change. Second, this qualitative and participatory methodology enabled the active involvement of citizens in scientific research processes and created space for inclusive and innovative research (Brondi et al., 2021).

Many of these findings will need to be validated in other types of research, but as a first step, these findings offer room for inspiration and reflection on the further development and overall importance of science communication on both the local and European levels. Science communication is not only one-way communication involving researchers talking to the public. It is also a two-way dialogue about scientific knowledge by experts and how what they say is perceived by the public. Listening to public opinion thus becomes an integral part of this communication, and it can lead to more successful dissemination of scientific knowledge as well as a greater degree of commitment and mobilization to change the perception of science and its greater public credibility.

Annex 1: Script of the public consultations - climate change

How citizens are informed about climate change.	
Discussion course around 15 min.	<p>Do you remember any news about climate change? What exactly was it about? /If no channel or source of information is specified /</p> <p>Do you remember the situation in which you heard / read / saw this message? (Possible answers: TV news, conversation with friends/ relatives/ colleagues, I got it on WhatsApp, I read it in a newspaper, I read it on Twitter ...)</p> <p>Is climate change a topic you are consciously looking for? Why, why not? / If the participants do not indicate what they do next with the information they receive /</p> <p>What will you do if you get information about climate change that interests you? (Possible answers: you will share the information, pass it on, talk about it.)</p>
Credibility of resources	
Discussion course around 15 min.	<p>If you would like to know some specific information about climate change, where would you look for it? Who would you ask? / If participants do not indicate where they would look for information /</p> <p>When you get information about climate change, do you notice where it comes from? How do you decide if a source is reliable or not? Have you ever searched on the internet for information on climate change? What resources? Do you have a favorite? If so, why? / If the participants do not mention specific people associated with this topic /</p> <p>Can you think of anyone who represents the topic of climate change for you? Why this person?</p>
Suggestions for improving science communication	
Discussion course around 15 min.	<p>What would you change to make information on climate change more interesting, complete, and reliable? How do you imagine information on climate change being presented?</p>
End of discussion	
15 min.	<p>The moderator of the discussion proposes a round of final comments. It is necessary to set aside time if one of the participants is interested in adding something to the discussion.</p>

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