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MODFaBe – Modelling individual farmers behaviours in Coupled Human Natural Systems under changing climate and society

Project no. 832464

Report on climate change perception in Italy: farmers and citizens perspective

Deliverable 2.2 (D2.2)

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1. Introduction

This Deliverable (D2.2) "Climate change perception in Italy: Farmers and citizens' perspectives" is part of Work Package 2 (WP2) "Climate change constraints affecting the Muzza system". The main objective of this work package is to provide a synthesis of the main climate change impacts and risks affecting agricultural activity in the Muzza system, in the Lombardy region (Italy), by addressing the gap between water scarcity and water demand scenarios and exploring its impact on the water-energy-food nexus. The focus has shifted from the physical dimension of climate change to considering it as a social phenomenon as well. This report aims to provide a review of the literature on farmers and public climate change risk awareness and perception, highlighting an Italian perspective when was possible.

The report (because of Tasks 2.1, 2.2 and 2.3) sets a reference for WP4 ("Key behavioural rules from individual farmer' perception and key stakeholders' decision") and associated tasks 4.1 and 4.2 which will focus on data collection about climate change perception from managers and farmers through semi-structured interviews and survey, respectively. In addition, D2.2 will also set the baseline for WP5 ("Behavioural models of individual farmers and key stakeholders using artificial intelligence and machine learning technique") by integrating those key points (outputs) from the literature as new utilities functions and multiobjective problems in the DistriLake model.

As a state-of-the-art report, it can be used for consultation by utility managers and operators, local government officials and planners, public interest groups, and end-users, like farmers. Starting with an overview of the project (Section 2), the report is structured in three parts:

- Part I: conceptual framework of risk perception of climate change, considering main approaches and methods
- Part II: farmers' risk perception of climate change, including observed impacts and main driving factors
- Part III: public perception regarding agriculture and farmers' role in climate change adaptation and mitigation.

2. MODFABE project overview

Worldwide water consumption continues to grow, and it is estimated that by the year 2030, more than 160% of the total water volume worldwide will be needed to satisfy global water requirements (Azhoni *et al.* 2018). Moreover, with available water resources diminishing in quantity and quality and increases in the range of water uses in competing sectors, water scarcity has become a critical issue (Fitton *et al.* 2019). Agriculture is the sector most affected by water scarcity as it accounts for 70% of global freshwater withdrawals and more than 90% of the consumption (including non-conventional water resources) (Ricart & Rico 2019). Consequently, irrigation systems are under pressure to produce more food with lower supplies of water (Levidow *et al.* 2014).

Climate change impacts such as high temperature, reduced rainfall, and increased frequency of extreme weather events will add new threats to irrigation systems and will compound existing human pressures through changes to hydrological processes and socio-ecosystem interactions (Reid *et al.* 2019). The mismatch between water supply and water demand in different temporal and geographical scales and according to different climate change scenarios calls for new approaches (Chen *et al.* 2018). Decision-makers need information on how climate change impacts affect water resources for all sectors, particularly agriculture, especially in the most drought-prone, water scarcity or surplus, and water competing users (Hunink *et al.* 2019).

Climate change and water resources management represent two necessarily interdisciplinary topics, in which the natural and social sciences must be integrated (Escribano-Francés *et al.* 2017). In the last decades, the shift to address the integrated management of water resources from a technocratic "top-down" to a more integrated "bottom-up" and participatory approach was motivated by the awareness that water challenges are complex, requiring integrated solutions and a socially legitimated planning process (Fritsch & Benson 2019). That is, assuming water flows as physical, social, political, and symbolic matters, it is necessary to entwining these domains in specific configurations in which water users, managers, and decision-makers could be directly involved (Ricart 2020).

Social learning is considered an important issue in achieving this goal of improving water management and decision-making processes (Johannessen *et al.* 2019). It refers to processes that involve active deliberation and engagement by end-users, managers, and key stakeholders with confronted water demands, which can lead to a new understanding or shared meaning to (1) increase adaptive capacity, (2) build trust and collaborative problem solving, and (3) ensure better co-working between stakeholders, who differently understand features of socio-environmental issues in climate change scenarios (Eriksson *et al.* 2019). The social perception of climate change is fundamental for two important reasons: first, because it constitutes a key component of the socio-political context within which policy-makers exercise their decisions in socio-ecological systems. The second reason is more direct: the process of mitigation and adaptation to climate change requires behaviour transformation and attitude change from those who each day make individual and participate in collective choices that have a huge impact on the planet climate balance (Antronico *et al.* 2020).

Water supply and demand nexus was generally overlooked in the modelling literature by mostly focusing on understanding the natural processes only while assuming one or a few scenarios of human actions generally treated as fixed boundary conditions (Giuliani *et al.* 2016). However, this unilateral perspective might no longer be appropriate if social-learning must be achieved, and a paradigm shift is required to put humans in the modelling loop (Wada *et al.* 2017). Modelling techniques have been recognized, also in social sciences, as effective computational techniques to simulate social influence processes in CHNS from interactions within a community of individual agents (van Bruggen *et al.* 2019). Consequently, modelling human behaviour can be used as a safe laboratory for policy experimentation, testing the effectiveness of strategies and policy measures on climate change by learning from human experience. Furthermore, modelling frameworks must find ways to glue the anthropogenic sphere with the hydrological systems such that the feedback between human activities and hydrological cycles can be addressed internally. Agent-Based Models (ABM) can accomplish this task by considering each agent as an active decision-maker who lives in the common environment and interacts within (Kremmydas *et al.* 2018). By modelling agents individually, the full effect of attribute and behaviour diversity of agents, which together give rise to the behaviour of a system, can be observed. The application of an ABM ensures not only the feedback between social (farmers' agents) and physical (water resources) environments but also the social network based on agents' interactions.

How farmers perceive climate change uncertainties, potential impacts, and risks is important because (Gardezi & Arbuckle 2020): 1) Local experience can be shared and compared and this would be useful to identify common patterns and individual strategies (to be transferred to policy-makers), and 2) assess the perception and effectiveness of climate change responses is the first step towards adaptation. Farmers are key constituents in the social-learning process of understanding both climate change impacts on food and water systems and how best to mitigate and adapt to these impacts (Soubry *et al.* 2020). Farmers develop their activity supporting the complexity of interrelated nature and human systems characterized by political, economic, institutional, cultural, and biophysical conditions (Abid *et al.* 2016). Accordingly, personal experience, local knowledge, and social-learning exchange between farmers and managers may help to promote mutual understanding and to reduce agricultural systems vulnerability. Besides, this could override political barriers to action on climate change and promote an integrated response to a shared problem (Marquart-Pyatt *et al.* 2014): How to ensure food and water security while addressing climate change impacts and risk management in a CHNS?

Modelling human behaviour, however, is rather a non-trivial task: human behaviour is well recognized as a complex non-linear, multi-variate process due to the high heterogeneity and uncertainties in human cognition and decision-making processes. The MODFABE project aims to increase the robustness of decision-making processes in CHNS by modelling farmers' perception and adaptation capacity to climate change. Departing from an existing very basic behavioural model (DistriLake) applied to the management of water supply and demand in the Lake Como to balance shoreline floods and irrigation deficit downstream (Li 2016), the MODFABE project aims to integrate observational data (farmers' perception) into the simulation model to increase the rationality of farmers' interventions in the decision-making processes considering multiple competing purposes and a multiobjective context. The updated behaviour model will contribute to characterize the water supply and demand side of the Muzza system –and its irrigation district as a case study– as one of the largest agricultural areas in northern Italy. MODFABE will offer "what-if" decision support functions to investigate new utility functions, optimization problems, and risk reduction options in the demonstration case study. This local context is a test to the understanding of the driving-factors affecting farmers' perception regarding climate change impacts and how their adaptation capacity affects the management of the CHNS. Results could be used to reformulate policy recommendations to better respond to climate change by considering the preferences shift toward a new equilibrium in decision-making processes to reduce the frequency of unsatisfactory system states (Mason *et al.* 2018).

A twofold question in today's climate change adaptation research will be addressed:

- Could behaviour modelling help farmers to promote actions and anticipate decisions to better adapt to climate change and become less vulnerable?
- Could social-learning from farmers' climate change adaptation capacity provide new social scenarios able to increase model robustness when addressing decision-making processes?

Both questions endeavour to connect climate change adaptation, a macro-level issue, with the behaviour and social learning from farmers and key stakeholders, a micro-level issue. The project also considers a systemic (water resources supply and demand) and stakeholder-centred (farmers, managers, and decision-makers) approach and seeks to collaboratively frame the issue of climate change by co-producing solution-oriented knowledge at the local scale from farmers' feedback. Results could be used to inform managers and decision-makers about the effectiveness of different types of interventions and to reformulate policies to better respond to climate change by considering the preferences shift toward a new equilibrium in decision-making processes to reduce the frequency of unsatisfactory system states (Mason *et al.* 2018). Furthermore, MODFABE will contribute to strengthening the role of farmers' perception of climate change impacts, actions, and barriers when planning interventions by highlighting the nexus between climate services and modelling. Consequently, managers and decision-makers will be empowered to perform climate perception proofs and adaptive policies to increase the robustness of the management of CHNS.

3. Risk awareness and perception of climate change – Conceptual framework

Key messages

- ✓ *Climate change is not easily detected by personal experience, even though it is open to observation and evaluation.*
- ✓ *Risk is commonly defined in terms of probabilities and effects, combining exposure and their negative impacts.*
- ✓ *Individuals and communities socially construct risk.*
- ✓ *Climate change awareness and perception are linked to different types of mental and behavioural models based on a set of beliefs and concerns.*

Climate change tends to be addressed by accurate statistics and modelling but it is perceived in an abstract way, differing from other hazards because it occurs over an extensive period, making it impossible to directly discern changes as they occur (Weber 2016). Concerning local climate change, the weather's natural day-to-day variability can make it difficult for some people to detect long-term local changes (Habtemariam *et al.* 2016), leading to divergent perceptions of climate change. Furthermore, observations are spaced in time, and individual and collective memory of past events can be faulty or uncertain (Song *et al.* 2021), distinguishing between knowing facts (semantic) versus reliving events or experience (episodic) (Plate 2017). Considered within this broader context, the conventional approach to climate change is semantic (e.g., what is a 1 in a 1,000-year event?), whereas storyline approaches are episodic (e.g., have we seen this before; and if so, what might the next event be like?) (Shepherd *et al.* 2018).

As a result, climate change is not easily detected by personal experience, even though it appears to be open to personal observation and evaluation, as most people consider themselves to be experts on the weather and do not differentiate very strictly between climate (the statistical expectation) and weather (what we get) (Weber 2010). Furthermore, insufficient concern and trust also complicate the transfer of scientific descriptions of climate change and climate variability from scientists to the public, policy-makers, and citizens, which is not a simple transmission of facts (Weber 2010).

In parallel, it is important to distinguish between decisions from personal experience (associative and affect-driven ways) versus those from the statistical description (more analytic ways). Associative processing is a very basic human ability that does not need to be learned because associations are made very quickly and automatically turn experienced adverse aspects of the environment into feelings of fear, dread, or anxiety, which then influence decisions (Loewenstein *et al.* 2001). On the other hand, analytic processing works by algorithms and rules that must be learned explicitly, requiring conscious effort and control (Marx *et al.* 2007).

Social and behavioural sciences and the humanities have discussed and debated about associative processing methods and the nature, extent, significance, and influence of personal 'experience of climate change' over the past decade to understand how it affects adaptation capacity (Figure 1) (Marlon *et al.* 2018, Broomell *et al.* 2015, Reser *et al.* 2014, van der Linden 2014, Myers *et al.* 2013). According to Reser & Bradley (2020), four main themes have been highlighted: 1) the extent and underpinnings of public acceptance or 'belief' regarding anthropogenic climate change; 2) how best to communicate with and engage the public regarding climate change; 3) the nature of environmental risk perception and response in the context of climate change; and 4) the unfolding and increasingly dramatic local and global biophysical environmental changes, events, and conditions attributed to climate change.

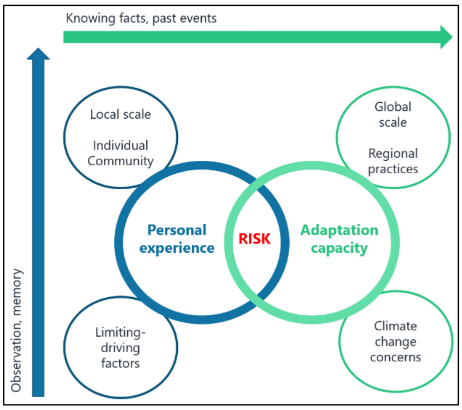

Figure 1. *Personal experience and adaptation capacity nexus. Source: Own creation from Niles et al. (2015)*

Considering climate change as both a physical and social phenomenon (Hulme 2009), personal experience has been analysed as the first step entailing how various audiences understand climate change risk (Asplund 2016). Climate change risk perceptions vary substantially among countries and regions, and differentially affect individuals and social groups, among whom exposures, attitudes, and capacities to manage risks vary greatly (Hultman *et al.* 2010). However, there is a paucity of literature on what climate change risk means because most of the attention was given to understanding the science behind climate change, the predicted impacts of the associated hazards, and mitigation efforts (Smith 2018).

While there are many definitions of risk, they all share three common elements: first, outcomes that adversely affect what people value; second, the probability of their occurrence; and third, a formula for combining the two (Dow *et al.* 2013). Consequently, risk is commonly defined in terms of two dimensions: probabilities and effects, combining exposure to a hazard and its negative impacts (Figure 2). Risk considers the magnitude of the hazards involved, the vulnerability of actors and infrastructure, and the presence of assets or actors (social, ecological, or otherwise) in an affected area (Soubry *et al.* 2020). In general terms, a risk representation is the product of a process in which a hazard is recognized, its characteristics identified, and the probability of its negative impacts occurring are estimated (Breakwell 2010). Its scale, complexity, and controversy have made climate change one of the most globally debated object of risk representation ever known. Likewise, 'risk' is often considered a generic term, without distinguishing its determinants, i.e. the hazard and its probability of occurrence (Li *et al.* 2017).

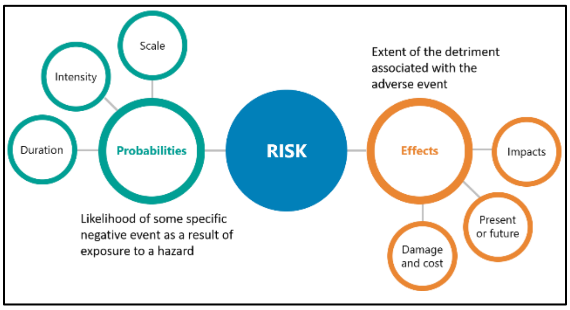

Figure 2. The two dimensions of risk. *Source: Own creation from Breakwell (2010)*

Individuals and communities socially construct risk, and societies with greater risk perception may be more apt to mobilize or adapt to newly emergent risks, like climate change (Smith & Mayer 2018). Climate risk is directly linked to vulnerability because risks of climate change impacts might result from the interaction of climate-related hazards with vulnerabilities of societies and systems exposed (Selvaraju 2012). In the agriculture sector, the climate risk represents the probability of a defined hydrometeorological hazard affecting the livelihood of farmers, livestock herders, fishers and forest dwellers (de Matos Carlos *et al.* 2020).

One of the unique characteristics of climate change risk is that it is often seen as a distant psychological risk (Sterman &

Sweeney 2007), in which effects and risks are spatially and temporally differentiated (Woods *et al.* 2017). In other words, it is assumed that its effects will impact other people that are geographically, temporally, and even generationally removed from themselves (Azadi *et al.* 2019). However, events perceived to be 'closer' to an individual (temporally, geographically, socially) are more salient and have a stronger proximate influence on individual decisions (Spence *et al.* 2012). For example, imagine a specific, personal episode where an individual experiences climate change in the future may bring climate change closer, thus increasing the perceived risk of climate-related risk events (Bo & Wolff 2020). Many have argued that reducing the psychological distance of climate change and making it more personal and relevant can increase the potential for behaviour change (Phadke *et al.* 2015, Geiger *et al.* 2017, Wi 2019).

Some studies have concluded how people in richer countries tend to be less concerned about climate change than those in poorer countries (Sandvik 2008). Meanwhile, additional studies have found those with more risk expertise to appear more concerned about global climate change than those with less (Slimak & Dietz 2006), although other variables such as faith, political affiliation, value systems, and preexisting opinions on the topic have all been linked with increased or decreased levels of understanding and concern over global warming (Niemeyer *et al.* 2005, Reynolds *et al.* 2010).

Climate change awareness and perception have been linked to different types of mental and behavioural models based on a set of beliefs and concerns about the environment that influence how people respond to problems caused by climate change (Sterman 2008). For example, Schlüter *et al.* (2017) highlighted that in various behavioural models, awareness and perception are the initial receptor stage, i.e., "what comes in" while the behaviour is the outcome, i.e., "what goes out." 'Belief' in climate change risks was found to be heightened by the awareness of more observable climate change phenomena (e.g. extreme weather events and water shortage), but it was not a direct cause of adaptation behaviour (Li *et al.* 2017). Along with different approaches, de Boer *et al.* (2016) point out that individuals manage to trade off the information they receive about the consequences of a phenomenon with their previous beliefs and experiences about the weather in their area, thus generating adaptive behaviours integrate both types of knowledge. How people become informed and learn about climate change risks is determined by personal experience and education level, highlighting different sensitivity and barriers (Figure 3). Likewise, an individual's level of concern on climate change can also vary by problem scale; problems often seem more urgent when perceived as local (Maas *et al.* 2020).

Consequently, awareness and perception can be determined by recency effects, that is, the recent occurrence of a climate variation event such as a rainy winter or a dry summer or changes in daily temperature (Ng'ombe *et al*. 2020).

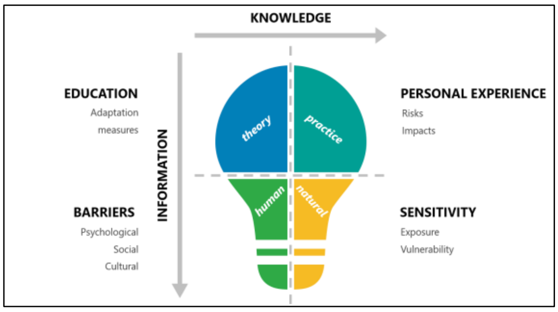

Figure 3. *Knowledge and information in climate change. Source: Own creation from Asplund (2016) and Azocar et al. (2021)*

Socioeconomic and demographic variables such as gender, age, education, and income affect climate change awareness and its risks (Azocar *et al*. 2021) (Figure 4). For example, it is postulated that men tend to be 'risk takers' while women are 'risk avoiders', or how as age increases, mental makeup to comprehend climate change also increases (Mallappa & Shivamurthy 2021). Furthermore, group norms and ideology, aligned with political party affiliation, have been shown to influence an individual's belief in anthropogenic climate change, particularly in the United States (Dietz 2020).

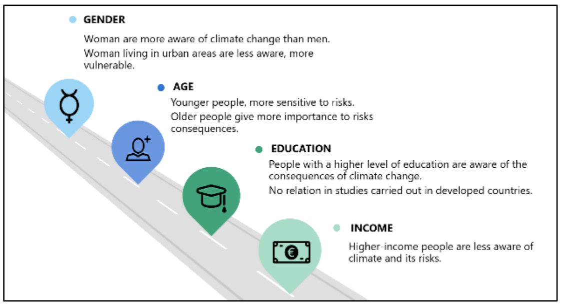

Figure 4. *Socioeconomic and demographic variables in climate change awareness. Source: Own creation from Shepherd et al. (2012), Roco et al. (2015), de Boer et al. (2016), Smith (2018), Owusu et al. (2019)*

Individual understandings of climate change are always contextualized within broader considerations, meaning that people are not 'blank slates' receiving information about climate change, but that information is always and inevitably filtered through values and worldviews (Wolf & Moser 2011). Some studies suggested that climate change's personal experience is interdependent with the information on climate change (Myers *et al*. 2013), which heightens perceptions of climate change's local risks (Akerlof *et al*. 2013). Likewise, (lack of or over) information tends to be related to climate scepticism (Hitayezu *et al*. 2017), considered disbelief or uncertainty concerning (anthropogenic) global warming that espouses a lack of acceptance or awareness regarding the seriousness of climate change and its consequences (Huber 2020). Kahan *et al*. (2011) found that simply providing climate sceptics with more climate change facts to get them to change their beliefs and adopt new behaviours was ineffective. Rather, they found that providing locally specific information on adaptation to impacts through peers or networks with whom they have trusted relationships and shared values is an effective means of encouraging behaviour change among sceptical audiences.

Knowledge, awareness, and perception are intertwined and interactive facets of climate adaptation: while the former is the sum of understanding and past experiences, the other two are a knot of subjective judgements, reactions to specific events or processes (of which climate change may be only one) (Soubry *et al.* 2020). Consequently, facing climate change impacts can be considered from three perspectives: risk awareness, risk perception, and adaptation capacity to mitigate negative impacts on the production system (Juana *et al.* 2013).

3.1. Risk awareness

Several authors have examined awareness of climate change as a significant factor in the managerial understanding of climate risks and climate action (Hoffman 2010). Interestingly, these scholars claim that awareness of climate change is not neutral but rather entails diverse evaluations of climate impacts (such as positive or negative) that determine the strategic intents of climate action. Consequently, risk awareness is a key factor determining the implementation of effective measures for climate change adaptation because the extent to which a community is aware of climate change reflects its level of exposure to climate risks (Ado *et al.* 2019). Increasing awareness is often considered important in the first stages of the adaptation process to manage its impacts, enhance adaptive capacity and reduce overall vulnerability. Likewise, in climate change, which has weak signals and uncertain threats, awareness is essential to define the problem, attribute blame appropriately, and determine appropriate behaviours to address it (O'Connor *et al.* 1999).

However, since awareness itself is a very broad construct, there is a lack of clear definitions with regard to how awareness is developed, what steps are involved in the awareness-development process, what actions are needed to go from one step to another, and who should lead these actions (Tiller & Schott 2013). Furthermore, research does not establish what aspects of awareness are clearly understood by individuals globally (Halady & Rao 2009). Some authors understand awareness not only as the first step prior to developing any resilience-building process but also as a requirement that must be met during the resilience development process because it drives transformation (Abegaz & Wims 2015). Moreover, Iturriza *et al.* (2020) collected main climate change awareness definitions, concluding that most of them define awareness based on the following attributes: perception, understanding, willingness to act, commitment and collaboration (Figure 5).

Figure 5. *Climate change awareness characterization. Source: Own creation from Iturriza et al. (2020)*

Consequently, be aware of climate change requires to perceive that climate change presents a problem, understanding the risks and the impacts derived from climate change to deal with it (Lieske *et al.* 2014). Furthermore, awareness is materialized in the willingness to act and collaborate to face the challenges posed by climate change (Nguyen *et al.* 2015). This collaboration depends on the commitment level, the higher the commitment level the better the quality and efficiency of the implemented efforts to deal with climate change.

In parallel, some authors provided some strategies to improve climate change awareness by focusing on spreading awareness meaning and knowledge as important elements in addressing the climate change issue. The communication maybe on various levels of interaction – whether on an individual's understanding of the phenomenon and its impacts, whether on possible initiatives which individuals themselves can take to address the concern, or whether communities should force economic sectors, such agriculture, to act to address the issue (Figure 6).

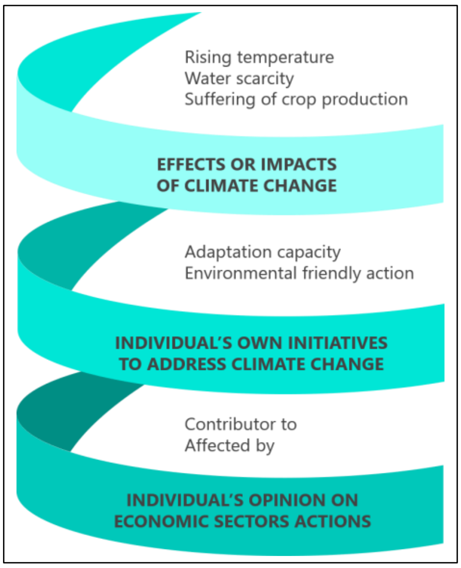

Figure 6. *Pillars of individual's awareness of climate change. Source: Own creation from Halady & Rao (2009 and reference therein)*

Although counterintuitive, higher awareness of climate change might relate to lower risk perception of climate change due to a process of risk normalization (Luis *et al.* 2018). Individuals could develop psychological risk minimization strategies as a way to minimize perceived threats and psychologically adapt to the situations.

3.2. Risk perception

Perception can be defined as the individual or collective awareness about climate change through their senses (Ferdushi *et al.* 2019). The aim is to understand risk perception by identifying hazards while deepening on the risk associated with them (Masud *et al.* 2016). A huge body of literature (Arbuckle *et al.* 2013, Mase *et al.* 2017, and reference therein) has confirmed that appropriate risk perception has a central role and is a prerequisite for choosing an effective adaptation strategy because climate change leaves impressions among the people contained in space and time. Thus, individuals' perceptions of climate change are differentiated by geographic locations and socio-personal characteristics (Hasan & Kumar 2020). Risk perception is how individuals receive information or stimuli from their environment, transform it into psychological awareness, and (re)act accordingly. In other words, it refers to a mental construct, an individual's assessment of the probability of a particular event and its consequences, or a subjective estimation of the nature of a threat and its severity (Azadi *et al.* 2019).

Risk perception is socially constructed and influenced by underlying values and beliefs, social roles, and cultural practices (Becken *et al.* 2013). Beliefs about climate change refer to the extent to which individual is conscient of and is influenced by climate change or their awareness of climate change-related phenomena (Hyland *et al.* 2016). As subjective evaluation, risk perception is formed through experience and personality dispositions that combine to influence attitudes and behaviour within a cultural context of everyday life (Niemeyer *et al.* 2005) (Figure 7).

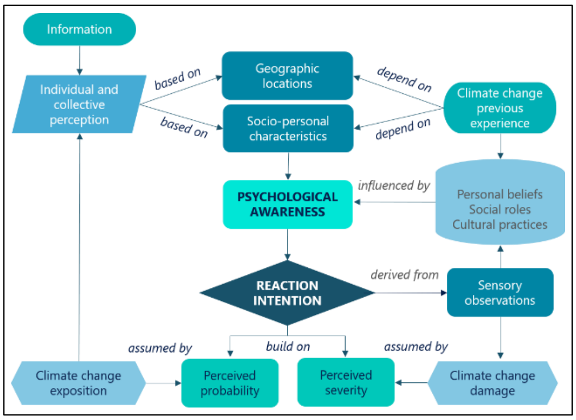

Figure 7. *Climate change perception characterization. Source: Own creation from Seipt et al. (2013), Hyland et al. (2016) and Hasan & Kumar (2020)*

Perception varies with the individual's past experiences and the present sets or attitudes act through values, needs, memories, moods, social circumstances and expectations. Consequently, people infer from a certain situation or phenomenon differently using the same or different information sets. Knowledge, interest, culture, and many other social processes shape the behaviour of an individual or social group who use the information and tries to influence that particular situation or phenomenon (Akhtar *et al.* 2019).

Risk perceptions are derived from and reinforced by people's daily sensory observations of experienced physical conditions and their local memory (Seipt *et al.* 2013), which often differs from the 'de-cultured' climate presented by scientists (Weber & Stern 2011). It describes how people assess the threat of climate change for themselves in terms of perceived probability and perceived severity (Dang *et al.* 2012). Perceived probability indicates people's expectation of being exposed to the threat of climate change, while perceived severity refers to the level of damage that people expect to bear if the threat is realised.

Adaptation could also be considered to be the last step of a linear three-step process starting from risk perception and continuing with intention (Abid *et al.* 2019). Consequently, timely and accurate risk perception is an important determinant of intentions and the choice of adaptation methods (Deressa *et al.* 2011). While poor risk perception may lead to maladaptation (i.e. fatalism, denial and wishful thinking), and increase farmers' vulnerability to climate change, accurate risk perception may positively influence the farm level's adaptation process (Le Dang *et al.* 2014).

The same authors consider that only when people perceive a threshold level of risk, they proceed to the adaptation assessment process. This process consists of perceived self-efficacy, perceived adaptation efficacy, and perceived adaptation cost. The first one indicates how people perceive their ability to conduct adaptive measures, while the second one refers to people's belief in the adaptive measures' effectiveness. Finally, perceived adaptation cost refers to the perceived money, time and effort to take the adaptive measures.

4. Farmers' awareness and perception on climate change

Key messages

- ✓ *Farmers' awareness of climate variability has increased due to recurrent climate variability (temperature and rainfall).*
- ✓ *Farmers may be aware of climate change based on personal experience or via professional and social communications.*
- ✓ *Warming temperatures, droughts and changes in rainfall patterns are the main perceived impacts of climate change.*
- ✓ *Historical meteorological data can verify farmers' observation.*
- ✓ *Education, age, income and access to credit, experience, assistance, and size and land tenure are driving-factors of farmers' perception.*

The fact that climate has changed in the past and will continue to change in the future underlines the need to understand how farmers aware of and perceive climate change. Farmers develop their activity supporting the complexity of interrelated nature and human systems characterized by biophysical conditions and political, economic and cultural issues (Abid *et al.* 2016). Likewise, farmers' perceptions of the regional climate reflect their judgments and awareness of climate change and may affect their adaptation and mitigation behaviours (Hou *et al.* 2015). Furthermore, knowing the level of awareness and perception of smallholder farmers enables policymakers to have a deeper understanding of climate change' realities at the local level, which is essential for policy formulation and implementation (Simane *et al.* 2016, Asare-Nuamah & Botchway 2019). Likewise, perception is an important source of climate change research to better understand local climatic changes and their social impacts (Lehner & Stocker 2015).

Information about farmers' awareness and perception is not geographically homogenised. Although recently, farmers' risk perceptions about climate change in developed countries have become an important research area (Takahashi *et al.* 2016), a low representation of Global North-based literature in this search query has been identified. A literature review by Soubry *et al.* (2020) confirms far more papers concerning regions in the Global South than regions in the Global North (85% vs 15%). Two potential explanations come to mind. Firstly, the Global North literature may not be focused on the perceived risk in the same way as the Global South: studies on Global North emphasised how farmers characterize themselves, rather than on how they react to climate change. Secondly and concomitantly, the fact that farmers in the Global South have generally suffered first, and more strongly, from climate impacts than those in the Global North might bias perceptions research towards the former region. Consequently, the vast majority of references cited in the following sections are focused on Global South experiences.

4.1. Risk awareness and farmers

Farmers are in a favourable position to provide first-hand observations of what climate change or climate variability means to them and might offer a deeper understanding of both the manifestation of climate change and its relevance and effects. However, Talanow *et al.* (2021) provide examples of how difficult it is for farmers to identify farming effects due to global warming:

> *It's very difficult to say that global warming has an effect on our farming, because last year was dry, it was a dry year, but this year it's more normal. And now the harvest is really good! So, what can you say now? Is it now global warming, what is it? I don't know."*
> (Talanow *et al.* 2021: 207)

Awareness of climatic change and its adverse effects is imperative for farm households to cope with those impacts. A review of the literature (Fahad *et al.* 2020) concluded that the farm households' decision about climate change adaptation strategies is directly associated with the climate change awareness level of farm households, resulting in vulnerability reduction and improvement in livelihoods. Sulewski & Kłoczko-Gajewska (2014) argued that if farmers are not aware of climate change risks, they will not respond to them. Likewise, if the threat was not serious enough, it would not be possible to stimulate precautions (Leiserowitz 2005, Weber 2006).

In the same line, Vanclay *et al.* (2006) argued that farmers' beliefs about climate change are pivotal for assessing the probability of possible adaptive measures, which is important, as ignorance and disbelief can mean a lack of action or even rejection of these threats (Eggers *et al.* 2015). Moreover, farmer perspectives of climate change differed across two dimensions: (1) the extent to which farmers believe climate change is happening and (2) the extent to which farmers believed humans were contributing to climate change (Niles & Mueller).

Farmers' awareness of climate variability has increased due to recurrent climate variability (e.g., abnormally rainfall patterns, increased temperatures, and more frequent episodes of floods and droughts periods) with direct effects on expected agricultural outputs (Fosu-Mensah *et al.* 2012), but also regarding socio-economic variables. Authors such as Li *et al.* (2017) applied path analysis to deepen on causality and inter-relationships between climate variability and farmers' beliefs, awareness, and adaptation capacity. The obtained results highlighted two main issues. Firstly, the belief in individual vulnerability was found not to directly influence adaptation behaviour. Secondly, belief in climate change risks was heightened by the awareness of more observable climate change phenomena (e.g. extreme weather events and water shortage) but it was not a direct cause of adaptation behaviour (in line with Wheeler *et al.* 2013).

Likewise, four main factors requested through a farmers' survey (human capital, social capital, financial capital, and farm characteristics) have been analysed to report their influence on explaining the beliefs-awareness-adaptation nexus (Figure 8). According to the analysis, 17% of the variation in 'adaptation' could be explained by including human capital factors such as education, considering no evidence to support the hypothesised direct relationship between education and adaptation, but identifying 'low education' as a positive cause of the 'awareness of extreme events'. The social capital factors could increase adaptation capacity by 24%, mainly if the householder comprises agricultural social groups. However, financial capital could explain an increase of 37% regarding the adaptation potential. Interestingly, the model identified two opposite causes to farmers' awareness of water shortage: higher farm income was lower this awareness, while greater production sales increased it. Finally, the farm characteristics increased the variation explained for adaptation to 28%. Farmers managing larger farms were more likely to have a deeper 'belief in climate change', a shallower 'belief in local agricultural exposure', and greater 'awareness of water shortages'.

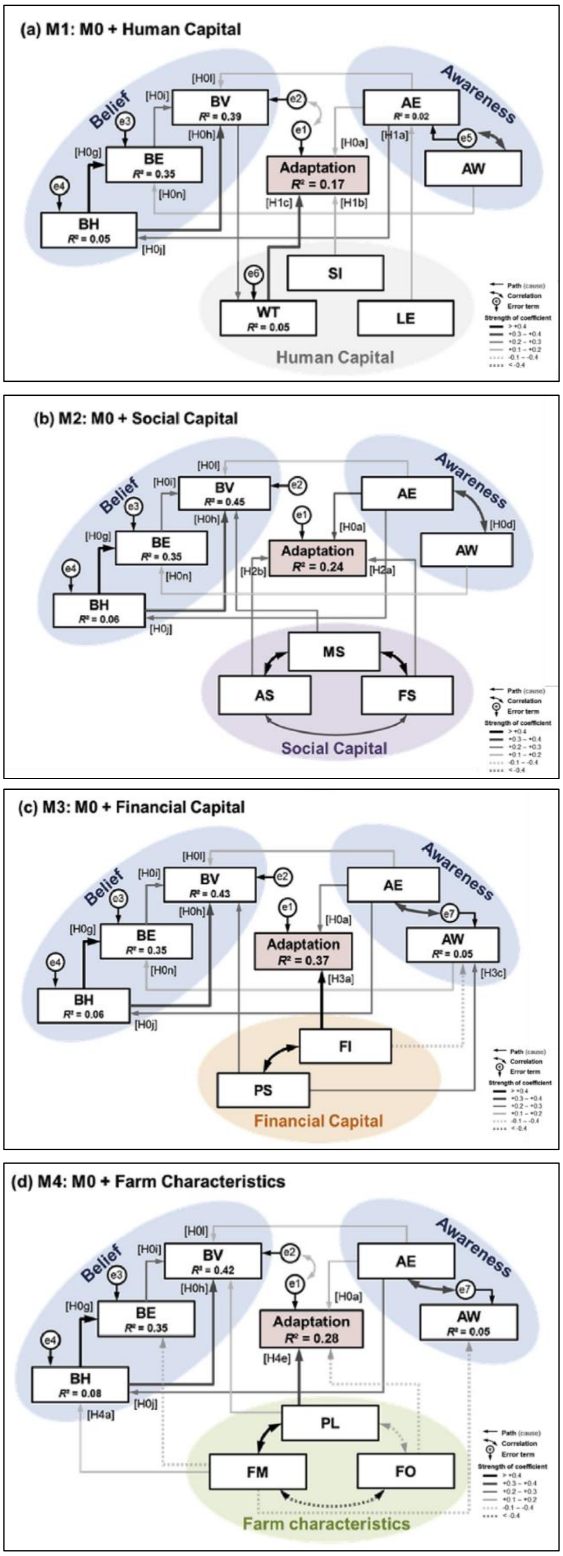

Figure 8. *The role of human capital (a), social capital (b), financial capital (c) and farm characteristics (d) in the causal relationships between farmers' climate change perception and adaptation. Legend: BV: Believe in individual vulnerability; BE: Belief in exposure of local agriculture; BH: Belief in climate change hazard; AE: Awareness of extreme events; AW: Awareness of water shortage; SI: Succession intention; WT: Willingness to try new land use plans; LE: Low education; MS: Membership in social groups; AS: Access to extension services; FS: Family members in social groups; FI: Farm income; PS: Production sale; PL: Purchased farm land (last 5 years); FM: Farm size managed; FO: Farm ownership. Source: Li et al. (2017)*

However, as some authors suggested, 'seeing is not believing' for farmers, and even after acknowledging their experience with climatic extremes, many continue to be resistant to the idea of the need to mitigate agricultural contributions to climate change (Houser *et al.* 2017, 2019). For example, a study by Prokopy *et al*. (2015) reported how farmer's concerns of climate change risk are lower than their belief in climate change. This is in line with other works on climate change awareness, concluding that individuals often perceive it as a distant problem (Spence *et al*. 2012, Niles *et al*. 2015). Interestingly, some studies reported a discrepancy between awareness and climate change knowledge. For example, in the study by Shukla *et al*. (2019), about 83% of the farmers were not aware of the term 'climate change,' yet the majority of the farmers (97%) believed that climate has certainly changed from what they recall of 20–25 years ago. Consequently, if farmers can be aware and concerned when experiencing climate change impacts and this experience is not leading them to support climate change mitigation efforts, this begs the question: How then are they interpreting their experiences with the impacts of climate change?

Farmers may be aware of climate change based on personal experience or via professional and social communications. For example, farmers that have in the past unexpectedly experienced droughts, floods, frost, heatwave, or extreme temperatures are more likely to be aware of climate change and risk to agriculture than otherwise (Ng'ombe *et al.* 2020). By experiencing such unusual weather events, farmers are more likely to become aware of climate change and its risk on agricultural production. In this line, literature examining farmer awareness reported different statements on farmers' attitudes. For example, asking about the statement 'climate change is occurring or had occurred', obtaining between 50-90% of farmers agreement and including examples in which awareness is significant or total (75-100%) (Hameso 2017, Hundera *et al.* 2019, Mutandwa *et al.* 2019, Zhang *et al.* 2020).

Most of the studies reveal how climate change awareness is mainly based on some observed changes in weather patterns, such as the change in temperature and rainfall patterns with about an 80-98% of agreement (Mandleni & Amin 2011, Shukla *et al.* 2016, Ado *et al.* 2019, Voss 2021, Yarong & Minpeng 2021). Likewise, more than 90% of the farmers thought climate change impacts the crop production, with 59% of the respondents asserting that the impact is quite obvious (Guo *et al.* 2021). However, whilst there was the awareness that anthropogenic climate change is a reality, there was some uncertainty of livestock's contribution to the problem (Hyland *et al.* 2016, Tzemi & Breen 2019, Li *et al.* 2021). It was interesting to observe how some studies have reported examples of farmers that were less hesitant in chastising other industries and activities as contributors to climate change (Figure 9).

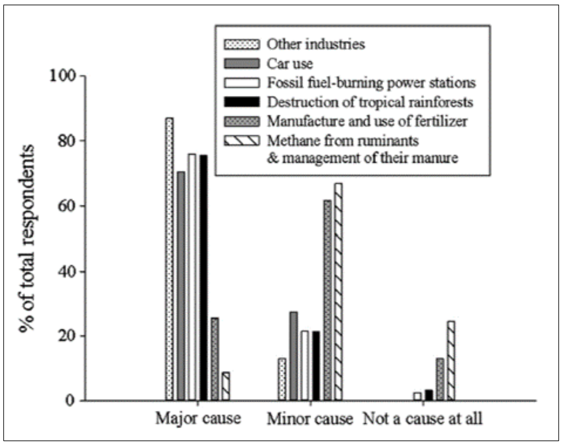

Figure 9. *Respondents' perceived anthropogenic causes of climate change. Source: Hyland et al. (2016)*

Respondents had heard about climate change by perceiving climate change as the second most worrying driver of change just after financial issues (Escarcha *et al.* 2018, Fahad *et al.* 2020, Guo *et al.* 2021). Moreover, close to 60-76% of the farmers were aware of climate change because the weather is becoming unpredictable (Shukla *et al.* 2016, Meldrum *et al.* 2018, Chhogyel *et al.* 2020). In these cases, some authors provide additional questions to farmers related to the concept of climate change and its 'unpredictable' nature to further examine the consistency of their awareness about climate change. For example, the results obtained by Hundera *et al.* (2019) revealed that only 40% of the respondents were able to conceptualize 'climate change' as changes in the average weather conditions over extended periods of time (30 years). Other studies deepen on the anthropic nature of climate change to identify the farmer's level of awareness, obtaining about 40% of positive answers (Chatrchyan *et al.* 2017).

Furthermore, some studies also found that a high level of uncertainty and scepticism still exists among those farmers aware of climate change (Davidson *et al.* 2019, Lane *et al.* 2019). One of the largest studies carried out in the United States to deepen on agricultural stakeholder views about climate change, which surveyed 4,778 corn and soybean farmers across eleven Midwestern states, found that 66% of farmers believed climate change is occurring, but a quarter considered that it had not been scientifically proved (Rejesus *et al.* 2013). However, nearly all respondents (98%) in the study carried out by Escarcha *et al.* (2018) stated that their overall production system had been affected negatively by climate change in the past decade. Results from Debela *et al.* (2015) stated that increased access to agricultural support services could improve the availability and quality of relevant climate information. This will further enhance a rural community's awareness of climate change by better management of climate-induced risks.

4.2. Risk perception and farmers

Although awareness alone may also directly cause concern and stimulate adaptation actions (Li *et al.* 2017), how farmers perceive climate change impacts strongly affects how they deal with climate-induced risks and opportunities, and the precise nature of their behavioural responses to this perception will shape adaptation options, the process involved, and adaptation outcomes (Ado *et al.* 2019). Nevertheless, perception is not sufficient for adaptation since farmers who have perceived climate change may not adapt. The nature of their adaptation response may vary as a result of a complex interplay among social, economic, environmental, and institutional factors (Elshirbiny & Abrahamse 2020).

According to the Intergovernmental Panel on Climate Change (IPCC), farmers' perceptions of climate change can be considered subjective evaluations based on farmers' knowledge of the severity of risks imposed by climate change, which help determine which adaptation strategies farmers adopt (IPCC 2014). Moreover, farmers' perceptions regarding climate risks are shaped by their knowledge about the causes of climate change, their beliefs, social norms, and values, as well as through their experience with climate-related information and past climate-related events (Eitzinger *et al.* 2018). Therefore, farmers that perceive climate change as an occurring phenomenon that is human-induced in nature are more likely to seek positive adaptation strategies, while if farmers do not believe that climate is changing, they will not be able to perceive that it is a treat, and consequently will not undertake adaptive approaches (Ferdushi *et al.* 2019).

According to the conceptual review

conducted by Damodar & Nibal (2020), there are four elements to shape perception of climate change: (1) *Experience* (from events during farmer career, (2) *Memory* (when farmers recall the risks of climate change while this events or risk not have been in the particular period of recall), (3) *Definition* (a set of criteria such as how long it will change and how much of climate indicators change) and as a result of their combination, (4) *Expectation* (the future of climate change risk and how is it expected to occur).

Likewise, authors such as Yang *et al.* (2021) differentiate between climate change perceptions in the short and long term. Short-term perception is defined as the perception of extreme weather events in the past year, whereas long-term perceptions are perceived changes in temperature and rainfall over the last 20 years. In perceiving short-term extreme weather events, farmers are expected to adopt immediate strategies, while perceptions of long-term climate change lead to more resilient adaptations with costly strategies available over time.

4.2.1 Observed impacts

It has been hypothesised that farmers who have observed or have knowledge about climate change phenomena are more likely to believe in the potential of future risks, including risks associated with high-end climate changes, and consequently are more likely to adopt adaptation practices (Menapace *et al.* 2015). Several studies indicate that farmers agree that the climate is changing, especially in the last 20 years, by personally experienced and perceived abnormal changes in their local climatic patterns (Manandhar *et al.* 2011, Hitayezu *et al.* 2017, Meldrum *et al.* 2018).

Changes in precipitation and temperature were the two main variables used as indicators of climate change. The study of Ado *et al.* (2019) pointed out how 95% of respondents reported negative impacts of climate change on crop production due to changes in temperature and rainfall patterns, while 92% reported negative impacts on their household revenue. However, a quarter considered that these impacts could not be exclusively related to climate change. The negative impacts of climate change due to changes in temperature and precipitation patterns have also been reported by Zhang *et al.* (2020), highlighting how 79% of the farmers believed climate change had reduced their agricultural and animal husbandry production yields, while 74% of farmers believed that climate change had driven up production costs.

In recent publications such as Habtemariam *et al.* (2016), Hameso (2017), Akhtar *et al.* (2019), Ramborun *et al.* (2019), Soglo & Nonvide (2019), Tesfahun & Chawla 2019, Lone *et al.* (2020), Mihiretu *et al.* (2020), Tessema & Simane (2020), Zhang *et al.* 2020, and Guo *et al.* (2021), respondents were asked for any observed changes in temperature and drought risk and frequency over the last 10-20 years. The results revealed a 70-95% agreement on identifying warming temperatures, higher than the 60% reported by Mutandwa *et al.* (2019), 58% by Min *et al.* (2020) or 53% by Li *et al.* (2021). In the same line, the study carried out by Alvar-Beltrán *et al.* (2020) concluded how, on average, the vast majority of the farmers (92%, the same pattern reported for dry-spell duration and longer dry spells during the rainy season) perceived a temperature increase in the last two decades.

Likewise, drought takes a central position in people's memory as it directly affects water and food availability (Etana *et al.* 2020). Most of the studies reported high percentages of agreement among farmers perceiving an increase in frequency and intensity of droughts risk, especially during the crop production season: almost all farmers (99%) (Soglo & Nonvide 2019), 91% (Zhang *et al.* 2020), 88% (Adzawla *et al.* 2019), 75% (Escarcha *et al.* (2018), 70% (Hundera *et al.* 2019), significantly higher than the 58% reported by Min *et al.* (2020), the 55% reported by Asrat & Simane (2019), and the 42% reported by Bonzanigo *et al.* (2016). Some qualitative studies such as Takahashi *et al.* (2016) provided examples of the most frequently mentioned impact of climate change on agriculture: it is changing and will continue to change, the length of the growing season and, the timing of planting dates and harvest times:

> *It's always hotter, so then our crops are getting ready earlier all the time. When I was in high school we never picked strawberries until at least graduation, so that was the 20th, 25th of June. Now it is normal for us to start the first week, second week of June, so everything has changed.* [Takahashi et al. 2016: 951]

> *In the last 50 years I can see where the climate is warming up a little bit earlier in the season, so it allows us to plant a little bit sooner. And it does allow us to harvest a little bit later in the fall season because it's obviously warmer in the fall.* [Takahashi et al. 2016: 951]

De Matos Carlos *et al.* (2020) reported how most of the farmers considered that the droughts are happening unpredictably, and the heat is increasing progressively. Both patterns (temperature and droughts) fit well with the increase in the number of dry summer days and extreme heat as part of a changing climate identified by Escarcha *et al.* (2018). Consequently, climate change effects in water scarcity were recognized by authors such as Chhogyel *et al.* (2020), who highlighted how about 50% of the respondents reported the drying of irrigation sources which is crucial for farming.

In terms of changes in precipitation and observations about rainfall patterns, between 50-86% of the respondents thought the average precipitation is getting perceptively unstable, reporting an overall change in seasonality of rainfall (Bojovic *et al.* 2015, Meldrum *et al.* 2018, Zhang *et al.* 2020, Guo *et al.* 2021, Voss 2021).

Before, there used to be a rainy season for four months but now, it's no longer four months. Now it's only two and half or three months. The rain stops when the plants are at the peak of their growth.
[Voss 2021: 4]

Consequently, the growing period of crops has been shortened as considered by the 87-89% of the farmers consulted in the study of Hundera *et al.* (2019), 77% of the farmers consulted by Tesfahun & Chawla (2019), and the majority of farmers consulted by Ramborun *et al.* (2019) (who highlighted a reduction in crop yields both qualitatively and quantitatively) and Tessema & Simane (2020). Likewise, about 90% perceived that extreme rainfall and extreme events frequency (floods) has increased during the last decades (Escarcha *et al.* 2018), in line with an average increase over the years in risk perception on late-onset on rainfall and erratic rain (Hameso 2017, Adzawla *et al.* 2019, Soglo & Nonvide 2019, Altea 2020).

However, a yearly decline in rainfall and water supplies were observed by 30-50% of farmers (Grimberg *et al.* 2018, Lone *et al.* 2020, Li *et al.* 2021), but about 77-85% according to Habtemariam *et al.* (2016, Figure 10), Alvar-Beltrán *et al.* (2020) and Mihiretu *et al.* (2020). Some studies pointed out that this reduction in precipitation mostly affects the summer pattern (an overwhelming majority of farmers, 99%, according to Shukla *et al.* 2019), while about 95% of farmers realized that the groundwater level has declined (Singh 2020).

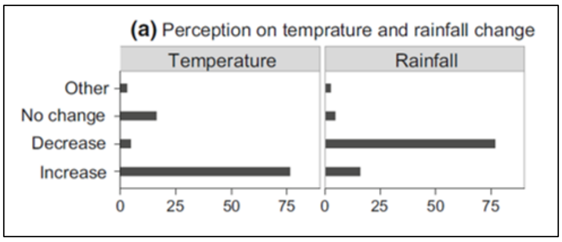

Figure 10. *Percentage of respondents on past temperature and rainfall change perception. Source: Habtemariam et al. (2016)*

Moreover, the majority of respondents (62-88%) agree with the late start and early ending of the rainy season (Habtemariam *et al.* 2016, Tesfahunegn *et al.* 2016, Roy *et al.* 2020, Diarra *et al.* 2021), while this percentage increases to 82-94% when asking for a perceived decrease in the length of the rainy season (Figure 11), which implicitly means an increase in the dry season (Tesfahunegn *et al.* 2016, Touré *et al.* 2016, Asare-Nuamah & Botchway 2019, Tesfahun & Chawla 2019, Etana *et al.* 2020) from six to four months in some case (Sanogo *et al.* 2016). Authors such as Roy *et al.* (2020) identified a decreasing intensity in rainfall in the past 20 years, while most of the respondents (89%) experienced a lower number of rainy days during the same period. However, the wet season was perceived as becoming wetter (increasing the number of rainy days) by about half of the respondents (53%) in the study of Escarcha *et al.* (2018) or 72% according to Ramborun *et al.* (2019).

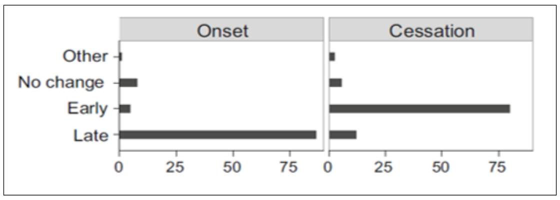

Figure 11. *Percentage of respondents on rainfall timing change. Source: Habtemariam et al. (2016)*

Farmers' perceptions of changes in temperature and precipitation can be verified by the historical meteorological data (Hein *et al.* 2019), revealing that about 70% of the sampled farmers had the correct perception of changes in climate, including studies in which farmers' perceptions of climate change were the same as the results of meteorological analysis (Patrick *et al.* 2017). However, there is a gap about why farmers' perception diverges from what has been happening in most cases. Some studies present findings where farmers' perception does not align with meteorological records (Mulenga *et al.* 2016). In general, farmers' perception of increasing summer and winter temperatures is mostly consistent with meteorological data (Manandhar *et al.* 2011). In some cases, after removing the seasonality and random components from the temperature time series, a decreasing trend is reported (Hasan & Kumar 2019). Regarding the rainfall patterns, an extensive review carried out by Foguesatto *et al.* (2020) reported how, in general, farmers perceive a decrease in rainfall amount while it not occurs, as exemplified in the study of Hasan & Kumar (2019) (Figure 12). One explanation for this inconsistency could be, according to Niles & Mueller (2016), that while farmers may have a closer relationship to weather and climate than many laypeople, it is also possible their perceptions are influenced by the infrastructure and management strategies on their farms designed to adapt to unfavourable conditions.

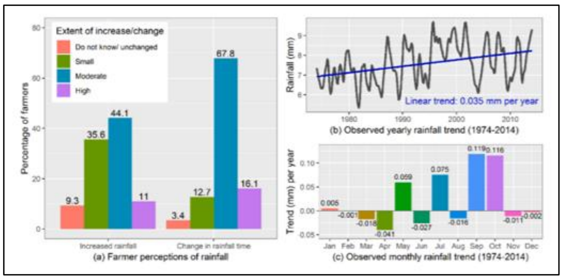

Figure 12. *Comparison between farmer perceptions and observed rainfall change. Source: Hasan & Kumar (2019)*

Furthermore, some studies are focused on which factors accurately explain differences between *poor* and *good* perception (more or less consistent with scientific data) (Figure 13), highlighting how family size, gender, and age, plus market distance are variables unable to provide good perception (consistency with meteorological data).

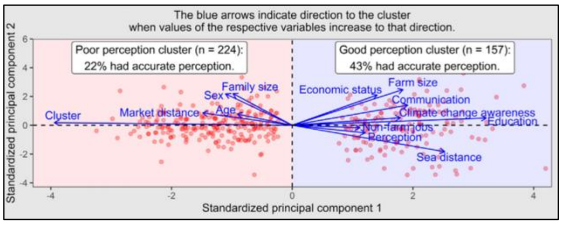

Figure 13. *Driving-factors explaining accurate perception vs meteorological data in farming activities. Source: Hasan & Kumar (2020)*

Contrary to contrasted analysis between the *poor* and *good* perception of past temperature and rainfall trends versus observational data, farmers' opinions on future climate conditions were relatively divided. A significant number of respondents tend to reply 'I do not know' when asked to predict future climate, showing that they cannot assume the future although information and knowledge from the past are provided (Carolan 2020). For example, when asked to anticipate future rainfall and temperature changes, only 45 and 37 % of respondents reported increasing future temperature and decreasing rainfall, respectively (Habtemariam *et al.* 2016, Figure 14).

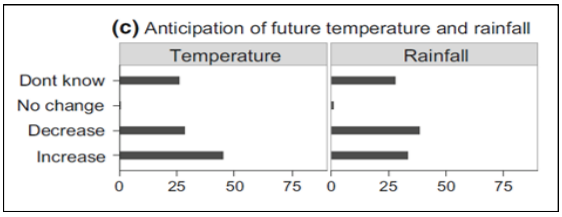

Figure 14. *Percentage of respondents on anticipation of future temperature and rainfall. Source: Habtemariam et al. (2016)*

While farmers tend to observe changes in extreme weather, many still do not believe that the extreme weather they experienced in the past was a major risk to their operations in the near future. For example, a study of 1,276 farmers in Iowa found that only 35% believed that extreme weather would occur more frequently in the future, while many farmers remained uncertain about whether extreme was a significant risk to their operations (Arbuckle *et al.* 2015).

4.2.2 Driving-factors

The literature identifies several drivers behind climate change perception among farming communities globally that can either act as a barrier or support adaptation behaviour (Roco *et al.* 2014, Tessema *et al.* 2019, Talanow *et al.* 2021). Socioeconomic features, like previous experience, land tenure, access to credit and technical assistance, on- and off-farm income, social networks, and size of the holding are some of the key factors that influence farmers' perception of climate change and adaptation (de Matos Carlos *et al.* 2020). Considering that the underlying mechanisms shaping farmer' perceptions of climate change are complex and multidimensional, factors also involve variables such as faith in key institutions (Arbuckle *et al.* 2015), political ideology (Grimberg *et al.* 2018), gender (Assan *et al.* 2018), education levels (Gebrehiwot & van der Veen 2013), cultural norms (Running *et al.* 2017), and personal experience with the weather (Lane *et al.* 2018).

For example, farmers with larger farms, larger yields, or more income sources tend to be wealthier, which makes them less sensitive to the marginal effects of climate change on agricultural economic profits (Botero *et al.* 2021). Landholdings also influence the perceived impacts; the larger the land area owned, the lower the likelihood that a farmer perceived climate change impact (Escarcha *et al.* 2018). As expected, farmers with large rural properties are likely to be more able to test and invest in strategies to attenuate climate risk (Ali & Erenstein 2017). Furthermore, intra-seasonal weather variation is also a predictor of perception since it affects farmers' planting decisions throughout the year (Thomas *et al.* 2007, Rao *et al.* 2011). Households' characteristics may also explain farmers' climate change perceptions, for example, farm size, crops' yield or the number of crops grown (Bryan *et al.* 2013, Mugi-Ngenga *et al.* 2016, Eitzinger *et al.* 2018).

Asrat & Simane (2018) and Ado *et al.* (2019) coincide with identifying the household head's education level and age as the main variables, which significantly increase the likelihood of farmers' perception of climate change. Education is positively associated with farmers' climate change perception and adaptation decision suggesting that educated farmers tend to better recognize the risks associated with climate change (Barnes *et al.* 2013, Withmarsh 2011). Education also more likely enhances farmers' reasoning capability and awareness about new technologies and hence induces them to adopt (Asrat & Simane 2018). Likewise, some studies concluded that age and length of farming experience have contrasting impacts on farmers' perceptions. For example, the older the farmers, and the less experienced, the more they perceived that climate change had affected their production systems (Escarcha *et al.* 2018). This finding contradicts other studies that identified age as a proxy of farming experience because more experienced farmers are significantly more likely to perceive climatic changes, such as variability in rainfall and increases in temperature (Lasco *et al.* 2016). However, other studies indicate that experience does not necessarily have to be strongly correlated with age (Lee *et al.* 2015).

Furthermore, risk perception also increases with the farmers' higher income level from agriculture, and vice versa (Aydogdu & Yenigun 2016) (Figure 15). Economically better-off farmers are more likely to generate their livelihoods from multiple sources that they are less dependent on weather-sensitive livelihood activities. Hence, they are likely to misperceive 'real' changes in climate variables (Etana *et al.* 2020). On the contrary, farm households with income other than farming have less awareness about climate change than are those with no off-farm income sources (Fahad *et al.* 2020).

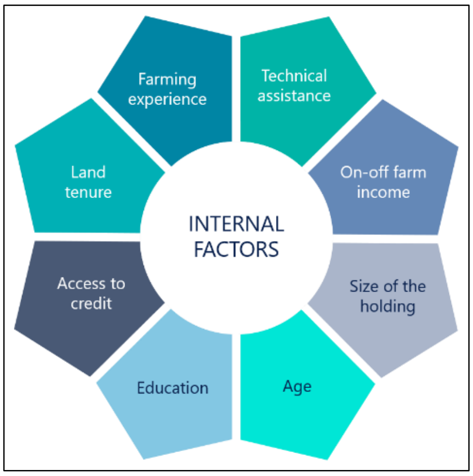

Figure 15. *Internal factors conditioning farmers' awareness and perception on climate change. Source: own creation from Escarcha et al. (2018), Ado et al. (2019), de Matos Carlos et al. (2020), Bolero et al. (2021) and Talanow et al. (2021)*

Barnes *et al.* (2013) asked farmers to identify what factors they perceived to have influenced on business performance in the last ten years. According to the results, market factors are most prominent, followed by government policies. Conversely, those factors which would be expected to increase in frequency because of climate change (increases in the numbers of pests and diseases, for example) have not, on the whole, significantly affected business performance in the farmer perceptions. Consequently, there seems to be a lack of evidence, at least from the farmer perspective, that climate change is proving a significant enough economic threat when they compare to other factors which influence planning. This may align with the concept proposed by Weber (2010) of a 'finite pool of worry', as other risks become more prominent then concerns regarding the environment, and climate change itself, decrease.

Some studies provided farmer' profiles in which most of these variables have been combined. For example, Etana *et al.* (2020) reported how lack of education, lack of access to media, being a young household head, and medium economic status further characterizes households with an inaccurate perception of flood occurrence.

4.3. Effects on climate change adaptation

In general terms, adaptation programmes, strategies, and policies tend to unconsider farmers' awareness and perception for their design, which means that adaptation approaches and mechanisms may fail due to a misalignment of farmers' preferences and acknowledged needs with adaptation' objectives (Botero *et al.* 2021).

Yet, farmers have always been adapting to changing conditions, and it may be difficult, if meaningful, to isolate whether climate change is the main driver behind their adaptations (Bonzanigo *et al.* 2016). Farmers' adaptations result from multiple signals (climate, market, policy) integrated within the same decision-making process for tactical and strategic choices in the farm. The greater the perceived risk to an objective, the greater the demand for adaptation to manage the risk. In this sense, adaptation objectives are consistent with prevailing social, cultural, or economic values and goals (Dow *et al.* 2013).

Understanding farmers self-identify, their awareness and perceptions of climate change risk are essential in tailoring initiatives to provide improvements in the environmental performance of agriculture while influencing the likelihood of farmers' voluntary uptake of climate change measures (Hyland *et al.* 2016). Evidence suggests that adaptation has become routinized into best management practices, like something any "good" farmer (Morton *et al.* 2017) ought to do regardless of their beliefs about climate change. However, awareness and perception of climate change impacts positively and significantly affect the respondents' level of adaptation (Adger *et al.* 2009, Juana *et al.* 2013). Being aware of climate change increases the likelihood of adaptation by 18.9% (Ado *et al.* 2019). According to Le Dang *et al.* (2014), when farmers believe that higher risks of climate change are threatening their physical health, finance, production, social relationships and psychology, they are more likely to have an intention to adapt to climate change. Furthermore, adaptation intention also increases when farmers perceive greater effectiveness of adaptive measures in general and more agency to conduct adaptive measures in particular.

On the contrary, some studies, such as Azadi *et al.* (2019), in line with Evans *et al.* (2011) or Arbuckle *et al.* (2013), concluded how farmers' beliefs and awareness of climate change had no effects on their adaptation behaviours and risk perception. These authors argued that farmers' adaptation behaviours may occur without engaging their belief systems about climate causality. Furthermore, the results obtained by de Matos Carlos *et al.* (2020) demonstrated that there is no direct relation between perception about the negative effects of climate change and adaptation; perception only affects adaptation when mediated by belief in the negative effects of climate change (this result is called by the literature of 'indirect effect'). In other words, awareness and perception will influence adaptation practices when farmers believe in climate change.

5. Public perception regarding farmers' role in climate change

Key messages

- ✓ *Climate change has become a major concern for two-thirds of Europeans citizens, including climate change in the list of the three most serious problems facing the world.*
- ✓ *Women, young and educated citizens are more conscient of the need for tacking climate change.*
- ✓ *Not enough is done to fight climate change, and the responsibility is shared between European and national governments, business and industry, and citizens.*
- ✓ *Farmers must be supported through the agricultural policy to face the consequences of climate change.*

Farmer actions and non-actions are scrutinized by the public, which can support them when these actions fit well with food security and ecosystem services' provision but criticized when impacting or overexploiting natural resources (Howley *et al.* 2014). Personal experience, local knowledge, familiarity, and social-learning exchange between farmers and the public may promote mutual understanding and reduce agricultural systems vulnerability (Goebbert *et al.* 2012). Likewise, farmers are more likely to adapt to climate change when they perceive more pressures from others (e.g. friends, relatives, neighbours) about conducting adaptive measures. Accordingly, subjective norms are important in instructing the farmers' adaptive behaviour because farmers are significantly influenced by whether people around them conduct adaptive measures or want them to do so (Le Dang *et al.* 2014).

Eurobarometer is a series of public opinion surveys conducted regularly on behalf of the European Commission since 1973. Its mission is to monitor member states' public opinion by using telephone or face-to-face interviews and digital questionnaires. The Eurobarometer program comprises different survey series or instruments, including *Special Topic Eurobarometer*. These intermittent surveys extensively address a wide variety of topical issues, including climate change and agriculture (Common Agricultural Policy, CAP) and environment and biodiversity, in which some questions about climate change are included.

From 511 special surveys published until now, 20 reports provide some nexus between these three main topics. Each survey provides European and by country results (in our case, Italy). The main questions addressed by the surveys are focused on: (1) Public perceptions of the seriousness of climate change, (2) The extent to which the public feel informed about climate change, (3) Public attitudes towards climate change and ways of combating it, and (4) Agriculture-environment nexus to climate change.

It should be considered that on some occasions, the fieldwork of the survey has been conducted coinciding with contextual dynamics that have influenced the results, as the economic crisis in 2008, the terrorism attacks in Paris in 2015 or the unpredictable weather events involving heatwaves, flooding, drought, and wildfires across Europe during 2018. All these focused on the debate about climate change and its consequences, affecting phenomena' public perception.

5.1. The Eurobarometer and climate change

Surveys on climate change are collected every two years, over the period 2008-2019. In line with a recent study conducted by Baiardi & Morana (2021), the issues investigated are nine reports conducted from 2008 to 2019 (Table 1). The sample includes the 27 current EU member countries plus the UK. Each report is structured in three main blocks: 1) Perceptions of climate change, 2) Acting on climate change, and 3) Looking at the future.

Table 1. List of special surveys consulted regarding climate change

Reference	*Date*	*Title*
300 *313* *322*	2008 2009 2009	Europeans' attitudes towards climate change
372 *409* *435* *459*	2011 2014 2015 2017	Climate change
479	2018	Future of Europe (including climate change)
490	2019	Climate change

For 6 of 9 reports, a factsheet with the country highlights is provided, including Italy. The next sections include an overview of the main subjective information about causes and consequences of climate change, the level of awareness and perception of climate change' seriousness, and the nexus between climate change and farmers' activity.

5.1.1. Perceptions of climate change

Climate change has become a major concern for many European citizens. In 2008, global warming was considered the most serious problem facing the world for 62% of the respondents at the community level (47% for Italian respondents). Men more frequently considered global warming and climate change to be serious problem than women. Likewise, people aged 15 to 24 years were more inclined to think that global warming and climate change were serious problems than older respondents (67 % compared to 56 %). Furthermore, those who position themselves at the left end of the political scale appeared to mention global warming and climate change considerably more often than respondents at the right end of the scale. The extent to which respondents feel informed about certain topics related to climate change, i.e. their *subjective* level of information, appeared to be of crucial influence on their perception of global warming and climate change. Three-quarters of Europeans (in line with Italians, 74%) thought that global warming and climate change was a severe problem (Figure 16). However, just a year later (2009), the increased mentions for a major global economic downturn as the most serious problem in the world have resulted in lower mentions for climate change (descending from 62% of mentions in spring 2008 to 50% in 2009, 41% for the Italians) and ranking third.

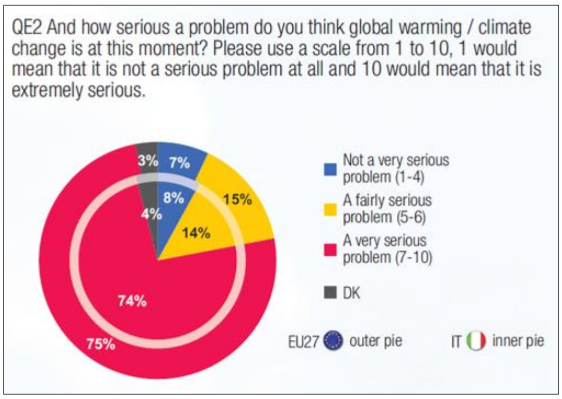

Figure 16. *Seriousness of climate change in 2009. Source: Eurobarometer 300 (2009)*

However, in 2011, one in five respondents (15% for Italians) said climate change was the single most serious problem. The only issue perceived to be more serious was poverty, hunger and lack of drinking water, which was mentioned by 28%. Furthermore, half of the respondents included climate change as one of the most serious problems to be faced are 51%. Concern about climate change was directly correlated with the level of education of the respondents. More highly educated citizens were more likely to mention climate change as a serious issue (e.g. those in managerial roles and students were most likely to mention climate change, 57%). Likewise, almost nine out of ten citizens (89%, 78% for Italians) rated the climate change' seriousness at 5 out of 10 or higher. However, the socio-demographic profile has been changed respecting 2009: women were more likely to describe climate change as a serious problem (average 7.5/10 compared to 7.2/10 amongt men).

The picture in 2014 was similar to the previous 2008-2011 surveys. Half (50%) of the Europeans think that climate change was one of the world's most serious problems, and around one in six (16%) thought it was the single most serious problem. Compared with 2011, small decreases (-4%) in the proportion of Europeans thinking climate change was the single most serious problem and the proportion mentioning it as one of the world's most serious problems (-1%). An explanation could be the increase in 25% of concern for the economic situation and an increase of 18% of the increase in poverty, hunger and lack of drinking water as the main problem to be faced. Moreover, most of Europeans (73%) recognise climate change as a serious problem, very similar to the 74% obtained in 2011. Likewise, nine in ten (82% for Italians) though that climate change was a very serious or a serious problem.

In 2015, climate change was seen as the fourth most serious problem, mentioned by 15% of the respondents (downing from 20% in 2011). The January 2015 attacks in Paris certainly impacted on reshaping the list of concerns by increasing the concern for international terrorism (occupying the second place in the general ranking). The proportion of respondents who consider climate change to be the single most serious problem facing the world has increased since 2015 in six Member States (but not in Italy, where only 7% of the respondents consider climate change the single most serious problem facing the world). More than eight in ten respondents in Italy (81%) considered climate change to be a very serious problem in 2017, while one-third (33%) thought that climate change was one of the most serious problems facing the world as a whole. Although climate change was again the third most mentioned problem at the European level (Figure 17), respondents were less likely to mention it than in 2015 (-4%), and the proportion doing so has consistently decreased since 2011 (-8%).

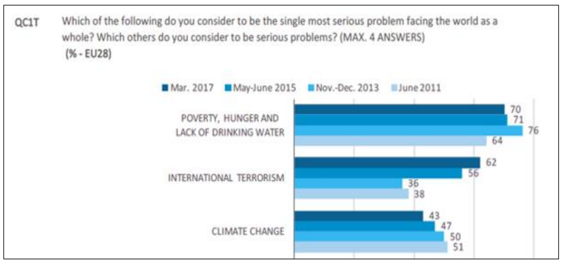

Figure 17. *The three most serious problems facing the world between 2011 and 2017. Note: Max. 4 answers. Source: Eurobarometer 459 (2017)*

One of the novelties presented by the 2018 report is the focus on the anthropogenic nature of climate change (Figure 18). A large majority of European citizens (93%, equal for Italians) said that climate change is due to human activity, either entirely (42%, 39% for Italians) or partly (51%, 54% for Italians).

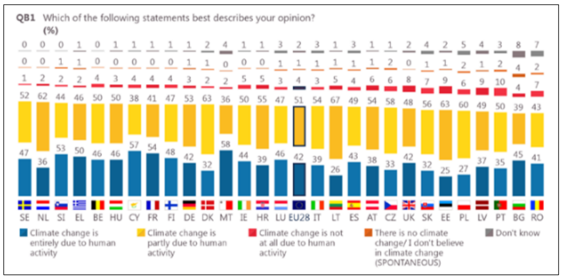

Figure 18. *Statements about the human nature of climate change. Source: Eurobarometer 479 (2018)*

The younger the respondent, the more likely they consider that climate change was entirely due to human activity: 46% of those aged 15-24 said this, falling to 39% of respondents aged 55 and over. Likewise, the longer a respondent remained in education, the more likely they tend to say climate change was entirely due to human activity: 44% of those who completed education aged 20 and over, compared with 39% of those who left education by the age of 15.

Another novelty in the 2018 report was the attention to extreme events and their role in climate change perception. Respondents related the occurrence of various extreme weather events with climate change, either 'definitely' or 'to some extent' (53% and 86%, respectively) (Figure 19). In Italy, about 80% of the respondents considered that heatwaves, floods, droughts, wildfires, heavy rainstorms, and landslides are mainly due to climate change, but only 59% considered earthquakes.

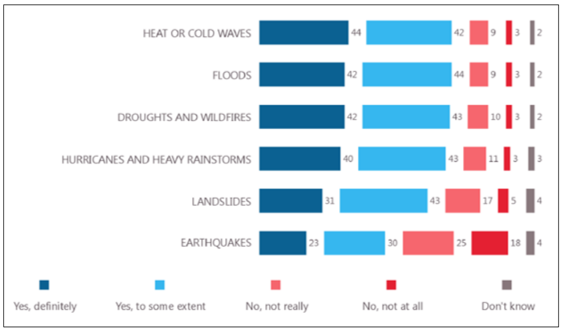

Figure 19. *Extreme events due to climate change. Source: Eurobarometer 479 (2018)*

According to the 2019 report, the most significant change since 2017 was an 11% increase in the proportion of respondents who think climate change is the most serious issue (until 23%, 19% for Italians), moving climate change from the third position in 2017 to second place in 2019 (Figure 20). The longer-term view showed that climate change now has the highest proportion of mentions since this question was first asked, while poverty, hunger and lack of drinking water is at its lowest point, although it still ranked first.

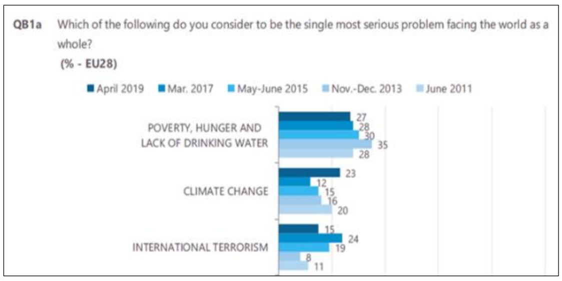

Figure 20. *The most serious problem facing the world as a whole between 2011 and 2019. Source: Eurobarometer 490 (2019)*

In 13 countries, a relative majority of respondents say poverty, hunger and a lack of drinking water was the most serious problem facing the world, while climate change was considered the most serious problem by a relative majority in eight countries (Figure 21). In comparison, Italy was the only country (also partially Romania) in which the single most serious problem facing the world was the economic situation.

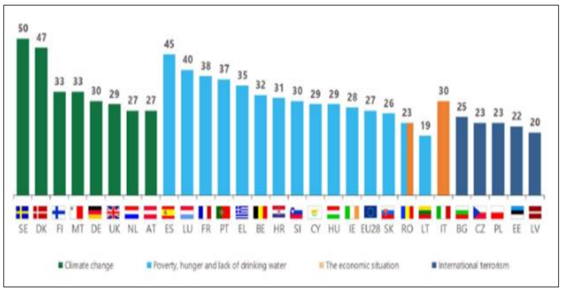

Figure 21. *The single most serious problem facing climate change in 2019. Source: Eurobarometer 490 (2019).*

In 2019, one-third of all respondents (+6% respecting 2017) thought climate change is an extremely serious problem. Likewise, respondents were more likely to say climate change was one of the most serious problems, and in 24 countries, the increase was of at least ten percentage points. The 56% of Italian respondents (multiple answers possible) considered climate change one of the most serious problems facing the world, and 19% considered a single answer option. The multiple answer value represents an increase of 23% respecting 2017. The average score of respondents seeing climate change as a very serious problem has increased slightly from 74% in 2017 to 79% in 2019 (Figure 22). For the Italian respondents, the percentage was higher (84%) (Figure 23).

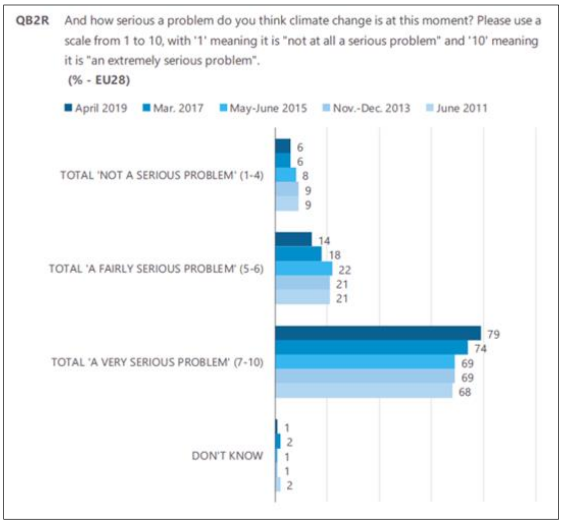

Figure 22. *Seriousness of climate change between 2011 and 2019. Source: Eurobarometer 490 (2019)*

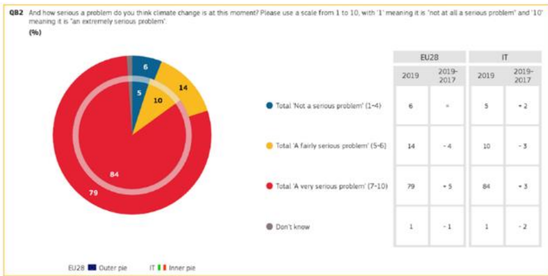

Figure 23. *Level of seriousness of climate change between 2017 and 2019. Source: Eurobarometer 490 (2019)*

As was the case in 2017, there were generally only minor differences between socio-demographic groups. In particular, there was a consensus between genders and across age groups that climate change was a very serious issue, although women and those aged 25-54 were slightly more likely to say this.

5.1.2. Acting on climate change

Europeans consider that not enough is done to fight climate change by the different actors. In 2009 around three-quarters of EU and Italian respondents considered that corporations and industry were not doing enough to fight climate change (Figure 24).

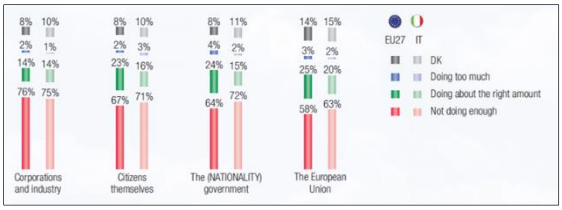

Figure 24. *Efforts to fight climate change in 2009. Source: Eurobarometer 300 (2009)*

Two years later, a further 23% of respondents (38% Italians) spontaneously responded that collective responsibility for tackling climate change involving all actors and individuals included. However, in 2011 national governments were mentioned by almost two-thirds of citizens (64%, but 27% by Italians) as responsible, followed by 58% who feel tackling climate change was the European Union and business and industry's responsibility. In 2014, responsibility levels for tackling climate change were redistributed between the national governments (48%, 39% for Italians), business and industry (41%, 33% for Italians), and the European institutions (39%, 31% for Italians).

The results in 2015 were similar to those of 2011 and 2014, especially regarding multiple answers options (Figure 25). Whilst the wording of the question was similar to that used in 2011, the answer list was extended in 2013 to include "environmental groups" (15% for Italians).

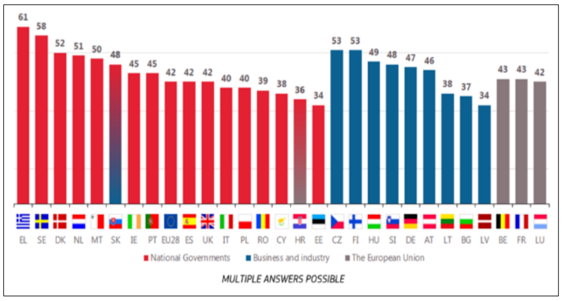

Figure 25. *Responsibility levels for tackling climate change in 2015. Source: Eurobarometer 435 (2015)*

The results of the survey also showed that personal action increases with education levels. In 2009 half (50%) of those who finished their education at age 15 said they have recently acted to face climate change, increasing to 53% for those who finished school between 16 and 19, and 62% amongst those who finished their education aged 20 and over. The data also suggested a link between income and climate action. Those who are unemployed, retired, still studying or in traditionally lower-paid fields were all less likely to report taking any personal action. This may be linked to education or may also have some association with the perceived expense of "being green".

The proportion of respondents saying they have personally taken action to fight climate change was almost stable since 2011. In 2015, younger respondents were more likely to say that they have a personal responsibility for tackling climate change, while older respondents (aged 55 and over) were more likely to say that national governments were responsible for tackling climate change. In 2017, the maximum responsibility for acting to face climate change was led by the national governments, led by the European Union, and the business and industry' roles (Figure 26). However, all 'of them action' option increased respecting 2015. At the national level, the main difference regarding the European tendency was the lack of personal action to face climate change (9% by Italians, 22% at the European level).

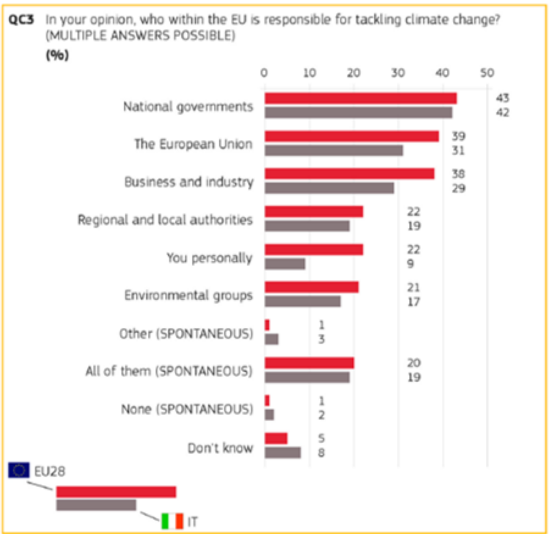

Figure 26. *Responsibility levels for tackling climate change in 2017. Source: Eurobarometer 459 (2017)*

Some considerable changes were identified in 2019. Respondents were much more likely to say responsibility for tackling climate change lies with themselves personally (+14%), business and industry (+13%), national governments (+12%), regional and local authorities (+11%) or the European Union (+10%). However, European respondents were less likely to say the responsibility lies with all of the actors mentioned (-9%). Likewise, more than half of all respondents thought national governments (55%) or business and industry (51%) were responsible for tackling climate change, while almost half (49%) mentioned the European Union. More than one third considered they personally (36%) are responsible, while 33% thought the responsibility lies with regional and local authorities. Likewise, more than one quarter (28%) said environmental groups are responsible. Furthermore, just over one in ten (11%) considered that tackling climate change was responsible for all of the actors listed.

5.1.3. Looking at the future

Looking ahead to the year 2050, the 2018 survey predicted how the biggest and firstly impact of climate change could be an increase in food and water shortages (mentioned by 31% of the European respondents), followed by concerns over soil degradation and desertification (18%), a biodiversity loss (13%), and an increase in infectious diseases or epidemics (11%).

5.2. The Eurobarometer and the agriculture

Surveys on agriculture are collected periodically, mainly every two years, over 2010-2020, resulting in four reports (Table 2). The sample includes the 27 current EU member countries plus the UK. Although each report is particularly structured in blocks differing on content, some issues can be highlighted: agriculture and the Common Agricultural Policy (CAP); information, priorities, performance, and budget of the CAP; agriculture and climate change nexus, and the agriculture and farmers' role in society. The next sections will provide a deepen analysis of the last two points.

Table 2. List of special surveys consulted regarding agriculture

Reference	*Date*	*Title*
336	2010	Europeans, agriculture and the Common Agricultural Policy
440	2016	
473	2018	
504	2020	

For all the reports, a factsheet with the country highlights is provided, including Italy.

5.2.1. Agricultural policy and climate change nexus

An overwhelming majority of respondents in 2010 (85% or more) were supportive of including helping farmers to face the consequences of climate change (89%) as one of the main aims of the agricultural policy (Figure 27). About half of respondents (46%, 57% for Italians) though that agriculture had already made a major contribution in fighting climate change. In 2015, protecting the environment and tackling climate change was among the CAP's main objectives (supported by 44% of the European respondents and 43% for Italians). The majority of Europeans (60%) agreed that the CAP contributed to mitigate climate change, while at least 50% of respondents (74% for Italians) in 23 countries 'agree' on that assessment (Figure 28).

Nonetheless, further action was called because many national respondents (83%) believed that agriculture would suffer strongly from the effects of climate change in the coming years. Furthermore, action to protect the environment and deal with climate change must be mainly promoted at the European and national levels (65% and 23%, respectively, 61% and 24% for Italians). Also, most respondents (67%, 72% for Italians) though that farmers need to change the way they work to fight climate change, even if that means that European agriculture will be less competitive.

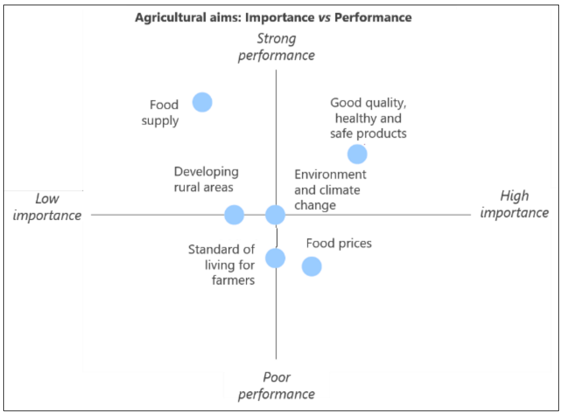

Figure 27. *Agricultural aims: Importance and Performance. Source: Eurobarometer 336 (2010)*

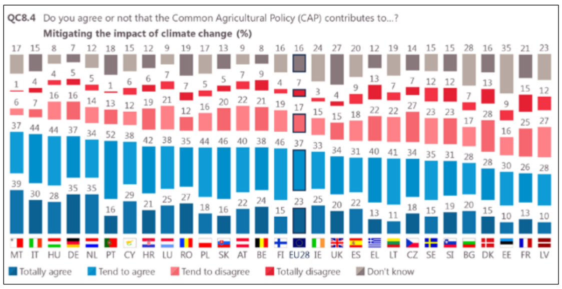

Figure 28. *CAP contribution to mitigating the impact of climate change. Source: Eurobarometer 440 (2015)*

In 2018, the main objectives of agricultural and rural policy were providing safe, healthy food of high quality (62%, +6% since 2015), protecting the environment and tackling climate change (50%, +6% since 2015), and ensuring reasonable food prices for consumers (49%). When Europeans are faced with the dilemma of balancing the fight against climate change and agricultural competition, the majority (72% for Italians) opt for favouring the fight against climate change even if it means paying 10% more for agricultural products that are produced in a way that limits their carbon footprint (Figure 29).

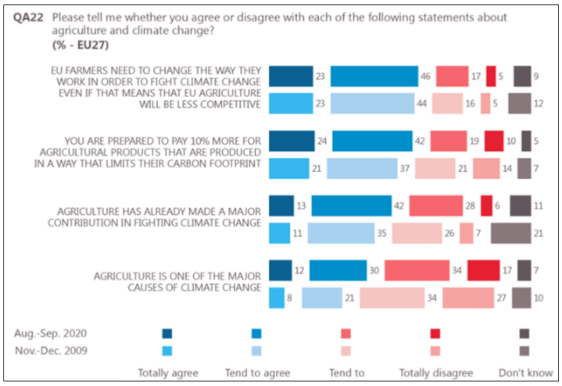

Figure 29. Statements about agriculture and climate change between 2009 and 2020. Source: Eurobarometer 504 (2020)

5.2.2. Farmers' role in society

According to the European public, the main priority for farmers in 2010 was ensuring agricultural products that were of good quality, healthy, and safe (59%, 63% for Italians), while protecting the environment and dealing with climate change was prioritised by 14% (41% and 34% of Italians if multiple answers options). Five years later, in 2015, the relative majority of respondents agree that Europe was fulfilling its role in protecting the environment and tackling climate change. To do that, farmers should assume different responsibilities, including protecting the environment (30%, 36% for Italians) (Figure 30).

Figure 30. Main responsibilities of farmers in society. Source: Eurobarometer 440 (2015)

In 2018, the three main responsibilities of farmers were considered to be providing safe, healthy food of high quality (55%), ensuring the welfare of farmed animals (28%), and protecting the environment and tackling climate change (25%). A large majority (82%) agreed that Europe needs to help farmers change the way they work to fight climate change (42% of Italian respondents considered that 'agriculture is one of the major causes of climate change'). The last report (2020) highlighted how protecting the environment and tackling climate change as one of the CAP's main functions has gained ground in 16 European countries, most notably in Italy (26%, +7% since 2018). To achieve this goal, most respondents (56%, 55% for Italians) considered that the European financial support to farmers in the next 10 years should be increased (Figure 31).

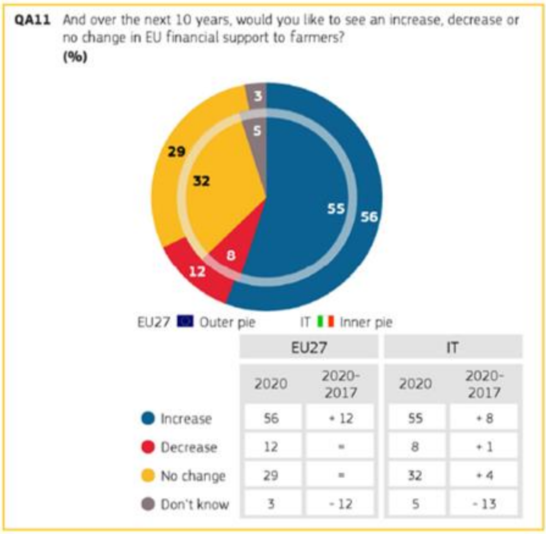

Figure 31. *European Union financial support to farmers in the next 10 years. Source: Eurobarometer 504 (2020)*

5.3. The Eurobarometer and the environment

Surveys on the environment are collected periodically, mainly every two years, over 2008-2020, resulting in seven reports (Table 3). The sample includes the 27 current EU member countries plus the UK. Although each report is particularly structured in blocks differing on content, some issues can be highlighted: information on environmental issues, action to protect the environment, efficient use of natural resources, and general perceptions and attitudes of the environment. This last point will be analysed regarding the nexus of climate change. For all the reports, a factsheet with the country highlights is provided, including Italy.

Table 3. List of special surveys consulted regarding environment

Reference	*Date*	*Title*
295 *365* *416*	2008 2011 2014	Attitudes of Europeans citizens towards the environment
436	2015	Attitudes of Europeans citizens towards biodiversity
468	2017	Attitudes of Europeans citizens towards the environment
481	2019	Attitudes of Europeans citizens towards biodiversity
501	2020	Attitudes of Europeans citizens towards the environment

In 2008, the basis of the 'environment' concept in Europeans' minds were examined by asking the first association with the concept they made and which environmental issues worry them the most. In this question, respondents were asked to directly associate the word 'environment' by choosing from a list of topics. The two main ideas which emerged were pollution in towns and cities (22%, 36% for Italians) and climate change (19%, 9% for Italians). Although socio-demographic factors did not appear to extensively affect respondents' spontaneous impressions, climate change was an exception: the younger the respondents are and the longer they have spent in full-time education, the more likely they are to connect the concept of environment to climate change.

Since climate change was already associated with the concept of environment in general, it is not surprising that it ranks as a top concern among respondents, with the absolute majority (57%, 47% for Italians) mentioning it among their top five environmental concerns. Respondents' concern on climate change seems to be linked to the level of information as the circle indicates in the graph (Figure 32). According to the figure, climate change represents a trans-boundary environmental problem that has become more visible in recent decades, while at the same time, it has been widely discussed in the media, which is likely to explain the relatively low lack of information.

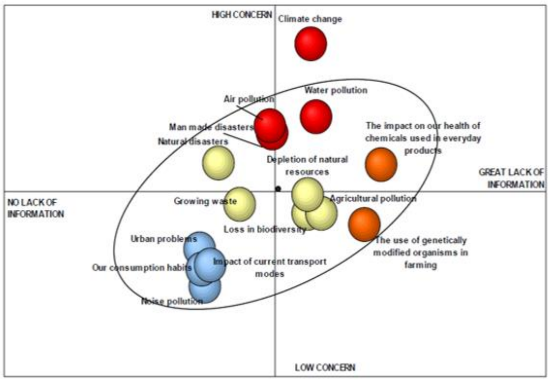

Figure 32. Link between climate change concern and lack of information. Source: Eurobarometer 295 (2008)

Environmental protection associations and scientists (both 36%) were the most trusted actor to recap information on environmental issues, such as climate change. However, at the national level, a higher than average proportion of Italians place their trust in institutional actors in the form of the European Union (16%), the national government (20%), and regional/local governments (15%), while a lower than average share of Italians trust scientists the most (20%).

In 2011 the concern about the protection of nature increased (+5%), with significant drops in the perceived importance of pollution in towns and cities (-9%) and climate change (-6%). Likewise, the most obvious change was that climate change' concern decreased from 57% to 34% (28% for Italians) because the major focus has been put on immediate issues such as the efficient use of natural resources. In 2015 the focus was on biodiversity, in which 67% of the respondents considered tackling climate change as the best way to stop biodiversity loss. Moreover, in 19 Member States, at least half of all respondents (56% for Italians) considered that climate change was very much a threat to biodiversity. Two years later, in 2017, respondents considered climate change (51%), air pollution (46%), and the growing amount of waste (40%) the most important environmental issues. However, Italians were worried about air pollution and the growing amount of waste (Figure 33).

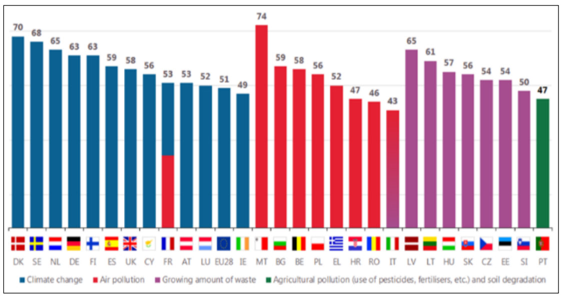

Figure 33. Four environmental issues most mentioned in 2017. Source: Eurobarometer 468 (2017)

However, looking more closely at respondents who say that climate change is one of the most important environmental issues, 40% of Italians choose climate change as one of the four main concerns regarding environmental issues (Figure 34).

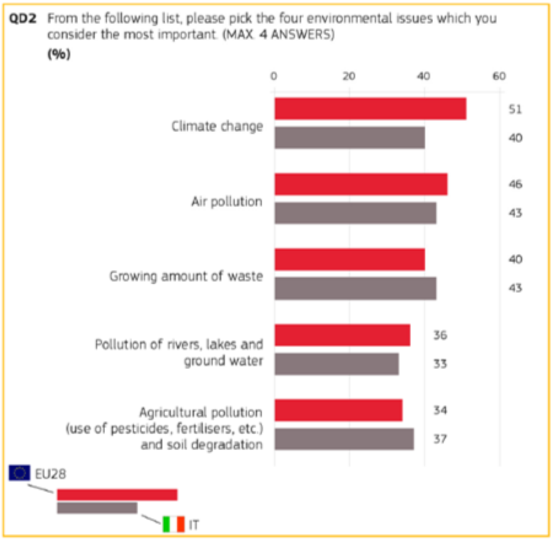

Figure 34. *Most important environmental issues in 2017. Source: Eurobarometer 468 (2017)*

In 2019, two-thirds of Europeans totally agree that looking after nature was essential in tackling climate change because climate change was one of the biggest perceived threats to biodiversity (58%, +7% since 2015, 53% for Italians) (Figure 35).

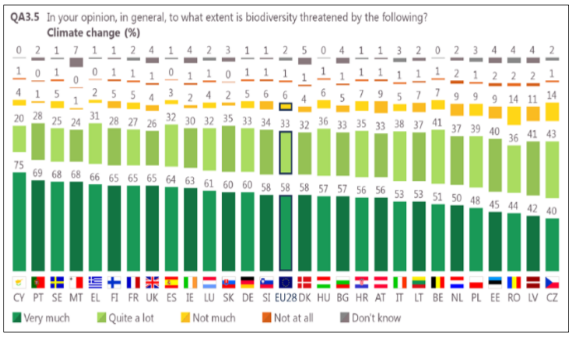

Figure 35. *To what extent is biodiversity threatened by climate change? Source: Eurobarometer 481 (2019)*

In the same line, the last report (2020) directly ask for the seriousness of climate change in addressing environmental issues, for which three-quarters of Europeans (76%) consider that climate change is a very serious problem in their country, including 31% who say it is an extremely serious problem. Italy is the country with the second higher value (86%), just after Spain (Figure 36).

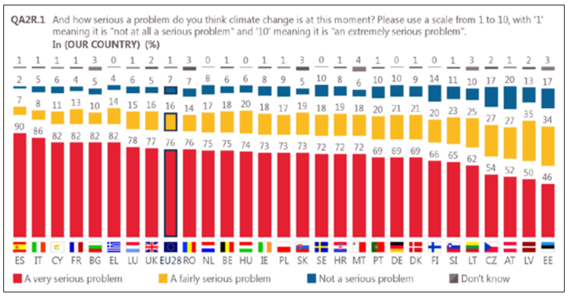

Figure 36. *How serious a problem do you think climate change is at this moment? Source: Eurobarometer 501 (2020)*

The socio-demographic analysis showed how women are more likely than men to consider climate change a severe problem (79% vs 74%), while young people aged 15-24 are the most likely to replicate this statement (80%) and also respondents who finished their education at the age of 20 or above. Furthermore, among a list of ten environmental issues, three in ten respondents said that agricultural pollution and soil degradation was one of the most important issues affecting both climate change and biodiversity, slightly higher than the proportions choosing frequent droughts or floods (28%) or the shortage of drinking water (24%). Likewise, climate change is again considered the most important environmental issue when multiple options are possible (53% for Europeans and Italians) (Figure 37).

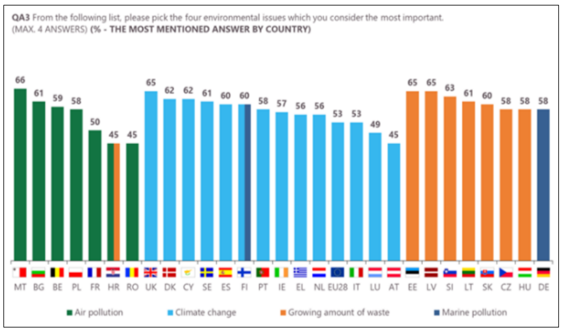

Figure 37. *The four environmental issues considered the most important in 2020. Source: Eurobarometer 501 (2020)*

Looking more closely at the respondents' socio-demographic profile who said that climate change is one of the most important environmental issues, age is a differentiating factor for several issues (e.g., climate change is chosen more frequently by younger people, 61% of 15-24 years old compared with 49% of those aged over 55 or over). However, older respondents are more likely to say that frequent droughts or floods, and agricultural pollution and soil degradation are important environmental issues related to climate change (32% of people aged 55 or over vs. 22% of those aged 15-24). Likewise, although results are mainly consistent in terms of education level, respondents with a higher level of education are more concerned about climate change (57% of those who left education aged 20 or above, compared with 48% of those who left education by the age of 15).

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