



# Climate change perception in Romania

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Received: 10 September 2021 / Accepted: 30 March 2022 / Published online: 13 April 2022  
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## Abstract

In the last decades, anthropogenic drivers have significantly influenced the natural climate variability of Earth's atmosphere. Climate change has become a subject of major interest for different levels of our society, such as national governments, businesses, local administration, or citizens. While national and local policies propose mitigation and adaptation strategies for different sectors, public perception is a key component of any implementation plan. This study investigates the CC perception in Romania, based on a national-scale online survey performed in the spring of 2020, aiming to outline the prominence of environmental and CC issues, level of information and interest, perceived causes, changes perceived in meteorological phenomena at the regional scale, perceived impacts, and the psychological representation of the CC. The study investigates single causal factors of perception. We found that particularly (i) the regional differences on climate change intensity strongly bias the perception of CC causes; (ii) age is very likely to influence the acceptance of CC, the importance of environmental issues, and the levels of information and interest; while (iii) age, gender, and place of residence (rural–urban) are very likely to control the changes perceived in the occurrence of various meteorological phenomena, and their impact. This research is the first statistically relevant analysis ( $\pm 4\%$ , statistical significance) developed at national and regional scales and the only study of climate change perception performed during the COVID-19 pandemic in Romania. Its results may represent the baseline for more in-depth research.

**Keywords** Climate change · Climate change perception · Romania

## 1 Introduction

Climate change (CC) is one of the major concerns of the worldwide scientific community, stakeholders, and general public. At the beginning of the 2010s, the EU citizens considered CC as the second most serious problem facing the world. They identified the economic benefits of tackling the

associated phenomena and adaptation challenges (European Commission 2014). The most recent Eurobarometer on Climate Change Perception (CCP) within the EU showed that 93% of the European citizens consider it a severe challenge in the near future (European Commission 2014).

The tremendous interest is justified by a plethora of clear evidence, such as measurements, observations, and

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impacts, but it is also extensively promoted by scientific publications and media coverage. For example, IPCC (2021) has very soundly documented the climate system's unequivocal warming, induced mainly by human activity, with unprecedented impacts on the environment and society. Media communication focuses on different perspectives of CC and contributes to shaping people's attitudes toward it (Pasquaré and Oppizzi 2012; Lorenzoni and Whitmarsh 2014; Metag et al. 2017). Mainstream movies and documentaries can increase anxiety or motivation to act (Lowe et al. 2006), and participatory workshops may change the public perception (Fernández-Llamazares et al. 2015). The individual perception of media messages is likely to be among the front line drivers of group behavior. Personal perception plays the ultimate role in developing and implementing adaptive responses (Wolf and Moser, 2011) and in the people's engagement to minimize the CC impacts (Reser and Bradley 2020).

Understanding the causes and especially, the impacts may support adaptation and mitigation measures, so numerous studies on various aspects of climate perception have been performed in the recent decades (Capstick et al. 2015). Stehr and Von Storch (1995) introduced the concept of social construct of climate, directly linked to the public perception, as a sustainable instrument for smooth adaptation of society and CC policies.

According to external and internal factors, people and communities may perceive climate variability and change very differently (e.g., Schnegg et al. 2021; Lee et al. 2020; Ruiz et al. 2020; Magistro and Roncoli 2001). For instance, those groups who rely more on exploiting natural resources such as fishermen, farmers, or woodcutters experience CC more acutely than those who live in the cities and rely indirectly on natural resources (e.g., Bacha et al. 2021; Sullivan and White, 2020). In this regard, Romania has the highest ratio of the population working in agriculture (21.2%) among the European countries (World Bank, 2021). Some studies investigated how factors like age, gender, education, income, political views, and occupation can be associated with the perception and willingness to act related to CC issues (Kabir et al. 2016; Luo and Zhao 2019; Pitpitunge 2013). Ruiz et al. (2020) separate direct factors which influence CCP, such as the common principles and ideals, and the physical experience of weather within a community, from indirect factors, namely the level of development of a community and the spread of CC information.

Rühlemann and Jordan (2021) emphasized the need for inclusive climate risk and development strategies and the importance of the relationships between organizations responsible for CC adaptation and vulnerability reduction and at-risk populations. These factors seem to contribute to either inaction or effective action to climate risk.

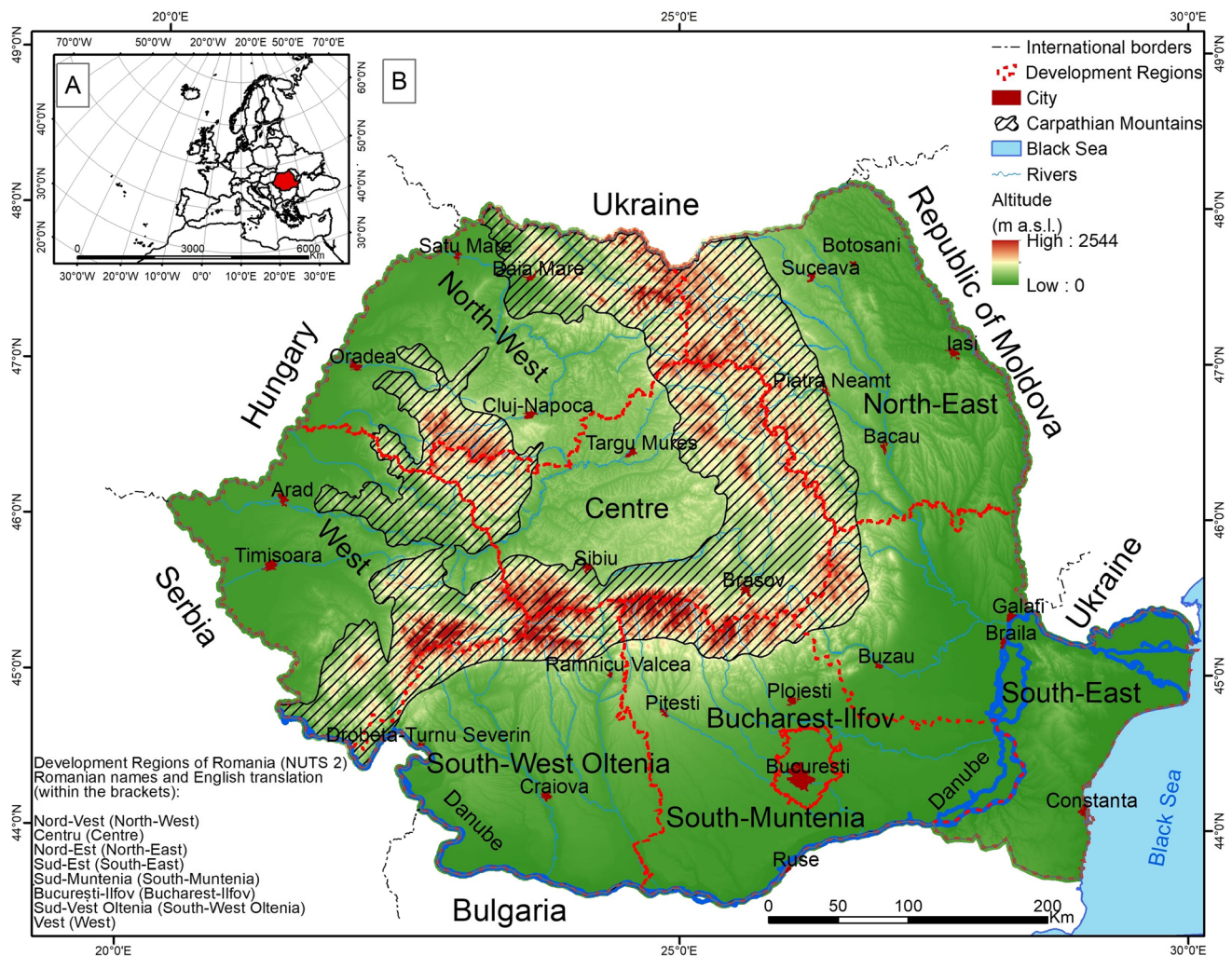
Based on a global scale analysis, Hansen et al. (2012) assumed that a person old enough to remember the climate of 1951–1980 should perceive CC signals, mainly regarding the summer months. Still, significant variations can occur among individuals, groups and geographical regions, pledging to perform local, national, and regional studies.

People living in different regions of the planet perceive, experience, and adapt differently to CC. Thus, the local knowledge of crop-climate linkage shapes the Indian farmers' CCP (Vedwan 2006; Puri 2015). Some other studies focused on the perception of extreme environments such as the Arctic, high mountainous, dry-places, low-lying islands in the South-Pacific, high Tibet, or villages from the Lower Danube Valley (Baer and Singer, 2018; Byg and Salick 2009).

Many studies on CCP focus on the local level (i.e., cities or villages in different regions). At the same time, the national scale has been less approached, probably due to logistic difficulties and the different sizes of the countries. For example, the Germans' risk perception of hazards is more frequent within the CC context (i.e., heatwaves, storms, and floods) (Frondel et al. 2017). In Hungary, CC is perceived as an ongoing but geographically remote phenomenon (Jankó et al. 2018). Only a small percentage of people hold a high level of CCP and intend to reduce the carbon lifestyle in Lebanon (Hussein et al. 2019). Comprehensive insights into the public perception of CC across France, Germany, Norway, and the UK were provided by the European Perceptions of Climate Change and Energy Preferences (EPCC) Project supported through the JPI-Programme, based on a survey conducted in 2016 (Steentjes et al. 2017). One of the main conclusions of the EPCC Project is that CC and environmental issues may be shadowed in public priorities by more urgent threats like immigration, unemployment, and economic situation. Another analysis conducted at the European scale revealed that findings cannot always be generalized, and the national context is an essential factor that shapes the CCP (Poortinga et al. 2019).

Previous studies tackled the Romanian public's perception of different environmental issues, such as natural hazards (Cheval 2003; Andrei et al. 2020), CC impact on forest (Blujdea 2005; Cosofret et al. 2014), flood risk (Armaş and Avram 2009), and earthquakes (Armaş 2006) or the CC issue at city scale (e.g., Bere-Semerédi and Bere-Semerédi 2020). Besides, the Romanians' perception of the CC issue was investigated in continental-scale studies (e.g., Poortinga et al. 2019; Hagen et al. 2015) or systematically reviewed (e.g., Capstick et al. 2015).

This research is the first study focused on the CCP performed over a statistically relevant sample at Romania's national and regional scale. This investigation aims to provide the first overall representation of the CCP in Romania, based on broad topics and national coverage approach, but



**Fig. 1** Study area: **A** Geographic location of Romania in Europe. **B** Development regions (NUTS 2), topography, and other relevant geographic features of Romania

detailed at the regional level. Besides, this work aims at providing a consistent framework for further, more in-depth research, development of CC policies, and effective management of risks associated or exacerbated by CC.

## 2 Data and methods

### 2.1 Romania—geographical context, relevant facts, and figures

By its geographical position within the continent (Fig. 1), Romania extends over a region of interference among five major pressure centers acting across Europe (the Azores, East-European and Scandinavian Highs, and the Mediterranean and Icelandic Lows). The interactions between their influence and the underlying topography play a key role in defining the regional climate

conditions across the country, which belong to four climate groups according to the Köppen-Geiger climate classification system (dry—Bsk, temperate—Cfa, Cfb, continental—Dfa, Dfb, and polar—ET) (Kottek et al. 2006), leading to a consistent temperature range between summer and winter, and moderate precipitation amounts. The average climate of the country is characterized by a mean annual air temperature varying from below 0 °C in high mountains to more than 11 °C in the South and Southwestern lowland regions, and annual precipitation amount of 400–500 mm in the Southeastern lowlands to more than 1000 mm in the high altitudes of the Western Carpathians (Sandu et al. 2008).

The Carpathian Mountains, located in the central part of the country, increase the diversity of climatic conditions in the country. Thus, they induce a decrease of temperature and increase the precipitation amount with the altitude, prevent or block the air masses advection, impose climatic asymmetries across the country, and different climatic patterns



in regions located inside and outside the range. Thus, Eastern and Southern Romania are subject to more severe cold waves generated by Eastern, or Northern Europe originated air masses. In contrast, Western Romania, sheltered from this type of advection, remains warmer (Apostol and Sfică 2013).

The regional differences in the climate variability and trends observed for air temperature (Marin et al. 2014), precipitation amount (Croitoru et al. 2018), aridity (Cheval et al. 2017) or heat waves (Sfică et al. 2017; Croitoru et al. 2018) can lead to differences on how CC is perceived in different areas. For instance, the increasing frequency of the heat waves in the Southern regions or the occurrence of high amounts of precipitation in the mountains could build the local population's CCP.

## 2.2 Survey delivery

This study relies on the results provided by a cross-national survey experiment conducted between April 30th and May 16th 2020, corresponding also with COVID-19 lockdown in Romania, to detect the level of public perception and views on CC across Romania. The survey used a structured questionnaire with 21 items in Romanian, including 15 opinion questions (Q) and six identification items (I) (*Supplementary material 1*). It was applied via an internet-based form to 2180 respondents from different social and demographic groups across the eight Development Regions (DRs) of Romania: North-West (NW), Center, North-East (NE), South-East (SE), South-Muntenia, Bucharest-Ilfov, South-West Oltenia (SW Oltenia), and West (Fig. 1). The regions correspond to the NUTS 2 level, and they are the basic territorial entities for applying regional policies in the EU member states (EUROSTAT 2020). The sample was weighted according to age, gender, residence (urban vs. rural), and level of education according to the statistical structure of the population of each DR (National Institute for Statistics 2020), resulting in a total sample of 835 respondents ( $N=835$ ), statistically relevant for the Romania population ( $\pm 4\%$ ) (*Supplementary material 2*).

The methodology of applying the questionnaire is associated with some representativeness features of the study, as follows: (i) the study considered the population with internet access and who frequently uses social media for communication; (ii) even after weighting, the sample records a bias for young, urban people with a high level of education population; data collection was performed by employing online relational groups, which alters the random nature of the selection; (iii) the sampled population comprises interdisciplinary character, with a majority of respondents belonging to the academia (29%), and ongoing higher education (students 25%); (iv) it was assumed that all terms are understood equally by all respondents, an assumption that was not subsequently qualitatively validated; and (v) the margin of error

for the weighted sample (Cochran method) is about  $\pm 4\%$  at a 95% confidence interval ( $p < 0.05$ ) (Cochran 1977).

All the figures are rounded to the nearest integer, considering the limitations associated with the representativeness of the study. The answers were ranked in five Likert-scale classes (Likert 1932; Findlater et al. 2019). The Relative Importance or Relative Influence Index (RII) was computed as weighted averages of the percentage allocated to each class to bring to a standard measure the CCP over the territorial entities analyzed (DRs).

## 3 Results and discussions

The results referring to different aspects related to Romanians' CCP are presented in the following sections, with the associated questions: (1) Prominence of environmental and CC issues (Q1–Q5); (2) Level of information and interest for CC issues (Q6–Q8); (3) Causes of CC (Q9); (4) Changes perceived in meteorological phenomena at regional scale (Q10–Q12); (5) CC impacts (Q13–Q14); and (6) Psychological representation of CC (Q15).

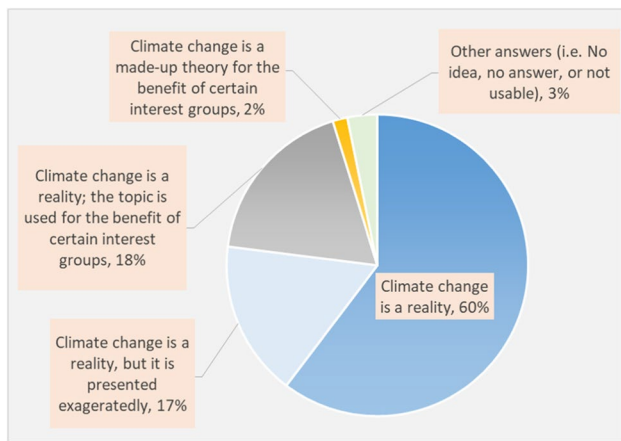
### 3.1 Prominence associated with environmental and CC issues

#### 3.1.1 Is CC real?

Climate variability is a common feature over the Earth's geological history. The increased frequency and impact of different extreme events specific over the last and estimated for the future decades are currently attributed to the ongoing changes in the atmospheric system (Brown 2020; Perkins et al. 2012). While most scientific literature and mainstream mass media agree that CC is a fact, its denial is not uncommon (Gross 2018; Medimorec and Pennycook 2015). In Romania, most respondents say that CC can affect the region where they live (92%), but 7% of the respondents declare they do not know, and 1% are pessimistic about this issue (Q1). Almost all the interviewed people believe that CC is a reality (95%), either as it is presented (60%), exaggerated for unmentioned reasons (17%), or used for the benefit of some interest groups (18%). At the same time, only a very negligible share of respondents considers it as a made-up theory (2%) (Q2) (Fig. 2).

Complete or partial denial of the CC records the highest values among older people (about 6%), who consider CC an invented topic for the interest of a limited group of influence, whereas 39% accept CC as a reality, although presented exaggeratedly. The belief that the topic is used to benefit some groups of interest prevails among the category of 30–44 years old (33% of the age interval, representing 2% of the entire sample).





**Fig. 2** Share of respondents who perceive CC as a reality, either explicit or distorted, or a made-up theory

### 3.1.2 How important are environmental and CC issues for Romanians?

This query aims to reveal the respondents' perception regarding the importance of the environmental and CC issues, both for the country and for the region of residence. It was addressed through Q3–Q5.

Although most respondents do not hold specialized environmental education (99%), the vast majority (91%) considers environmental issues important or very important topics for Romania. In comparison, CC is perceived as an essential or very important national or regional issue by only about 80% of the people (Fig. 3). The outputs show that Romanians perceive general environmental problems as more important than the CC for the country, which can be justified by the urgency and immediate impact on their well-being or that

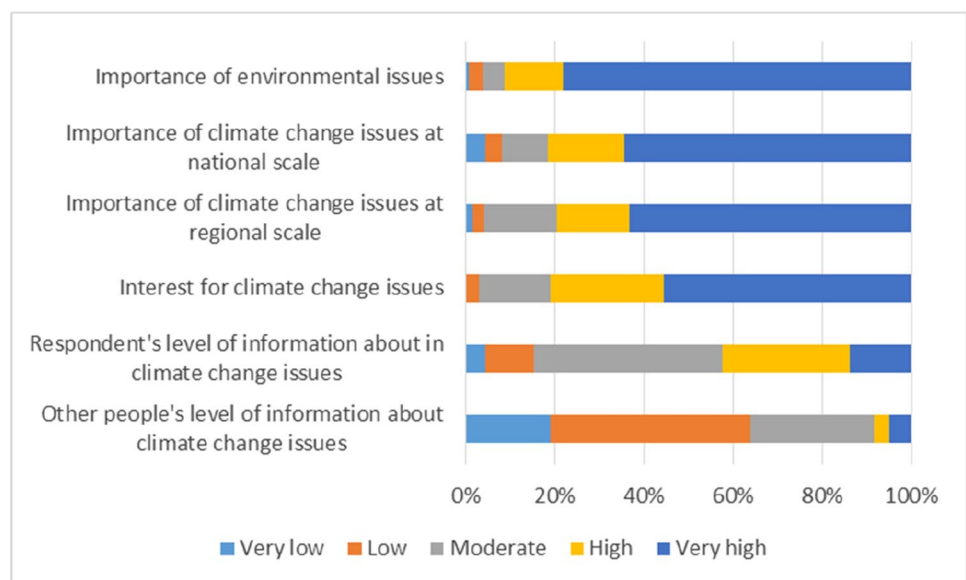
the people subsume the CC issues to environmental ones. Moreover, the proportion of Romanians considering the CC as the single most serious problem facing the world is one of the lowest in Europe (7%) (European Commission 2021).

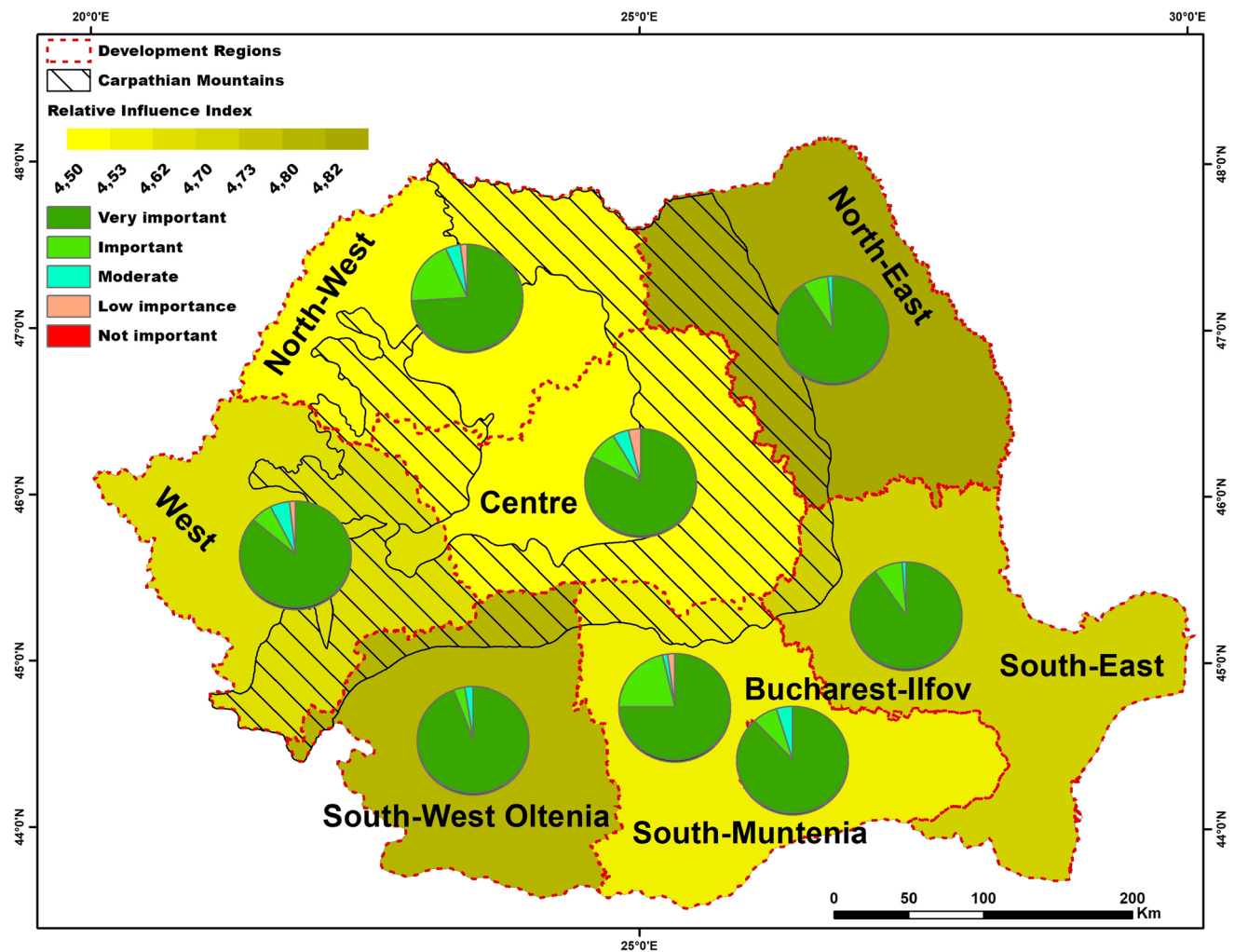
Age seems to be a very influential factor that shapes this way of thinking. For example, 87% of the persons above 65 years old believe that environmental issues are very important, whereas only 55% of the people between 18 and 29 share the same belief. The reason could derive from the young people's priorities, more focused on professional and short-term goals, and less related to environmental issues. Regional differences regarding the overall importance for the country refer only to quantitative characteristics (i.e., environmental issues are very important for 87% of the respondents from NE DR, 90% from SW Oltenia DR, 67% from NW DR, and 74% from the Centre DR). In contrast, the opinion that environmental issues are very important is qualitatively dominant in all the DRs (Fig. 4).

Overall, most people (79%) answer that CC is an important or very important issue for the region where they live, whereas only 4% consider the topic is rather not important at a regional scale (Fig. 5). There are people (17%) who cannot decide if CC is important or unimportant for their region. The Carpathian chain triggers a clear limit between two distinct views about this issue. Thus, the RII have higher values in the DRs outside the Carpathians. About 90% of the people living in the extra-Carpathian regions perceive the CC as an important or very important topic. Only 66% of the people living in the intra-Carpathians regions value CC as an important or very important topic important regional issue (Fig. 6).

People's perception is inherently socially, economically, and culturally influenced and may be different from the perception of a person living a few hundred kilometers away in a different ecological setting. They judge according to their direct living experience of climate. The personal

**Fig. 3** Level of perceived importance, interest, and information for environmental and CC issues





**Fig. 4** The relative importance of the environmental issues

experience with varying patterns of climate and CC identified at a regional scale may explain such a clear distinction between the two areas (Barnes et al. 2013; Welch-Devine et al. 2020). The intra-Carpathian regions are less exposed to extreme weather conditions, such as heatwaves, cold waves, extreme precipitation, blizzards, and drought events in the present climate, and less susceptible to immediate impacts of CC than extra-Carpathians regions. Thus, they perceive less the danger induced by extreme weather events (Sandu et al. 2008; Croitoru et al. 2018).

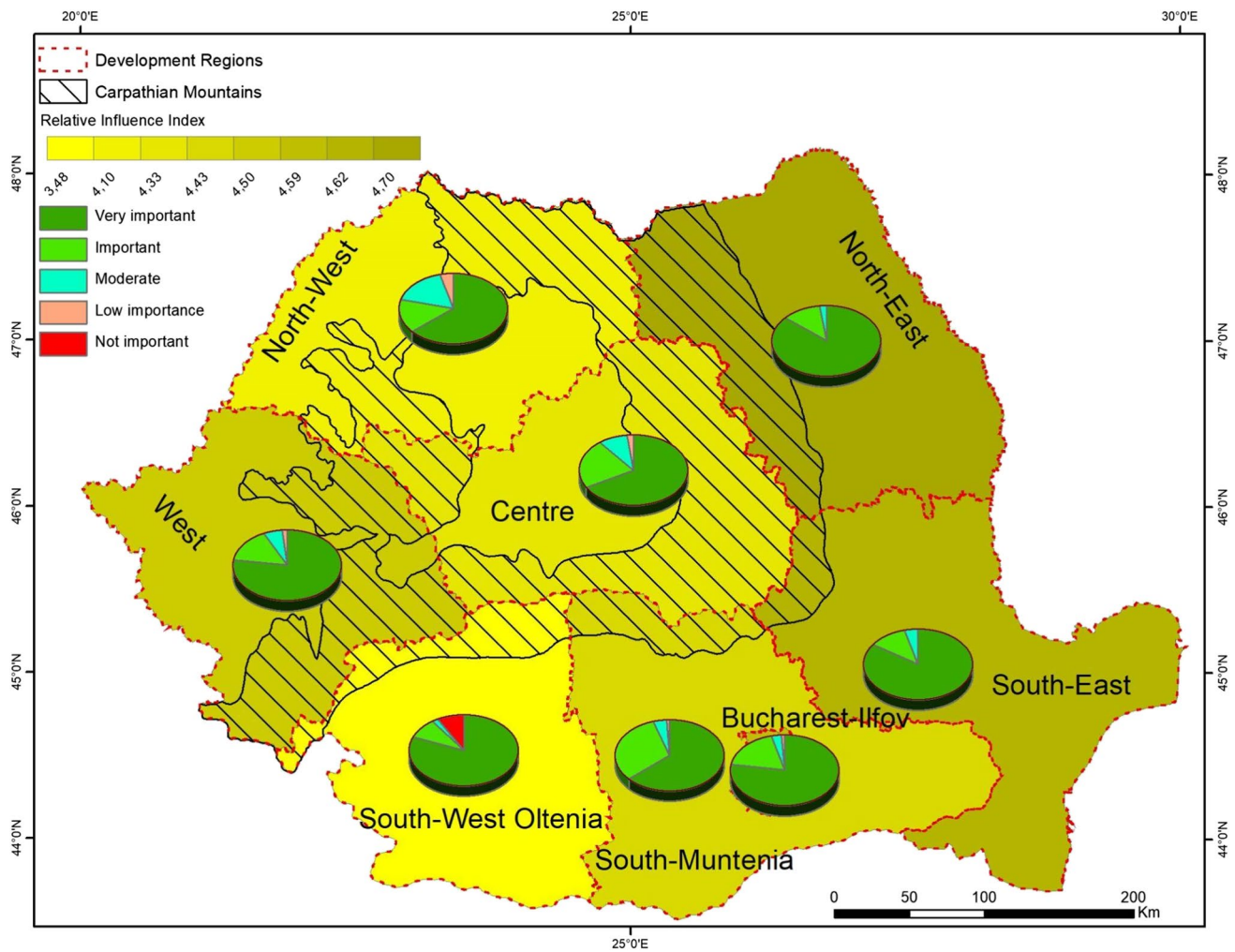
### 3.2 Level of information and interest for CC issues

Specific questions (Q6–Q8) addressed the respondents' opinions about other people's knowledge, their own level of information/knowledge, and their interest in the CC and its impact.

The outcome shows a perception structure relevant for marginal problems, when the level of declared interest for a topic is considerably much higher than the level of

information, assumed as an indicator for ongoing action and potential implication (Sherif and Hovland 1961; Van der Linden 2015). Thus, 82% of the respondents declare that they are interested or very interested in the CC and its impact. Still, only 43% of the total sample consider themselves well or very well informed. A consistent majority (64%) appreciates that the other Romanians than themselves are rather poorly or very poorly informed about this topic (Fig. 7). The perception structure revealed by this study may explain the very low level of personal implication in actions to fight against CC recorded in Romania at present, which is the lowest in the EU (European Union 2021).

Regional differences are revealed for the level of both information (either own or others) and interest. For example, the respondents from the NE (RII = 2.22) and SW (RII = 1.63) regions have the lowest trust in the Romanians' level of information, while the people from the SE (RII = 2.55) and Bucharest-Ilfov (RII = 2.76) regions are the most confident in others' level of knowledge about CC



**Fig. 5** The relative importance of the CC issues for Romania

issues. On the contrary, most respondents from the SW DR ( $RII=4.06$ ; 81% from the total sample) declare that they are well or very well informed about CC, whereas people from NW ( $RII=3.00$ ), NE ( $RII=3.22$ ), and West ( $RII=3.23$ ) regions consider themselves rather moderately informed (Fig. 8). The perceived level of personal information has the highest value in the rural areas (54%), mainly at the population between 30 and 65 years old, with an under average education level and low income, suggesting a strong agricultural dimension of the CCP issues in Romania. The urban respondents above 45 years old with higher education level are the category stating the uppermost interest in this topic, and consider that the others are not sufficiently informed. This may explain the regional differences, but a more detailed investigation is needed at a regional and local scale.

Inhabitants of all DRs declare a relatively high to a very high interest for the CC issues, with the highest values in SW ( $RII=4.77$ ), Bucharest-Ilfov ( $RII=4.48$ ), and NE

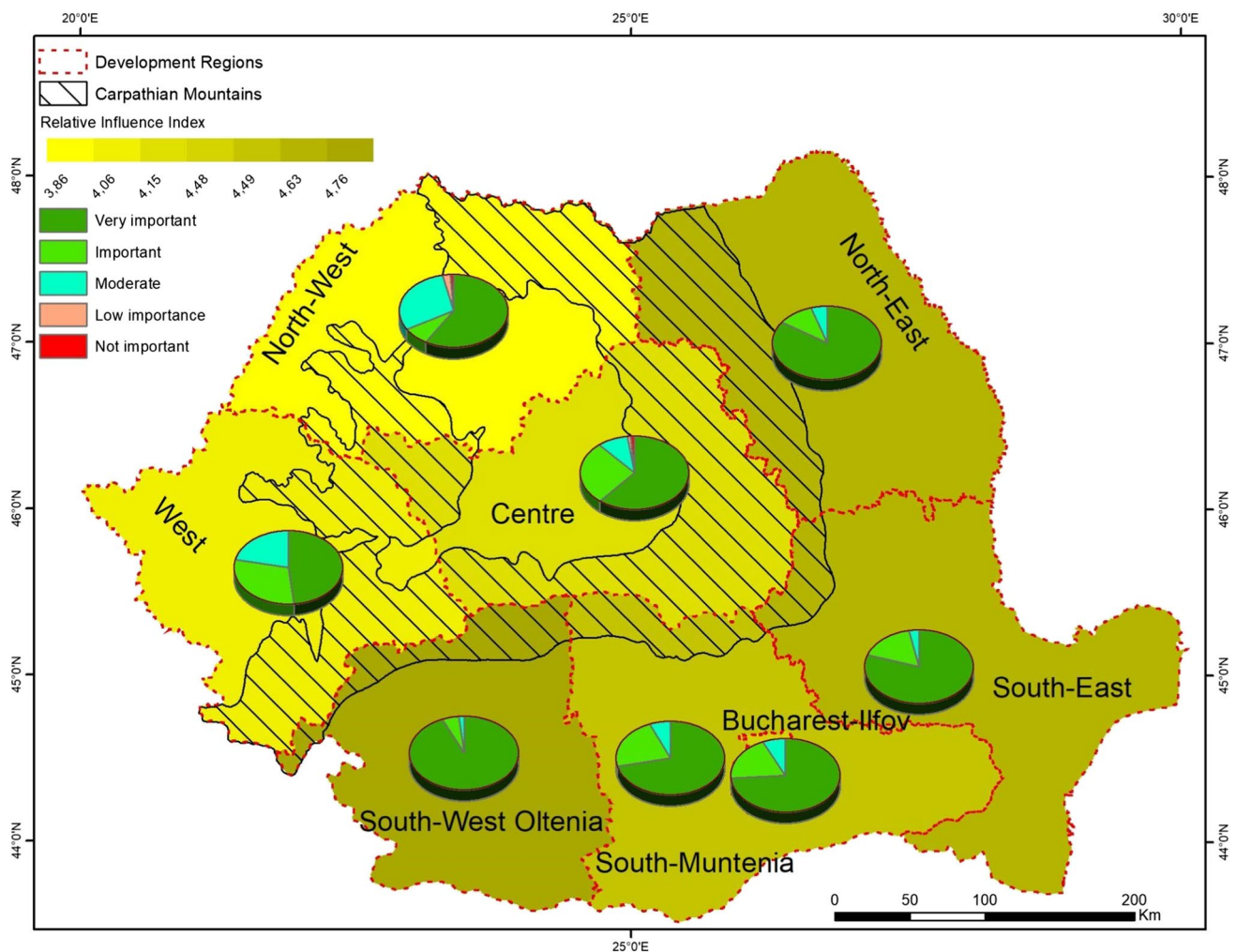
( $RII=4.44$ ) regions (Fig. 9). However, there is an important gap between the declared self-information (i.e., relatively low) and interest (i.e., relatively high) in all the DRs (Fig. 10). It is possible that people either underestimate their level of information, overestimate their level of interest, or even both causes are valid simultaneously.

### 3.3 Causes of CC

The perception of the possible causes of CC at a regional scale was examined based on a predefined set of variables, leaving open the possibility to propose additional triggering factors. Multiple choices were permitted.

Extensive deforestation was considered to generate the CC by about 77% of the respondents, whereas the overall anthropogenic activities and industry were mentioned as influencing factors in more than 60% of the answers each (Fig. 11). The national administrations of the industrialized countries or urbanization were also considered responsible





**Fig. 6** The relative importance of the CC issues for the region of residence

by 41–46% of the people, while natural causes or agriculture recorded lower percentages (30% and respectively 23%). About 4% of the respondents assume “Other causes” may be important, but they are all associated with the predefined variables (i.e., pollution, radioactivity, and traffic are industrial factors). “Divinity” is perceived as responsible for the CC by 3% of the investigated population. This low share may be influenced by the structure of the respondents, with the majority belonging to academia and ongoing higher education.

“Extensive deforestation” was more frequently mentioned as a factor generating CC by the people between 45 and 64 years old (82%) living in rural areas, with high school as the highest level of education (81%). Women see “extensive deforestation” more frequently responsible for CC than men (85% vs. 65%). The highest share of people incriminating the “extensive deforestation” as a CC trigger lives in the southern DRs (SW Oltenia, Bucharest-Ilfov, and SE regions), where the coverage of forest land is lower than in the other

areas. One can assume that the impact of deforestation news is stronger in areas where woodland spots are already sparser (Fig. 11). Overall, this response may be an output of the public discussion on deforestation in Romanian mass media during the last 10 years. Also, this role attributed to deforestation as a CC driver is a consequence of the respondents’ overall poor understanding of the CC complexity.

Age and gender biased the perception of the triggering factors of CC. About 55% of the young respondents and 62% of the women in Romania consider that “all people” are responsible for it, which is considerably higher compared to the elderly (41%) or men (44%). Industrial development was identified as a triggering factor by 61% of 18–29-year-old people and 28% of the 65+ people. The last one is the generation who witnessed the industrial boom of the 1970s and society’s intense focus on the important role and performance of the Romanian industry developed during the 1980s. In contrast, environmental protection and CC were minor issues on the public agenda. On the other hand, the

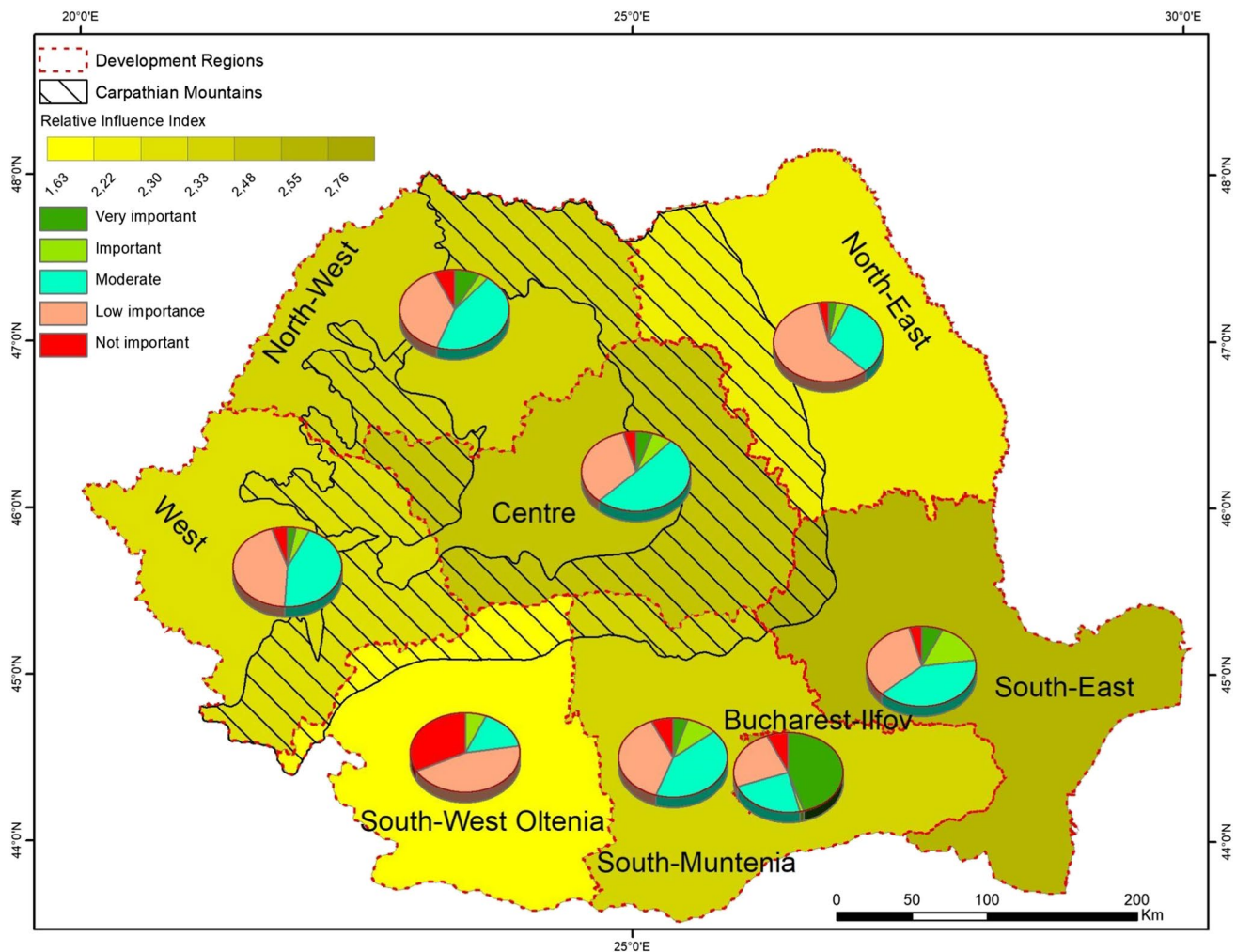


Fig. 7 Level of perceived relative information of Romanians about the CC issues

actions of the governments of the industrialized countries are considered an important CC factor mainly by older people: 47% of the people within the category 65 + compared to 26% from the people in the age category 18–29.

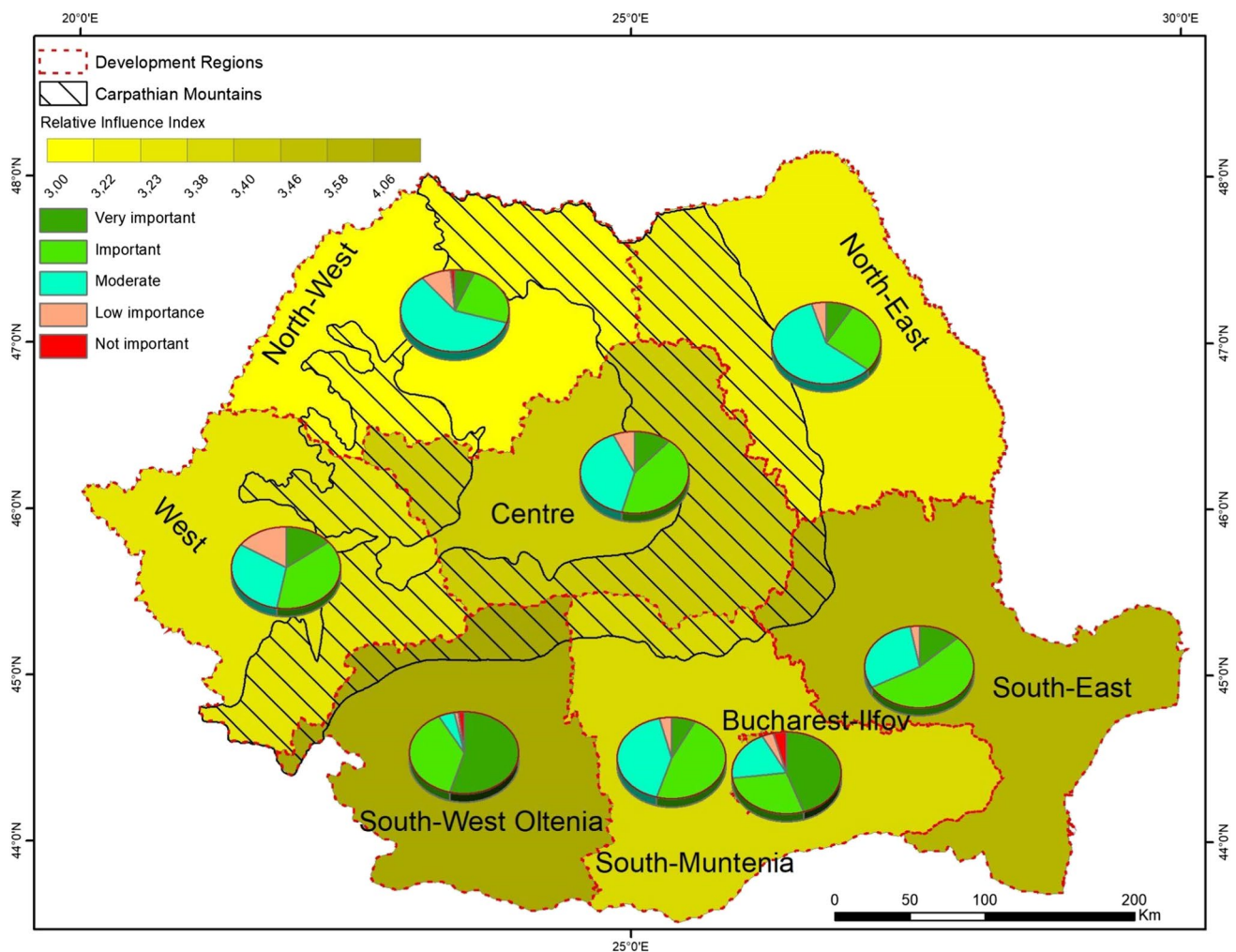
Both “urbanization” and “natural causes” are more frequently identified as causes for CC by the people living in cities. Also, almost 20% of the urban dwellers believe that intensive agriculture has an important influence on CC, compared to only 11% of the respondents living in rural areas.

### 3.4 Perception of changes in the local occurrence of dangerous meteorological phenomena

The survey also investigated the public perception related to the dangerous meteorological phenomena (severe weather conditions) most often associated with CC in Romania. The results revealed how the Romanians perceive the local changes of temperature, precipitation, and several meteorological phenomena proposed in the survey based on existing

reports on observed changes: heat and cold waves (Piticar et al. 2017; Croitoru et al. 2016, 2018), rainfall events (Busuioc et al. 2017), snow cover (Micu et al. 2015; Birsan and Dumitrescu 2014), drought, storms, and new or rare events, such as tornadoes (Andrei et al. 2020).

Individuals’ conceivable timescales for visioning and concrete engagement extend to about two decades into the future (Lorenzoni and Hulme 2009), while the perception of the observed changes in temperature and precipitation focused on the 15–20 years before the survey. About 85% of the people believe that the regional climate is warmer and drier than 15–20 years before, and 7–8% declare that they perceive no change or the climate is colder and wetter (Fig. 12). The bias related to age, gender, region or other factors is negligible. The perception is in perfect agreement with the observed temperature variability, but the perceived decrease of precipitation is not supported by scientific evidence (Dumitrescu et al. 2015; Croitoru et al. 2016, 2018). The increasing rain intensity trends associated with warming



**Fig. 8** Level of perceived relative own information of the respondents about the CC issues

processes (Busuioc et al. 2017) trigger longer intervals with no or little precipitation amounts and less water available in some periods, influencing the public perception of the drier climate over Romania.

The main issue reported as a CC marker within the local environment is snow cover, perceived as decreasing over the last decades by 75% of the respondents (Fig. 13). The decreasing precipitation (i.e., droughts) and increasing heatwaves frequency are also associated with CC by most people (almost 70%). More often, storms and the increasing frequency of phenomena less common or new in Romania, such as tornadoes, are noticeably related with CCs by 22–23% of the respondents, while other severe weather conditions are less present in the answers, i.e., more frequent cold waves (15%), more frequent heavy rainfall events (3–4%), and other phenomena (less than 1% each).

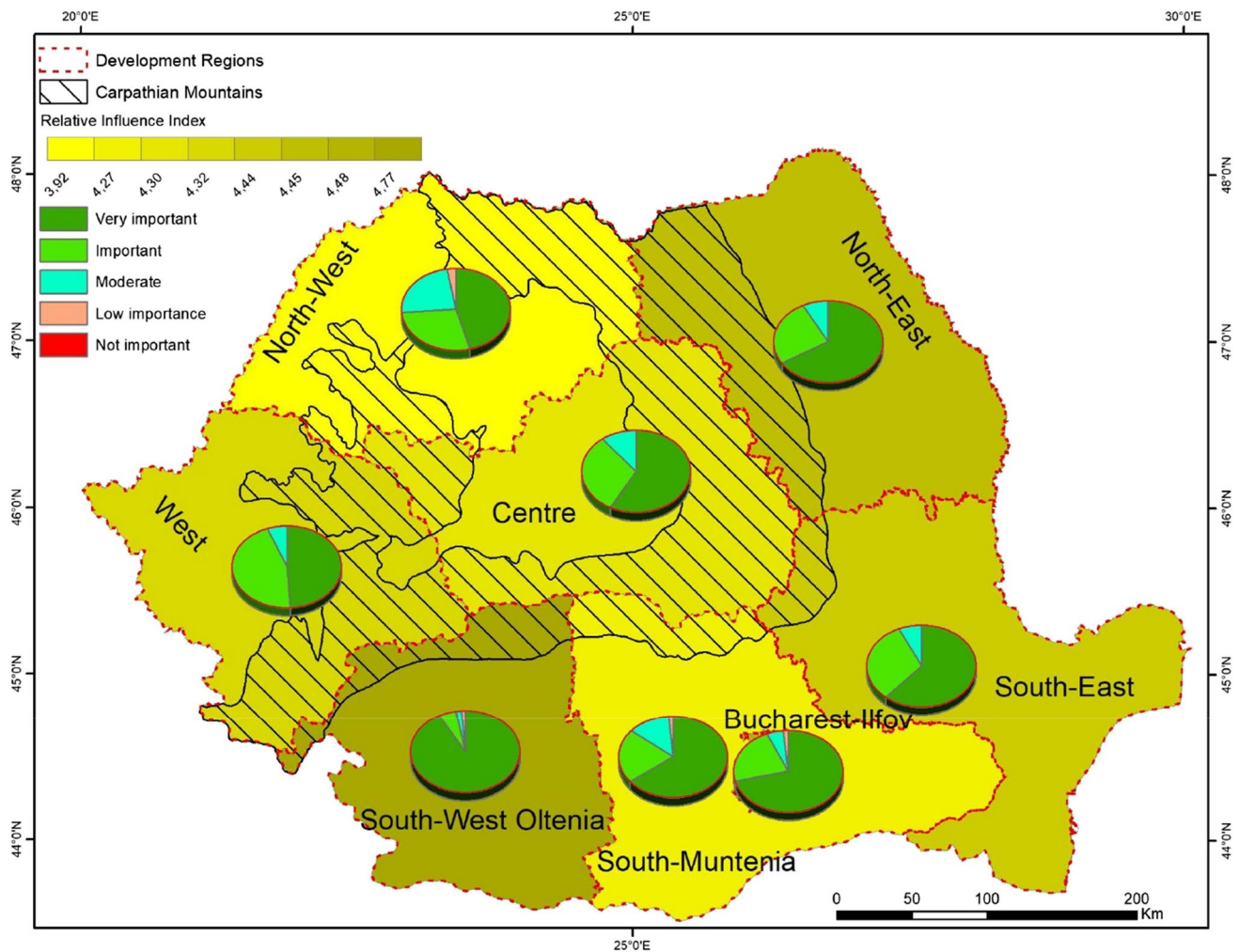
The perceived changes in general climate at the local scale varies significantly ( $p < 0.05$ ) with age, type of settlement, geographical location (DR), and gender. The

heatwaves and drought events were perceived as more frequent nowadays than over the last decades by the majority of two age groups: 65+ population (77%) and those of 30–44 (52%). The young generation (18–29 years old) considered more frequent heavy rainfalls as the most important change in weather conditions. Both categories agree with scientific findings (Bojariu et al. 2015; Croitoru et al. 2018).

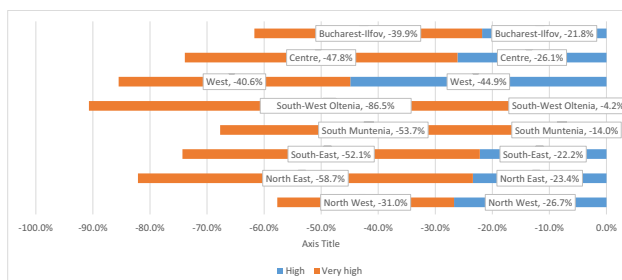
Urban residents associate rainfall events with CC three times rarer than the rural population. Still, heatwaves are indicated 30% more often, in close relation to the events impacting the most both urban and rural population (Herbel et al. 2018; Ichim and Sfîcă 2020).

At the regional level, one can notice that the respondents from the Bucharest-Ilfov DR provided multiple answers and put the new or unusual phenomena in relation to CC much more often than the others. Almost all respondents from Bucharest (95%) consider that the heatwaves are more frequent than in the recent past, with this share being well above the country average (67%). The respondents of the SW Oltenia DR

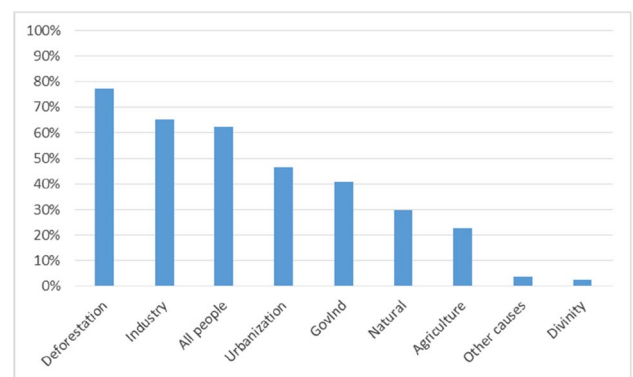




**Fig. 9** Level of perceived relative interest of the respondents about the CC issues



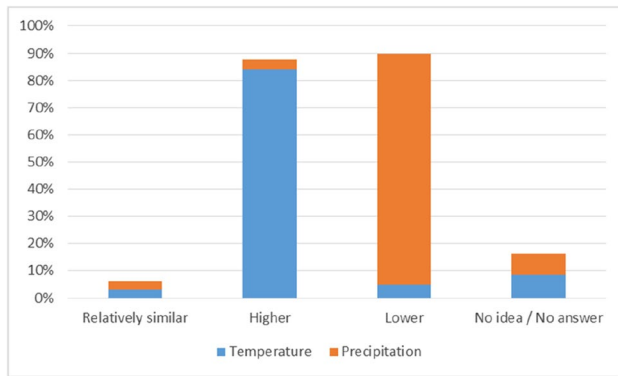
**Fig. 10** Differences between declared high and very high levels of self-information and own interest for CC issues



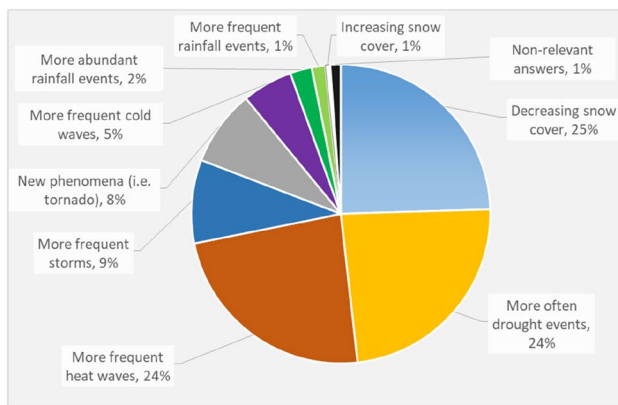
**Fig. 11** Perception of causes of CC (All people: all anthropogenic activities; GovInd: Governments of Industrialized Countries)

are the least sensitive to CC issues relative to the meteorological phenomena listed in the survey. Other relevant differences between DRs are listed in Table 1.

The gender proportion is significantly unbalanced, as the women respondents more often associate the phenomena proposed to CC than the men sample (+8%).



**Fig. 12** Perception of changes in temperature and precipitation over the last decades



**Fig. 13** Perception of changes occurring in the recent decades at local scale

### 3.5 CC impacts

#### 3.5.1 Perception of CC impacts at regional scale

Most people (92%) say that CC may impact the region where they live, and only 1% of the subjects deny the possibility of such an impact (Q1), which is in very good agreement with the acknowledgement of CC as a reality by 95% of the respondents (Q2). The difference from the results revealed by the 2014 Eurobarometer on CC (European Commission 2014), suggesting a low level of awareness of Romanians on CC topics, may be induced by the sample structure of this study. However, this topic requires more refined and consistent investigations. The difference between young people and the older generation perception is negligible in this

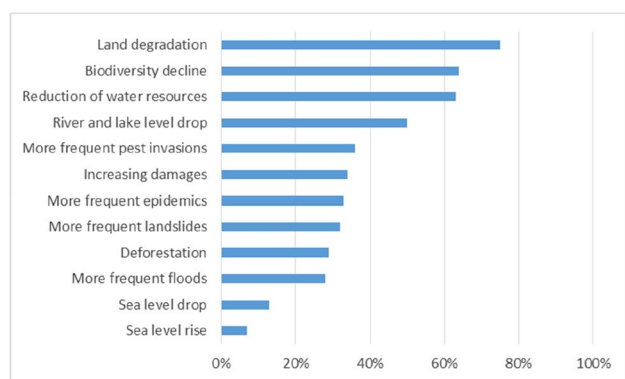
**Table 1** Dominant changes associated to CC identified by respondents

Development region (DR)	Perceived CC
Bucharest-Ilfov	New phenomena (i.e. tornado); More frequent storms; More frequent heatwaves; More frequent droughts
NW	Decreasing snow cover
NE	More frequent heatwaves
South Muntenia	More frequent heatwaves; Decreasing snow cover
SE Oltenia	More frequent heatwaves; More frequent droughts
West	More frequent storms; More frequent cold waves; More frequent droughts
Centre	More frequent heavy rainfall events

case (87% vs. 83%). The perception of environmental issues suggests that the young generation is more interested in CC than in the general environmental agenda. Still, the clear distinction between CC and general environmental issues within the public perception should be investigated in further studies. A high percentage of the respondents (85%) associate the potential impact of CC with the importance of environmental issues since they attribute a high value to both issues (Q3, Q4).

Land degradation, biodiversity loss, water resources decline, and river and lake levels drop are the issues most frequently perceived as specific local CC impacts from the 12 predefined options proposed in the questionnaire (Q13) (Fig. 14). Each category mentioned above is present in more than 50% of answers, with a maximum of 75% for land degradation.

Generally, the respondents' proposed impacts have been well incriminated as potentially caused by CC (i.e., around 30–35% of answers indicated “more frequent floods,” “deforestation,” “more frequent landslides, epidemics material damages, or pest episodes”). The low percentage of answers indicating “sea level rise” as a CC impact can be explained primarily by the physical distance between respondents' residence location and the coastal region or by the actual increase in sea level is not perceived as being dangerous for the moment. However, this general perception level is also in line with some previously developed studies (Medvedev et al. 2016), showing that this process is expected to exert a limited impact even in the worst-case CC scenarios within a low-tide water body of the Black Sea. The high percentage of respondents indicating 'more epidemics' as a consequence of CC could be biased by the period when the questionnaire was applied, which overlapped the beginning of the COVID19 breakdown period in Romania.



**Fig. 14** Perception of changes of the frequency of occurrence of specific CC impacts in the recent decades in Romania

In many cases, regional differences have essential values: SE vs. West regions regarding the land degradation, or NE vs. West regions regarding the biodiversity decline (Table 2). The respondents in the SE region indicate biodiversity loss as a main effect of CC in relation to the loss of diversity in marine life or along the Danube and its delta. The perception of CC impacts is unbalanced by gender, residence, and age. Thus, women and rural residents mentioned more categories of impacts than men and urban respondents. The young generation (18–29) is dominantly concerned about 'deforestation', while biodiversity loss and reduction of water resources are significantly more frequently selected as possible CC impacts by people between 30 and 44 years old (70%) or by rural residents (73%) and higher educated

people (71%). The perception of the sea-level rise as a CC impact dramatically diminishes with age (11% of the 18–29 years old group and 1% of the 65+ group).

The reduction of water resources is an issue with a high level of visibility within the 30–44 age group (70%). Similarly, the same impact is significantly lower in the view of younger people (49%). The SW Oltenia DR stands out for the highest share of 97% of the total population mentioned in the survey. This share could be explained in relation to the underlying semi-arid climatic conditions and with a high frequency of drought phenomenon in this region (Sandu et al. 2010). Conversely, the lowest share was recorded in the NE DR (40%). People living in rural areas indicated this CC effect more frequently than those living in urban areas (73% vs. 55%). Women from urban areas are more sensitive to this issue than men (68% vs. 58%).

“Decreasing water level in rivers and lakes” showed a similar level of concern in the population sample regardless of age. This issue has significantly higher visibility than the average in the NW (65%), West (62%), and SW Oltenia (62%) DRs.

The invasion of pests is a category of CC effects attributed by most respondents aged 30–44 years (54%), which shows relatively similar shares in all regions of Romania. The respondents from rural areas (44%) and a high share of people with an education level below average (49%) indicated a more significant sensitivity to the same topic.

“Material damage” induced by CC is a consequence mainly tackled by adult respondents aged between 30 and 44 years (44% mentions), as well as by people with

**Table 2** Changes in the frequency of occurrence of specific CC impacts in the recent decades at the local scale, as perceived in each DR

Development Region (DR) \ CC Impacts	NW	NE	SE	South Muntenia	SW Oltenia	West	Centre	Bucharest-Ifov
Land degradation	74%	77%	44%	73%	87%	93%	58%	81%
Biodiversity decline	67%	48%	54%	73%	66%	77%	58%	70%
Reduction of water resources	62%	40%	49%	66%	97%	77%	51%	71%
River and lake level drop	65%	31%	51%	44%	62%	62%	48%	45%
More frequent pest invasions	42%	29%	32%	39%	40%	26%	29%	38%
Increasing damages	42%	19%	26%	25%	42%	21%	23%	40%
More frequent epidemics	53%	26%	24%	21%	49%	22%	25%	25%
More frequent landslides	51%	27%	24%	29%	6%	27%	15%	52%
Deforestation	35%	39%	29%	29%	3%	6%	33%	36%
More frequent floods	50%	23%	28%	19%	5%	32%	20%	36%
Sea level drop	28%	3%	4%	6%	37%	6%	3%	4%
Sea level rise	9%	10%	4%	3%	4%	6%	10%	7%
Other	2%	2%	0%	0%	0%	0%	1%	1%



an education level below average (48%), within a higher share of responses in the NW (42%), SW Oltenia (42%), and Bucharest-Ilfov (40%) regions.

The “increasing number of epidemics” has been attributed to CC by all age groups (somewhat similar shares of responses). Regionally, this consequence received higher-than-average visibility in the NW (53%) and South-Oltenia (49%) DRs. People from rural areas with below-average education levels are significantly more likely in this attribution than the rest of the population.

The landslides show a similar concern in all categories of the population. Unexpectedly, a higher-than-average percentage of respondents mentioned this effect in the Bucharest-Ilfov DR (52%), which is not prone to these geomorphic processes. People in this highly urbanized area also indicate “land degradation”—a problem that apparently should be more important for the rural citizens—as a very important output of CC. These results suggest that the response of this group of population is not driven by their direct experience on the topic but shaped by their effort to gather information on CC issues.

### 3.5.2 Perception of CC impacts on the personal life

Almost half of the respondents believe that CC will impact their personal lives negatively (23%) or even profoundly negative (25%). In contrast, only a small share of answers indicated positive (5%) or profoundly positive impacts (2%) in this respect (Fig. 15).

Respondents living in the countryside show higher concern about the potential impact of CC on their lives (62% of them) compared to the urban residents (37% of the sample). This perception may be generated by the dominant agriculture-based economy in the rural areas, which is directly influenced and more vulnerable to CC and associated extreme events. For instance, farmers in the SW Oltenia DR may perceive CC more than other Romanians due to its direct influence on their crops and living and socio-economic conditions. Or, the land degradation of the lowlands in Southern Romania may trigger a more acute perception of CC than for people who do not directly experience such rapid environmental changes (Stringer and Harris 2014). However, the SW Oltenia and South Muntenia DRs, where rural areas are quite extended, reported the lowest concern regarding the CC impact on personal life (Fig. 16), despite the differences noted in the level of knowledge and interest.

In contrast, the people from NW DR perceived that the CC impact could be high or very high, although they expressed very low interest in the topic (Figs. 8 and 9). This contradiction suggests that various factors influence the CC perception, and the result is not always predictable, which demonstrates the need for more detailed perception studies. The way people evaluate their own capacity to adapt to CC is an essential element in shaping their perception. For instance, even if they experience CC as a very important issue, the people in

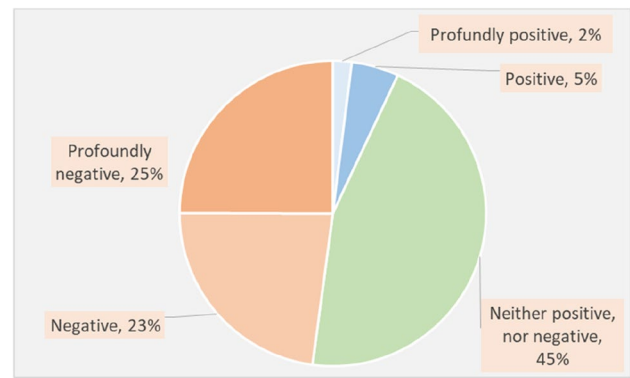


Fig. 15 Perception of CC impact on personal life at country scale

SW consider they can adapt to it relatively easy in the future. Therefore, the impact of CC on their life should be minimized.

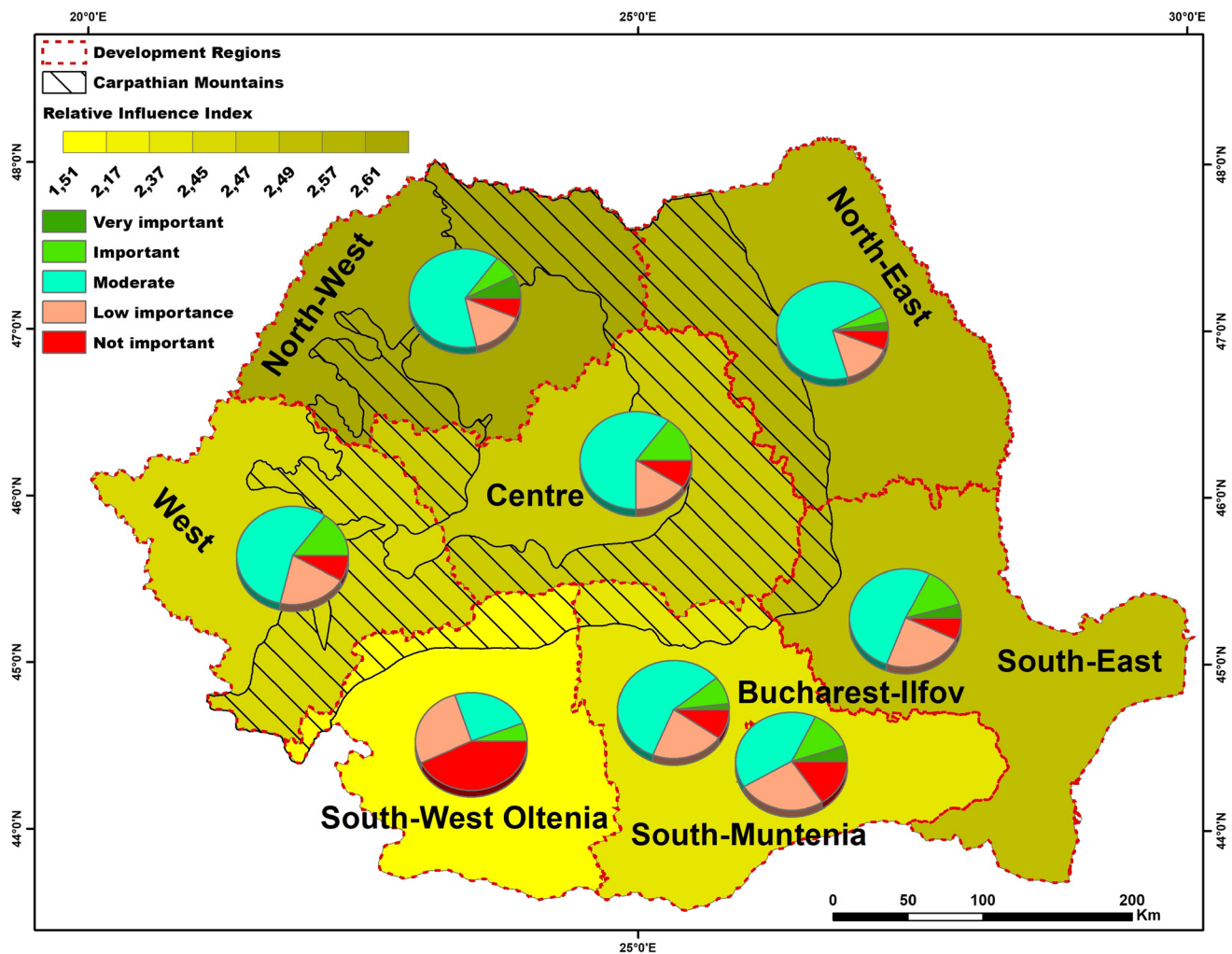
### 3.6 Psychological representation of CC

The “free association” of terms by writing without censorship was applied to investigate the content of individual consciousness and gain insight into how people represent CC (Joffe and Elsey 2014; Vulchanova et al. 2019). This method indicates the overall picture of CC designed by the subjects, with no particular focus on causes or impact. The initial list was expert-based filtered and validated as helpful for this study considering the following criteria: (a) similarity between the meaning of the words in the climate context (e.g., cold and very cold; dry and drought; starvation and famine); (b) typos; (c) the meaning of the terms in the CC context (e.g., “I don’t know” or too general terms, such as “impact” or “scale” were eliminated). In the second step, the valid terms were grouped into four categories, namely (1) Societal and Economic Issues, (2) Psychological Factors, (3) Environmental elements, and (4) Climate and Weather (Table 2).

Most respondents (77.8%) associated CC with “environmental elements” or “climate and weather” terms; about 20% of the respondents indicated either “societal and economic issues” or “psychological factors” as the first related to CC, and a negligible share of answers was not usable (i.e., 2%). “Famine and poverty” (2.5%), “recklessness, carelessness, and irresponsibility” (1.4%), “pollution and anthropogenic activities” (7.4%), “drought and aridity” (14.9%) are the syntagms most frequently mentioned from each of the four main categories. In comparison, “drought and aridity” and “warming and heatwaves” (13.1%) had the highest frequency among all terms (Table 3).

## 4 Conclusions

This study provides a general view regarding the perception of CC in Romania captured in the spring of 2020, including regional differences, and consideration about



**Fig. 16** Perception of CC impact on personal life in each DR

age, gender, living environment, and type and level of education which are likely to bias the outputs. To the best of our knowledge, this is the first study addressing the national level, but considering the perception at the regional level, too and associated with sociological and definite statistical relevance.

Overall, the perception of CC in Romania is dominated by the following characteristics:

- 1 CC is considered a fact, even though media and different groups of interests can overrate it.
- 2 Both environmental issues and CC are considered important or very important topics of the current societal agenda, and environmental education does not bias the perception.
- 3 Most people declared a high to very high interest in CC issues; however, less than a half considered they are well or very well informed, whereas the other people are generally seen as poorly or very poorly informed about CC. Most people from rural areas, with an under average education level and low income, considered themselves well or very well informed. Most urban respondents with higher education declared a very high interest in CC issues and thought the others were not sufficiently informed.
- 4 Extensive deforestation, overall anthropogenic activities and industry, governments of industrialized countries, and urbanization are the most influencing factors that control the CC. This is explicable by the magnitude of public debate on legal and especially illegal deforestation in Romania over the last 2 years. TV shows, public debates, and social media accusations to private forest enterprises gained visibility in the public space and made deforestation a critical political issue.
- 5 The regional climate is perceived as being warmer and drier than 15–20 years before.
- 6 Decreasing snow cover depth and precipitation amount (i.e., droughts) and increasing frequency of heatwaves are the primary CC markers, which are in agreement with the scientific findings.

**Table 3** Categories and terms indicated by using the “free association” with CC. The top three words of each category are in bold (with the frequency of occurrence from the total number of answers mentioned in brackets)

Societal and economic Issues (11.6%)	Psychological factors (8.6%)	Environmental elements (27.9%)	Climate and weather (49.9%)	Not valid (2.0%)
<ul style="list-style-type: none"> <li>• <b>Famine and poverty (2.5%);</b></li> <li>• <b>Danger (General, Crisis, Self-destruction, Problems, Destruction, Evil, Death) (2.4%);</b></li> <li>• <b>Agriculture and food (1.8%);</b></li> <li>• Health, hygiene, and disease (including epidemic);</li> <li>• Instability and chaos; Economy, consume, damages and costs;</li> <li>• Industry; Education and information;</li> <li>• Energy; Technology and science;</li> <li>• Financial incentives and penalties;</li> <li>• Administration;</li> <li>• Mass media</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Recklessness, carelessness, and irresponsibility (1.4%);</b></li> <li>• <b>Humankind (1.1%);</b></li> <li>• <b>Responsibility, activism, NGO (0.9%);</b></li> <li>• <b>Psychological impact (fear, sadness, hate, unsafety, concern, curiosity) (0.9%);</b></li> <li>• Changes and instability;</li> <li>• Ignorance and indifference;</li> <li>• Adaptation;</li> <li>• Uncertainties and unpredictable;</li> <li>• Life (in general) and life quality;</li> <li>• God and religion;</li> <li>• Experiments,</li> <li>• Manipulation;</li> <li>• Future generation;</li> <li>• Overpopulation;</li> <li>• Unavoidable;</li> <li>• Exaggeration or unbelievable;</li> <li>• Fast, short term;</li> <li>• Reality;</li> <li>• Injustice;</li> <li>• Holiday;</li> <li>• Marvellous;</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Pollution and anthropogenic activities (7.4%);</b></li> <li>• <b>Glacier melting (general), including polar ice caps and mountain (4.3%);</b></li> <li>• <b>Nature, environment and ecosystems, Biodiversity (Fauna and vegetation) (4.2%);</b></li> <li>• Deforestation;</li> <li>• Desertification;</li> <li>• Derived hazards (landslides, land degradation, floods);</li> <li>• Snowpack (missing or reduced);</li> <li>• Physical characteristics of the environment (albedo, atmospheric chemical composition, inversion of Poles, air pressure, solar radiation, relief, soil, water, thermohaline, beach, dust);</li> <li>• Sea level rise; Forest fire;</li> <li>• Waste;</li> <li>• Habitat loss;</li> <li>• Resources;</li> <li>• Cities;</li> <li>• Earth;</li> <li>• Recycling;</li> <li>• Miscellaneous (Earthquake);</li> <li>• Protection;</li> <li>• Globalization;</li> <li>• Fossil fuels</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Drought and aridity (14.9%);</b></li> <li>• <b>Warming and heat waves (13.1%);</b></li> <li>• <b>Atmospheric hazards (extremes, risks, deviations, disasters) (7.0%);</b></li> <li>• Changes in seasons / Continentalism;</li> <li>• Past;</li> <li>• Regional scale</li> <li>• Storms and hurricanes;</li> <li>• Atmospheric chemistry, gases, radiation (CO<sub>2</sub>, O<sub>3</sub> and ozone layer, UV);</li> <li>• Air temperature;</li> <li>• Greenhouse effect and GHG emissions;</li> <li>• Tornadoes;</li> <li>• Cold;</li> <li>• Rainfall;</li> <li>• Wind;</li> <li>• Precipitation (in general);</li> <li>• Sun;</li> <li>• Meteorology and weather;</li> <li>• Hail;</li> <li>• Blizzard;</li> <li>• Thunderstorms</li> </ul>	<ul style="list-style-type: none"> <li>• Not usable answers;</li> <li>• I don't know;</li> <li>• Impacts;</li> <li>• Not a topic of interest;</li> </ul>



- 7 At the individual level, the CC is likely to have a negative impact rather than positive consequences.
- 8 CC is most frequently associated with “environmental elements” or “climate and weather” terms, while “societal and economic issues” or “psychological factors” are also present in the “free association” exercise. “Drought and aridity” and “warming and heatwaves” have the highest occurrence of terms related to CC.
- 9 Frequently, the responses are different from region to region of Romania due to the specific climate conditions in the country regions or the local importance of various environmental issues.

Geography (emphasized by analysis considered at DR level), age, gender, and living environment (i.e., urban or rural) often bias the CCP. For example, the older generation tends to focus more on the influence of the establishment and is less convinced about the industry’s impact. Women and young people tend to blame anthropogenic activities more often, while urban citizens are more likely to indicate “urbanization,” “natural causes,” and “agriculture” as important CC generators.

In summary, (i) the regional characteristics (DRs) have the most robust bias on the perception of CC causes, changes in the frequency of various meteorological phenomena, and impact; (ii) the age strongly influence mainly the acceptance of the existence of the CC, the importance of environmental issues, the level of information and interest, the changes in the occurrence frequency of various meteorological phenomena, and their impact; (iii) the gender is essential for perceiving the changes in the frequency of various meteorological phenomena, and their impact; while (iv) the residence habitat (rural vs urban) strongly influences the level of information and interest for CC issues, the changes perceived in the frequency of various meteorological dangerous phenomena, and their impact.

Further studies must address this exploratory investigation of the CCP in Romania, as well as some limitations. For example, the complete statistical representativeness for the country scale of the research is biased by several methodological issues, such as the “internet only”-based approach, the confidence intervals of the sampling, or insufficient coverage of the entire population. The high complexity of factors influencing the CC perception requires more in-depth investigations, while this study has provided the general framework. However, this study proposes consistent follow-ups and in-depth examination of CCP in Romania. It could aim to a better spatial resolution (e.g., local or regional scale), more diverse influences (e.g., economic factors, religion, or occupation), or context (e.g., national or international policy, or natural disasters). Besides, this study is a genuine argument for implementing systematic reviews of the CCP at a national scale to support the development of CC policies well aligned to real societal needs.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s00704-022-04041-4>.

**Acknowledgements** The authors kindly acknowledge the anonymous reviewer for the valuable comments and suggestions that helped improve this paper’s quality. Special acknowledgements are for Dr. Cristina Florina Vîrtan (Roşca) for technical mapping support.

**Author contribution** Conceptualization: Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Ştefan Dorondel, Lucian Sfîcă, Adrian Țîşcovschi; methodology: Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Lucian Sfîcă, Adrian Țîşcovschi; formal analysis and investigation: Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Ştefan Dorondel, Dumitru Mihăilă, Lucian Sfîcă, Adrian Țîşcovschi; writing—original draft preparation Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Ştefan Dorondel, Dumitru Mihăilă, Lucian Sfîcă; writing—review and editing: Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Ştefan Dorondel, Dana Micu, Lucian Sfîcă; supervision: Sorin Cheval, Ana Bulai, Adina-Eliza Croitoru, Dana Micu, Lucian Sfîcă.

**Funding** Stefan Dorondel’s work in this paper is supported by the Grant PN-III-P4-ID-PCE-2020–1238 of the UEFISCDI, The Romanian Ministry of Research and Digitalisation. Adina-Eliza Croitoru’s work for this research was partially conducted under the framework of the experimental demonstration project *Redefining the agro-suitability zones for maize and winter wheat crops toward a smart climate change-oriented agriculture in Romania* ([www.agroclim.ro](http://www.agroclim.ro)) funded by the Executive Unit for the Financing of Higher Education, Research, Development and Innovation in Romania (UEFISCDI), grant number PN-III-P2-2.1-PED-2019–2310.

**Data availability** The datasets generated during and/or analyzed during the current study are not publicly available due to GDPR regulations but are available from the corresponding author on reasonable request.

**Code availability** No code was used in this research.

## Declarations

**Ethics approval** The authors confirm that the manuscript upholds the integrity of the scientific records.

**Consent to participate** All authors have given the consent to participate in this research.

**Consent for publication** All authors have read and agreed to the published version of the manuscript.

**Conflict of interest** The authors have no conflicts of interest.

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