Emőke Kiss[*]
István Fazekas[**]
Dániel Balla[***]

Investigation of conceptual networks related to climate change among inhabitants: A case study in Eastern Hungarian settlements with word association method

Abstract

In this study, the word association method was applied in relation to municipalities in Eastern Hungary (Hajdú-Bihar county), where the Sustainable Energy and Climate Action Plan (SECAP) already exists, and where the SECAP has not yet been introduced. In addition to the six municipalities examined, Debrecen, a county seat with the SECAP, was also included in the survey. The aim was to explore the conceptual networks related to climate change and the strength of the relationship between the stimulus word and the associated concepts. The associations representing a common meaning were categorised. The results

[*] PhD Student, University of Debrecen, Department of Landscape Protection and Environmental Geography, Hungary, kiss.emoke@science.unideb.hu. ORCID: 0000-0003-4976-1241.

[**] Senior lecturer, University of Debrecen, Department of Landscape Protection and Environmental Geography, Hungary, fazekas.istvan@science.unideb.hu. ORCID: 0000-0001-7973-9454.

[***] Senior lecturer, University of Debrecen, Department of Data Science and Visualization, Hungary, balla.daniel@inf.unideb.hu. ORCID: 0000-0002-8051-1518.

show that the distribution of conceptual networks and that of categories related to climate change exhibit a similar picture in the group of municipalities with (3 villages) and without the SECAP (3 villages), although significant differences were found when the settlements were examined separately (7 municipalities). Studying the distribution of categories by demographic groups, it was found that educational attainment determines, to the greatest extent, the answers.

Keywords: climate change, questionnaire survey, conceptual network, word associations, SECAP, Hajdú-Bihar County, demography, educational level

Introduction

Climate change is one of the greatest and far-reaching problems facing humanity today. The effects of climate change are widespread and intensify existing environmental and social problems (IPCC 2014). The majority of scientists warn of devastating consequences if societies do not adequately reduce greenhouse gas emissions (Maibach et al. 2014), but the choice of the most effective method with which to communicate a scientific consensus on climate change is key (van der Linden et al. 2014). Compliance with the goals of the Paris Agreement, which entered into force on 4 November 2016, can only be achieved through stronger efforts than before (Doelle 2016; Johansson et al. 2015; Holman et al. 2019; Jonas and Żebrowski 2019). The EU has been at the forefront of climate protection for decades and plays a key role in shaping global climate policy (Oberthür and Roche Kelly 2008; Jagers et al. 2020); indeed, its objectives are the most ambitious in the world (Oberthür and Groen 2017; Stoczkiewicz 2018). Not only the leaders, but also the inhabitants of the EU, consider climate change a serious problem. According to the Eurobarometer 490 Report, almost eight out of ten respondents (79%) and at least two-thirds of respondents thought climate change was a 'very serious' problem in almost all countries in the EU in 2019. In Hungary, this figure is higher at 85%. In the EU, 23% of the respondents considered climate change to be the world's most serious problem, while in the case of Hungarian respondents the figure was slightly lower, but can be considered very significant, at 17%.

Questionnaire survey is a methodology applied in numerous scientific fields (Radu 2012; Knific and Bojnec 2015; Yarkova and Mutafov 2017; Bednarek-Szczepańska 2019). Questionnaire surveying in relation to climate change among the population is also widespread globally (Greenhill et al. 2014; Tranter and Booth 2015; Ziegler 2017; van der Linden 2018; Goldberg et al. 2019; Poortinga et al. 2019; Ballew et al. 2020). It helps to gain information on the perception of climate change, misconceptions, the level of knowledge about climate change causes and consequences, risk perceptions, concerns and attitudes (Leiserowitz 2006; Whitmarsh 2009a; Whitmarsh 2011; Smith and Leiserowitz 2012; Yu et al. 2013; Goldberg et al. 2020; Hoogendoorn et al. 2020). The exposure of this information is vital, as these, together with socio-demographic characteristics, determine the mitigation and adaptation related actions (O'Connor et al. 1999; Bord et al. 2000). According to Bouman et al. (2020), the more concerned people are about climate change, the more likely they will take appropriate action. Considering demographic factors, gender is the strongest influence on concern and risk assessment (Slovic 1999; Rowe and Wright 2001). This claim is also supported by the results of Sundblad et al. (2007), who examined demographic factors and concluded that women were more concerned about climate change than men. Risk assessment is influenced by knowledge of the causes and consequences of climate change, and the only demographic factor that affects this is educational level. In addition, increasing age may have an impact on knowledge and thus on the level of concern (Sundblad et al. 2007; Whitmarsh 2011). Many believe that the ozone hole or disturbed weather is the cause of climate change (Lorenzoni et al. 2006; Leiserowitz 2012), which leads to the emergence of misconceptions (Leiserowitz 2006). The level of knowledge, the degree of concern, and misconceptions can be easily exposed by word association analysis and the assessment of conceptual networks. In addition, the method shows the impact of demographic factors and the difference between them.

Most of the studies presenting questionnaire results put forth findings at national level, but this may distort the variability of subnational (regions, states, counties or localities) levels (Howe et al. 2015). In addition, there are very few studies on surveys at municipal level and on how the existence of climate documents affects an individual's sensitivity, knowledge and attitudes towards climate change.

Word association

The word association method is applied to explore conceptual structures. The essence is that, after being given the stimulus word, the respondent is asked to freely associate and describe what comes to mind about that stimulus word (Wagner et al. 1996; Hovardas and Korfiatis 2006). Associated words (or images) may refer to mental representation or projection of cognitive content (Leiserowitz 2003; Leiserowitz 2006). Responses depend on the stimulus word and the images formed about it, as well as the knowledge of it (Wagner et al. 1996). The main advantage of this method is that free associations minimise the researcher bias caused by closed-ended questions in questionnaires. Free associations are spontaneous, context-free and unfiltered, making the method a unique tool for accessing and evaluating subjective meanings (Leiserowitz 2006; Lorenzoni et al. 2006; Smith and Leiserowitz 2012). There are very few word association studies on climate change in Hungary, taking into account both national and subnational levels.

Climate documents

In 2008, the European Commission established the Covenant of Mayors Climate and Energy initiative, which aims to reduce CO_2 emissions at local level, adapt to climate change, and achieve safe and sustainable energy. Municipalities that signed the initiative are committed to actively supporting the realisation of the climate protection objective of the EU: a 40% reduction in greenhouse gas emissions by 2030 and adaptation to climate change. The members of the covenant agree to submit a local strategy (*SECAP – Sustainable Energy and Climate Action Plan*) outlining the main activities to be carried out (Covenant of Mayors for Climate and Energy; Climate ADAPT).

The second National Climate Change Strategy in Hungary came into force in 2018, replacing the first National Climate Change Strategy adopted in 2008. County-level climate strategies (19) and the climate strategy of the capital, Budapest, were also prepared in 2018. Local strategies are already available for numerous settlements in Hungary, but the number of settlements with a SECAP is still low.

Aims

Based on the above, in the course of our work the objective of conducting a word association study in order to explore the conceptual networks related to climate change, the number and type of associations, and the strength of the relationship between the stimulus word and the associated concepts was set:

(1) for the full sample,

(2) for settlement groups with and without a SECAP, and

(3) for the settlements.

A further aim was to categorise the associations on the basis of the Code book which we ourselves created:

(4) for the full sample,

(5) for settlement groups with and without a SECAP,

(6) for the settlements,

(7) and for the various demographic groups, such as gender, age and educational level (independent hard variables).

Material and methods

Description of study area

The survey was carried out in Hungary, in 3 settlements in Hajdú-Bihar county where the SECAP already exists, and in 3 other settlements in a county where the SECAP has not yet been introduced. The selected settlements with a SECAP and their permanent population according to the census performed by the Central Statistical Office in 2011 are the following: Bedő (255 people), Körösszakál (886 people), Újszentmargita (1,546 people) (HCSO 2011). In addition, settlements were selected with nearly the same permanent population and the distance between the pairs did not exceed 50 km. The conditions were met by Told (316 people), Gáborján (914 people) and Hortobágy (1,579 people).

Figure 1. Location of the study area
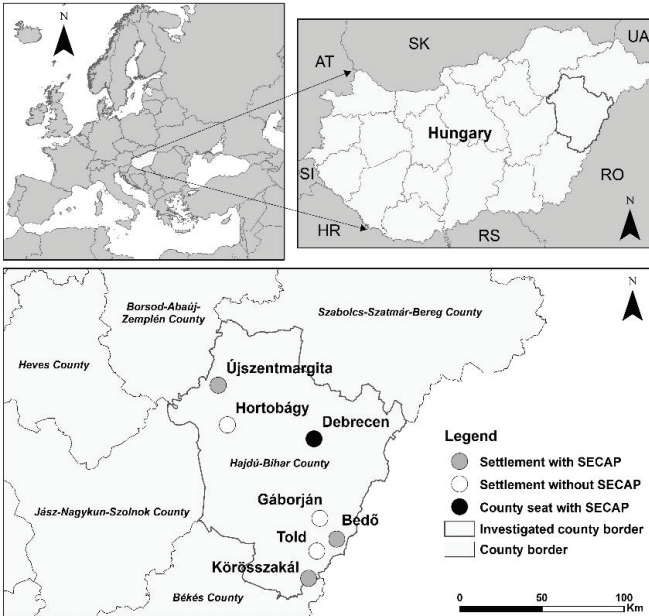
Apart from the six studied settlements, Debrecen (196,858 people), a county seat with a SECAP was also included in the survey in order to obtain a more complex image. The location of the settlements is shown in Figure 1.

Bedő, Told, Körösszakál and Gáborján belong to periphery areas in Hungary along the border, while Újszentmargita belongs to an inner periphery area. Periphery areas are characterised, in general, by population decline, lower educational levels than the national average, higher unemployment rates, economic underdevelopment, and infrastructure deficiencies (Süli-Zakar and Kozma 2003; Pap and Tóth 2005; Kovács 2014; Pénzes et al. 2015; Pénzes et al. 2018). Hortobágy shows a similar image, although it is also a tourist centre of national importance, as the oldest national park in Hungary can be found there (Vasvári and Martonné 2015; Formádi et al. 2017). Debrecen is the second largest city in Hungary, and is a dynamically developing regional, economic, educational and tourist centre (Formádi et al. 2017).

Procedure and respondents

The questionnaire study was carried out between July and September 2020. In the course of data acquisition, the sampling framework was provided by data according to type of locality and data on localities of Hajdú-Bihar county in the census performed by the Central Statistical Office in 2011 (HCSO 2011). The respondents were determined by quota sampling, representative of both gender and age by settlements. In the course of sample selection, only the adult population aged over 18 from the 15–19 age group used by the CSO was taken into account. The number of elements in the sample was 200 in Debrecen, 90 in Újszentmargita and Hortobágy, and 50 in Körösszakál and Gáborján, while it was 16 in Bedő and Told. The full sample was 512. Table 1 shows the number of respondents by study groups and their proportion in the full sample. Data were collected via personal interview, using the random walk sampling technique, and applying Leslie Kish systematic sampling, which involved visiting houses and flats.

Question-wording

The questionnaire consisted of several questions, but only the results of the word association question are presented in this study. A number of studies have shown that wording strongly influences respondents' attitudes (Whitmarsh 2009b; Villar and Krosnick 2011; Schuldt et al. 2011; Schuldt et al. 2015; Soutter and Mõttus 2020). For this reason, the term 'climate change' (in Hungarian: klímaváltozás) was used instead of 'global warming' (in Hungarian: globális felmelegedés) or 'global climate change' (in Hungarian: globális klímaváltozás). The reason for this is that the SECAP and the Hungarian county strategies (e.g. Climate Strategy of Hajdú-Bihar county) also use the word 'climate', and thus we assumed that the population would associate more with this word. We asked respondents the following question: *What comes to your mind when you hear about climate change? List a maximum of three things!*

Table 1. Distribution of respondents by study groups

Study groups	Number of respondents	Proportion of respondents in the full sample (%)
Settlement		
Debrecen	200	39.06
Újszentmargita	90	17.58
Hortobágy	90	17.58
Körösszakál	50	9.77
Gáborján	50	9.77
Bedő	16	3.13
Told	16	3.13
Demographic indicators		
Gender		
Women	273	53.32
Men	239	46.68
Age group		
18–34	153	29.88
35–49	131	25.59
50–64	130	25.39
over 65	98	19.14
Highest educational level		
Primary school or less	110	21.48
Vocational school	94	18.36
Vocational high school	48	9.38
Grammar school	107	20.90
Technical school	32	6.25
College or university	121	23.63

Data analysis and visualisation

Data analysis consisted of four main steps. The first step was to organise the raw data into a database. As a second step, associations with the same meaning were merged in order to clearly ascertain the strength of the connection between the concepts, e.g. change/changing/constant change; no four seasons/no seasons/no winter, spring, summer, autumn; heat/it is hot/it is hotter/great heat/it is very hot/burning heat/constant heat. The third step was to reduce the data and to categorise associations for easier comparison. Concepts were coded according to topics, which represented common meanings, creating, in this way, a Code book, which contained 27 categories (the code book is available as an appendix).

The conceptual network was visualised on the basis of the merged meaning, according to the relative frequency of the concepts. In determining the relative frequency of associations, the number of respondents mentioning the concepts was divided by the number of respondents in the studied group. Thus, a concept could reach 100% frequency if all respondents mentioned it. As a result, no high values could emerge. Based on Szabó et al. (2020), only those concepts that reached a frequency of at least 3% were visualised (Table 2). The distribution of categories in the studied settlements was also visualised according to their relative frequency, although in this case all categories were visualised for better comparability. The thematic map was prepared using ArcGIS Desktop version 10.2. Data visualisation was performed using yED Graph Editor and Tableau Desktop.

Table 2. Strength of relative frequencies and the method of visualisation

Relative frequency	Strength of connection	Method of visualisation
under 3 %	very weak	not visualised
3.0–5.0 %	weak	
5.1–10.0 %	medium	
10.1–20.0 %	strong	
above 20.1 %	very strong	

Results and discussion

Number of mentioned associations and the conceptual network of the studied settlements

In total, 8% of the full sample could not list a single association, 28.9% gave one word, 25.6% two words and 37.5% three words. Bedő had the highest proportion of respondents who did not mention a single word (18.8%), while the proportion of respondents who mentioned the maximum of three words was highest (61.5%) in Debrecen. Handling the settlements with a SECAP (Újszentmargita, Körösszakál, Bedő) as one group, it can be concluded that the proportion of respondents who did not mention a single word is 13.5%, while in settlements without a SECAP (Hortobágy, Gáborján, Told) this figure is only 6.4% (Figure 2). It is important to note that, when study groups with and without a SECAP are discussed, Debrecen is not included in the analysis so as not to distort the results.

Since each respondent was allowed to list a maximum of three words, the 512 respondents could have mentioned a total of 1,536 words. Instead, however, only 986 words were mentioned, which represents a response rate of 64.19%. Debrecen shows the highest rate (78.83%), and Bedő shows the lowest (45.83%). This proportion is 53.21% in the settlement group with a SECAP and 56.41% in the group without a SECAP, thus meaning there is no significant difference between them (Figure 3).

A total of 465 different associations were mentioned for the full sample, taking repetitions into account. As associations with the same meaning had been merged, their number was reduced to 272. The conceptual network of the respondents is visualised based on the merged meaning according to the relative frequency of the concepts. In the full sample, 10 concepts achieved a relative frequency higher than 3%, which means that these are the 10 most common concepts that respondents think of in relation to climate change (Figure 4). Due to the significant variability of associations, a very strong connection (above 20.1 %) did not occur for any concept. A strong connection (10.1%-20.0%) was observed in the case of the concepts 'warming' and 'global warming', while a medium-strength connection (5.1%-10.0%) was found in the cases of 'weather change' and 'warm'. The above indicates that the

respondents associated with the synonym of climate change and its general manifestation, such as temperature rise and the possible consequences. A weak connection (3.0%-5.0%) was found in the case of the 'storm', 'extreme weather', 'air pollution', 'weather', 'hotness', and 'drought' concepts. In this case, again, rising temperature, the weather and possible consequences were mentioned. Another environmental problem, air pollution, also appears, which could be a possible cause of climate change.

Figure 2. Proportion of respondents mentioning different number of associations according to study groups (%)
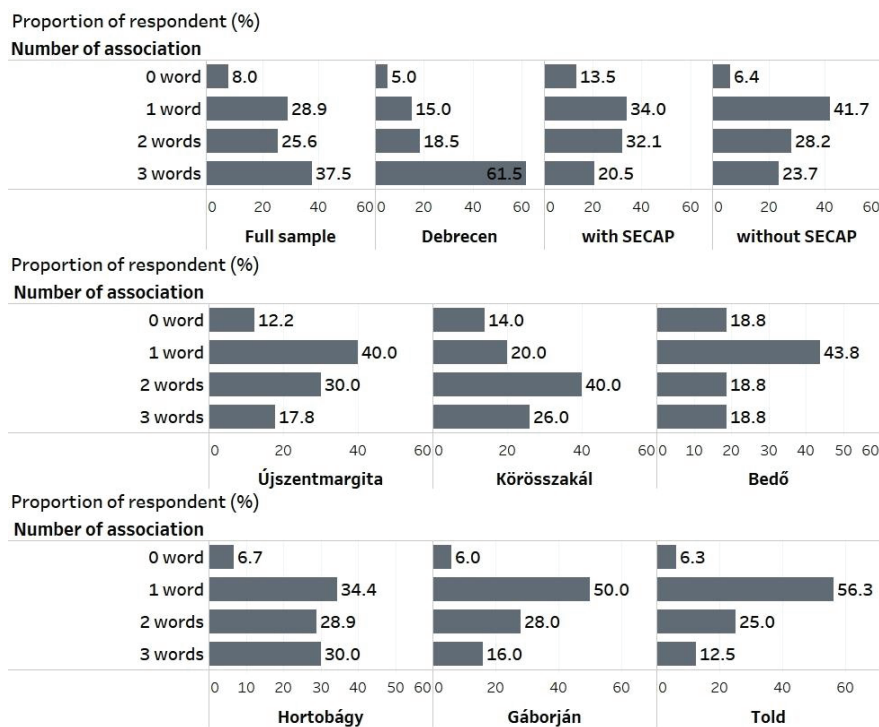
Figure 3. Response rate by study groups (%)
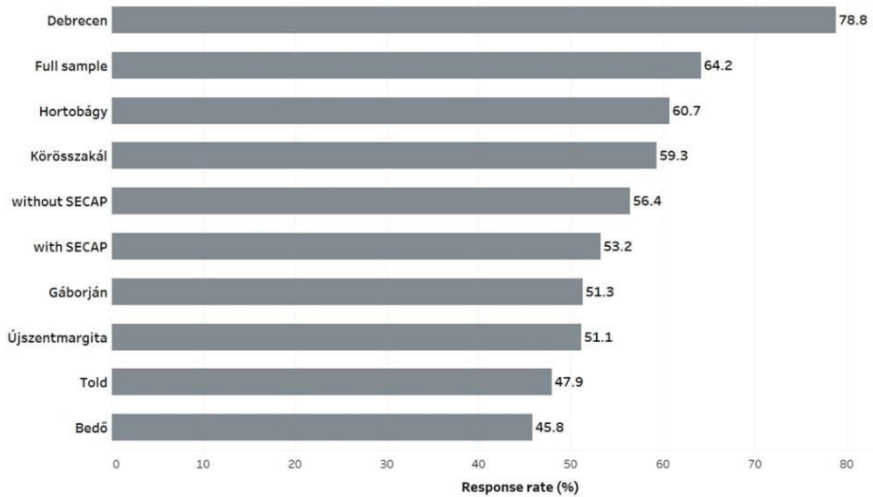
Figure 4. Conceptual network of the full sample in relation to climate change according to relative frequency (%)
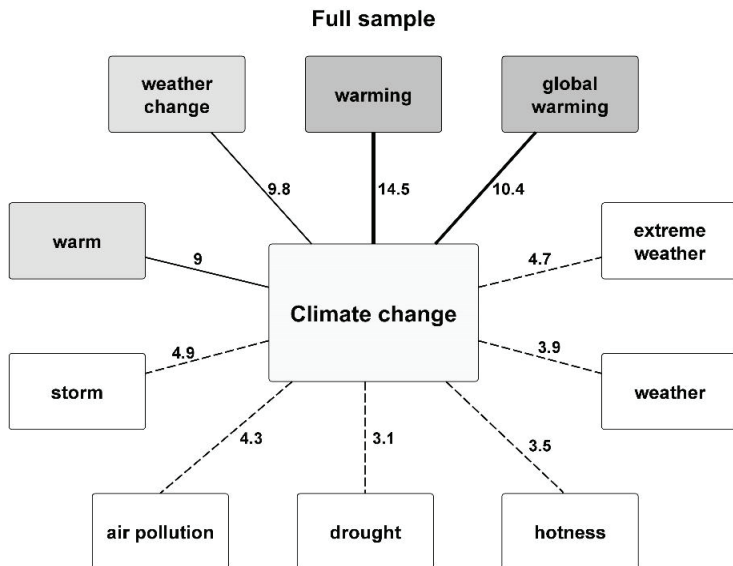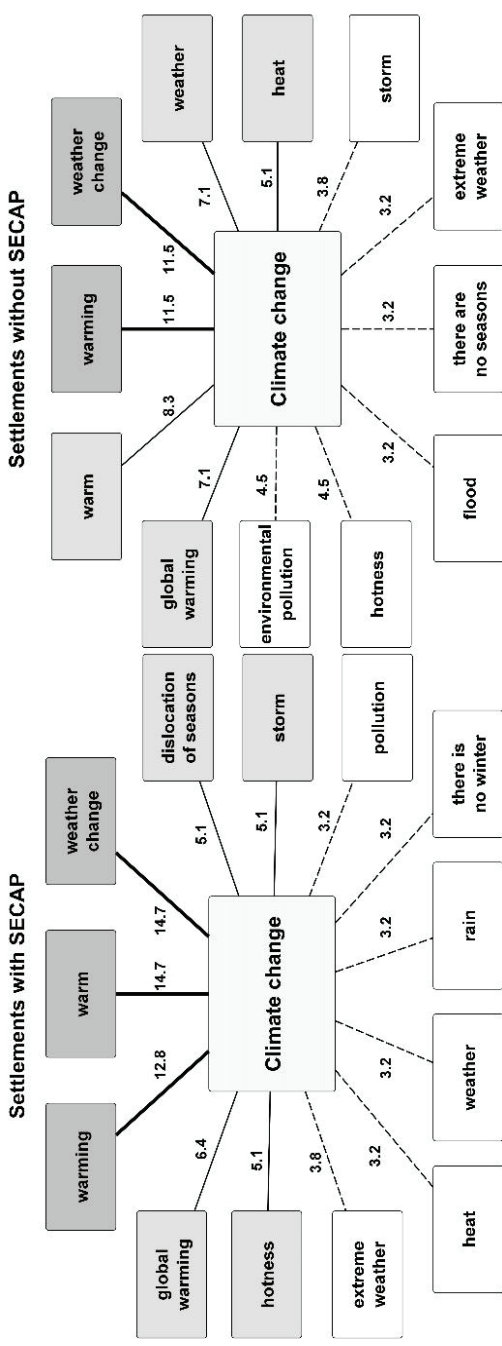
Figure 5. Conceptual network of settlements with and without a SECAP in relation to climate change according to relative frequency (%)

The conceptual network of groups with and without a SECAP shows a similar image (Figure 5). The former had 13 associations and the latter 12 associations in the conceptual network. 'Warming' and 'weather change' both had a strong connection, 'global warming' had a 'medium' connection, and 'extreme weather' had a weak connection. In addition, the concepts 'warm', 'storm', 'heat', 'hotness' and associations with similar content, such as 'pollution' and 'environmental pollution' all appeared in the network of both.

The conceptual network of respondents by settlements was also analysed, and significant differences were found. The more associations the respondents identified, the more diverse the conceptual network which developed (Figures 3 and 6). In Debrecen, 19 associations were included in the conceptual network, 15 in Újszentmargita, 14 in Hortobágy and Gáborján, 13 in Körösszakál, 4 in Told and 2 in Bedő (Figure 6).

In the case of settlements, again words related to temperature rise, such as 'warm' and 'warming' appeared most frequently, in six of the settlements. 'Warm' and 'warming' did not reach the relative frequency of 3% only in Bedő and Told, respectively. 'Warming' always showed a strong connection strength, while the concept 'warm' was very strong in Körösszakál, strong in Újszentmargita, Gáborján and Told, and exhibited a weak connection strength in Hortobágy and Debrecen in the conceptual network.

The concepts 'weather change', 'global warming' and 'storm' reached a relative frequency of 3% in 5 settlements. The concepts of 'weather change' and 'global warming' did not appear only in Bedő and Told. The concept of 'weather change' in the network of the settlements showed a strong connection strength, except in Debrecen, where the association appeared with a weak strength. In the case of 'global warming', the situation was the opposite, as it appeared in all settlements with a medium connection strength, except in Debrecen, where it showed a strong connection strength. The concept 'storm' appeared in all settlements except Gáborján and Bedő, with a strong connection strength in Told, medium in Körösszakál and Debrecen, and weak in Újszentmargita and Hortobágy.

'Extreme weather' appeared in 4 settlements, with weak strength in Újszentmargita and Hortobágy, and moderate strength in Debrecen, as well as a strong connection in Told. The concept 'hotness' was also found in 4 settlements: with a strong connection in Bedő, medium in Újszentmargita and Gáborján, and weak in Hortobágy (Figure 6). The most frequently occurring associations related both to the synonym of climate change and to the possible consequences, which are primarily based on the empirical experiences of the respondents.

Figure 6. Conceptual network of the studied settlements in relation to climate change according to the relative frequency (%)
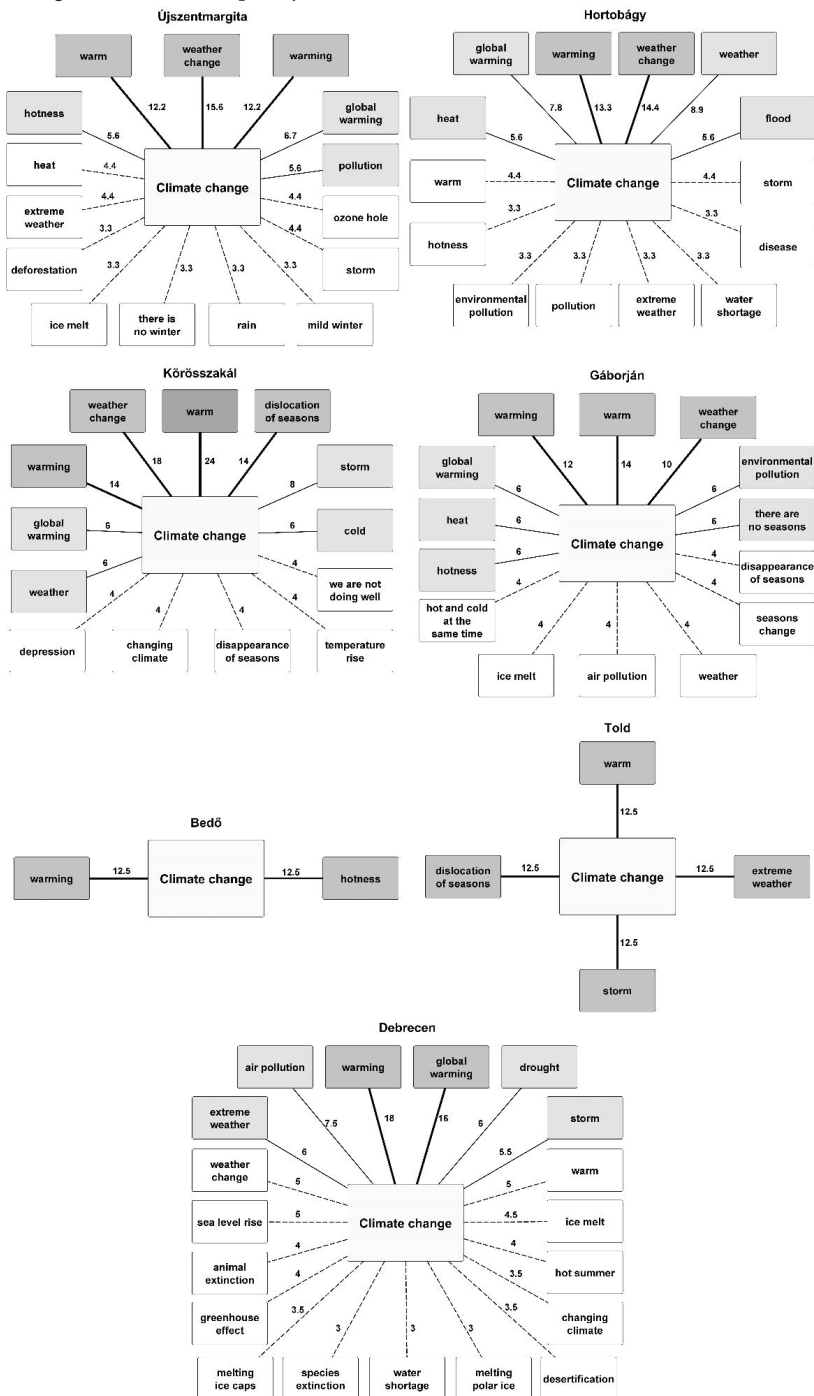
Distribution of the relative frequency of the categories
in relation to the full sample and the settlements

Further on in the research, occurring associations were categorised for the full sample, in relation to the group of settlements with and without a SECAP. A total of 27 categories were distinguished in relation to climate change (appendix), which appeared with varying relative frequency in the groups studied. Encoding of the associations in the settlements was relatively simple using the same categories.

The highest relative frequency, shown in Figure 7, was achieved by the category Heat (e.g. 'hotness') in the full sample, as well as in settlements with and without a SECAP. In addition, the categories Season change (e.g. 'there is no autumn/spring'), Warming (e.g. 'warming planet', 'warming'), and Weather change (e.g. 'frequent weather changes') had high frequency values. These all point to the consequences of climate change, rising temperatures and changes in weather, based on the empirical experience of the respondents.

Debrecen shows a different picture, as Ice melt (e.g. 'melting polar ice') had the highest value, suggesting that the respondents in the settlement currently consider this to be the symbolic image and the most prominent effect of climate change. In addition, Heat, Warming and Global warming (e.g. 'global warming'), which also indicate rising temperatures, had high relative frequencies and the synonym of climate change also occurred. Flora and fauna (e.g. 'destruction of animals and plants') were also shown to have a high frequency, which means that respondents are aware that climate change can also have a serious impact on the biosphere.

It should be noted that the categories Scepticism (e.g. 'it is a lie') and Happening, need actions (e.g. 'fast and effective solution is needed') both had the highest values in the group of settlements without a SECAP. In general, groups with and without a SECAP showed a similar picture based on the distribution of the frequency of categories. The most significant differences were shown by the categories Water and food shortage (e.g. 'starvation', 'there will be no water'), with a 7.5-fold difference (0.6% and 4.5%), and Lifestyle, production (e.g. 'waste', 'industry', 'human's fault'), with a 3.5 fold difference (2.6% and 9%). In all cases, higher values were found in the study group without a SECAP; moreover, Sea level rise, flood (e.g. 'disappearance of Venice', 'floods') did not occur at all in the SECAP group. The Pollution (e.g. 'air/water/environmental pollution'), Ozone

(e.g. 'ozone hole', 'UV radiation'), Greenhouse effect (e.g. 'CO$_2$ emission'), and Disaster (e.g. 'natural disaster', 'volcano eruption') categories occurred at the same frequency (Figure 7).

Figure 7. Relative frequency of the categories in the full sample, in settlement groups with and without a SECAP and in Debrecen (%)

Percentage of relative frequency

Categories	Full sample	with SECAP	without SECAP	Debrecen
Heat	21.1	26.3	19.2	18.0
Season change	18.6	24.4	17.9	14.5
Warming	14.5	12.8	11.5	18.0
Weather change	14.3	19.2	18.6	7.5
Global warming	10.4	6.4	7.1	16.0
Pollution	10.2	9.0	9.0	12.0
Ice melt	10.2	3.8	4.5	19.5
Flora and fauna	9.0	2.6	6.4	16.0
Human health	7.2	10.9	7.1	4.5
Extreme weather	7.2	5.1	3.8	11.0
Lifestyle, production	5.9	2.6	9.0	6.0
Drought, desertification	5.9	1.3	4.5	10.5
Storm	5.5	5.1	4.5	6.5
Sea level rise, flood	5.1	0.0	6.4	8.0
Happening, need actions	4.9	3.8	5.8	5.0
Ozone	4.7	4.5	4.5	5.5
Other	4.5	3.2	3.8	6.5
Greenhouse effect	4.5	1.3	1.3	9.5
Precipitation change	4.3	3.8	5.1	4.0
Changing climate	3.9	2.6	1.9	6.5
Water and food shortage	3.7	0.6	4.5	5.5
Forest	3.5	3.8	3.2	3.5
Problems	3.3	1.9	1.3	6.0
Temperature change	3.1	0.6	1.3	7.0
Skepticism	3.1	1.9	3.8	3.0
Agriculture	2.3	0.6	1.9	4.0
Disaster	1.8	1.3	1.3	2.5

When the settlements are studied separately, significant differences can be detected in the occurrence of the categories, as shown in Figure 8. Only Hortobágy had all 27 categories, i.e. here the respondents gave the most diverse associations. The number of occurring categories corresponds with the number of respondents per settlement. The more respondents were interviewed, the more categories occurred. Heat reached the highest value in Újszentmargita, Körösszakál, and Gáborján. The Heat category also had the highest relative frequency in Told together with Extreme weather (e.g. 'extreme weather', 'whimsical weather') and Scepticism, while Season change topped the list in Bedő and Weather change in Hortobágy. There were only two categories, Heat and Season change, which could be found in all settlements.

The category Greenhouse effect requiring a higher level of knowledge, indicating the cause for climate change, was only mentioned in Körösszakál and Hortobágy, while Ozone as one of the most widespread misconceptions regarding the cause of climate change, occurred in Újszentmargita, Hortobágy and Gáborján. Scepticism reached the highest value in Told, while Happening, need actions was highest in Bedő. Occurring in all settlements were the categories Pollution suggesting other environmental problems and thus other possible reasons for climate change, and Lifestyle, production suggesting anthropogenic activities, while this was also the case for Global warming (Figure 8).

**Figure 8.** Distribution of the relative frequency of categories by settlements (%)

Percentage of relative frequency

Categories	Újszentmargita	Körösszakál	Bedő	Hortobágy	Gáborján	Told
Heat	24.4	36.0	12.5	14.4	28.0	18.8
Weather change	20.0	24.0	0.0	23.3	14.0	6.3
Season change	20.0	30.0	31.3	15.6	24.0	12.5
Warming	12.2	14.0	12.5	13.3	12.0	0.0
Pollution	11.1	4.0	12.5	7.8	10.0	12.5
Ozone	7.8	0.0	0.0	2.2	8.0	0.0
Human health	6.7	18.0	12.5	8.9	6.0	0.0
Global warming	6.7	6.0	6.3	7.8	6.0	6.3
Ice melt	5.6	0.0	6.3	5.6	4.0	0.0
Extreme weather	5.6	4.0	6.3	3.3	0.0	18.8
Storm	4.4	8.0	0.0	5.6	0.0	12.5
Forest	4.4	4.0	0.0	4.4	2.0	0.0
Precipitation change	3.3	2.0	12.5	4.4	8.0	0.0
Other	3.3	2.0	0.0	4.4	4.0	0.0
Flora and fauna	3.3	0.0	6.3	7.8	4.0	6.3
Skepticism	2.2	2.0	0.0	4.4	0.0	18.8
Lifestyle, production	2.2	2.0	6.3	11.1	6.0	6.3
Happening, need actions	2.2	4.0	12.5	6.7	6.0	0.0
Changing climate	2.2	4.0	0.0	1.1	4.0	0.0
Water and food shortage	1.1	0.0	0.0	5.6	2.0	6.3
Temperature change	1.1	0.0	0.0	2.2	0.0	0.0
Problems	1.1	4.0	0.0	2.2	0.0	0.0
Drought, desertification	1.1	2.0	0.0	4.4	4.0	6.3
Agriculture	1.1	0.0	0.0	2.2	0.0	6.3
Sea level rise, flood	0.0	0.0	0.0	10.0	0.0	6.3
Greenhouse effect	0.0	4.0	0.0	2.2	0.0	0.0
Disaster	0.0	4.0	0.0	1.1	2.0	0.0

Distribution of the relative frequency of categories by demographic groups

In our study, we also looked at the dominant factors that determine the answers of respondents, and therefore the distribution of the categories in relation to demographic groups was also analysed for the full sample.

Gender

The response rate was 62.52% for women and 66.11% for men, thus meaning that no significant difference was detected. Figure 9 shows the distribution of the relative frequency of categories among women and men. For gender, it was found that the distribution of categories showed a similar picture. There was only one category which showed a significant difference, namely Scepticism (e.g. 'fake news', 'hysteria', 'it is a problem only in the cities', 'deceiving people'). It occurred at a relative frequency of only 0.7% among the women, while in the case of the men it had a frequency of 5.4%, which means that, in the full sample, men are 7.7 times more sceptical about climate change than women.

Figure 9. Distribution of the relative frequency of categories among women and men (%)
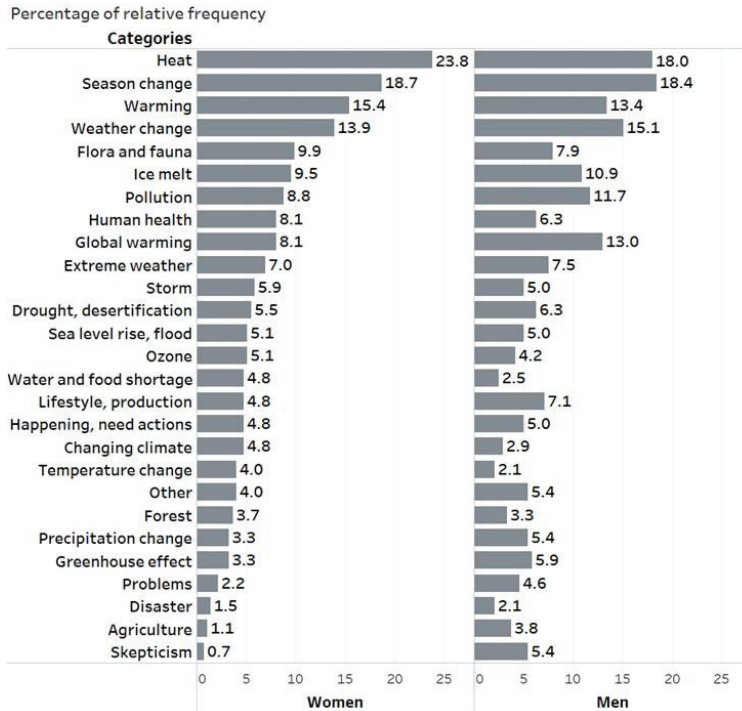
Age

The response rate was 65.14% in the 18–34 age group, 68.45% in the 35–49 group, 64.10% in the 50–64 group, and 57.14% in the over 65 age group, thus meaning that no outlier difference was detected. There was a greater differentiation between age groups in terms of the distribution of categories (Figure 10). Only the over 65 age group did not have all 27 categories. The categories Greenhouse effect (e.g. 'greenhouse effect'), Forest (e.g. 'deforestation', 'felling of trees'), and Disaster (e.g. 'end of the world', 'disasters') did not occur.

Heat (e.g. 'hotness') reached the highest relative frequency in all four of the studied age groups. For the over 65 group, Weather change (e.g. 'weather change') ranked second, while Season change (e.g. 'dislocation of seasons', 'seasons disappearance') ranked second in the rest of the age groups. Season change was the third most frequent in the over 65 group, while Global warming (e.g. 'global warming') ranked third in the 18–34 group, Warming (e.g. 'warming', 'warming planet') for those aged 35–49 and Warming a Weather change among those in the 50–64 group.

As age increased, the relative frequency of the Global warming, Greenhouse effect and Forest categories decreased. As age increased, the frequency of Precipitation change (e.g. 'hectic precipitation change', 'extreme precipitation in a short time') and Happening, need actions (e.g. 'very annoying', 'it is happening right now') increased.

The largest difference in relative frequency could be found in three categories. The value of Sea level rise, flood (e.g. 'sea/ocean level rise', 'deluge') was 6.9 times higher in the 35–49 age group (6.9%) than in the over 65 age group (1%). The occurrence of Temperature change (e.g. 'temperature change') was 5.7 times higher in the 18–35 group (4.6%) than in the 35–49 group (0.8%). Drought, desertification (e.g. 'desert', 'rivers dry up') showed a relative frequency 4.6 times higher in the age category of 18–34 (9.2%) than in the over 65 category (2%) (Figure 10).

Figure 10. Distribution of the relative frequency of categories in age groups (%)
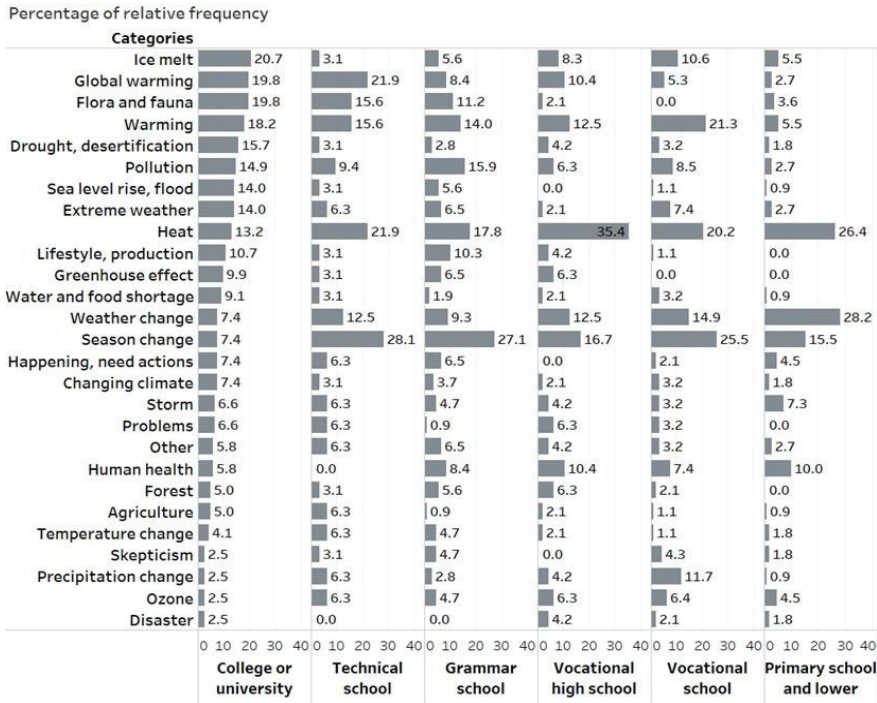

Percentage of relative frequency
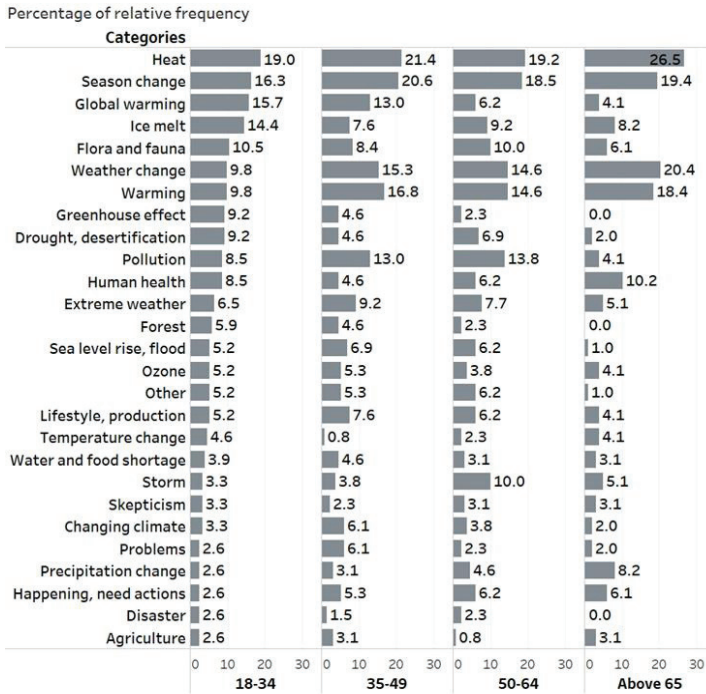
Educational level

There was no chance to take representative samples in relation to educational level, and therefore the number of respondents was not evenly distributed among the groups (Table 1).

There was a clear trend between educational level and response rates (primary school or less – 44.85%; vocational school – 57.80%, vocational high school – 58.33%, grammar school – 65.73%, technical school – 69.79%, college or university – 86.23%): the higher the respondent's qualification, the more associations he/she could list.

Figure 11. Distribution of the relative frequency of categories by educational level (%)

Percentage of relative frequency

Categories	College or university	Technical school	Grammar school	Vocational high school	Vocational school	Primary school and lower
Ice melt	20.7	3.1	5.6	8.3	10.6	5.5
Global warming	19.8	21.9	8.4	10.4	5.3	2.7
Flora and fauna	19.8	15.6	11.2	2.1	0.0	3.6
Warming	18.2	15.6	14.0	12.5	21.3	5.5
Drought, desertification	15.7	3.1	2.8	4.2	3.2	1.8
Pollution	14.9	9.4	15.9	6.3	8.5	2.7
Sea level rise, flood	14.0	3.1	5.6	0.0	1.1	0.9
Extreme weather	14.0	6.3	6.5	2.1	7.4	2.7
Heat	13.2	21.9	17.8	35.4	20.2	26.4
Lifestyle, production	10.7	3.1	10.3	4.2	1.1	0.0
Greenhouse effect	9.9	3.1	6.5	6.3	0.0	0.0
Water and food shortage	9.1	3.1	1.9	2.1	3.2	0.9
Weather change	7.4	12.5	9.3	12.5	14.9	28.2
Season change	7.4	28.1	27.1	16.7	25.5	15.5
Happening, need actions	7.4	6.3	6.5	0.0	2.1	4.5
Changing climate	7.4	3.1	3.7	2.1	3.2	1.8
Storm	6.6	6.3	4.7	4.2	3.2	7.3
Problems	6.6	6.3	0.9	6.3	3.2	0.0
Other	5.8	6.3	6.5	4.2	3.2	2.7
Human health	5.8	0.0	8.4	10.4	7.4	10.0
Forest	5.0	3.1	5.6	6.3	2.1	0.0
Agriculture	5.0	6.3	0.9	2.1	1.1	0.9
Temperature change	4.1	6.3	4.7	2.1	1.1	1.8
Skepticism	2.5	3.1	4.7	0.0	4.3	1.8
Precipitation change	2.5	6.3	2.8	4.2	11.7	0.9
Ozone	2.5	6.3	4.7	6.3	6.4	4.5
Disaster	2.5	0.0	0.0	4.2	2.1	1.8

Among the demographic factors in the studied sample, greatest differentiation in the relative frequency of categories was experienced in the case of educational level. All categories occurred only in the case of those who had graduated from college or university, and therefore they gave the most diverse associations (Figure 11). As educational level increased, the relative frequency of categories that include associations related to the cause, consequences and symbolic images of climate change also increased. In the case of respondents with a university degree, the following categories had the highest relative frequency: Ice melt (20.7%); Flora and fauna (19.8); Drought, desertification (15.7); Sea level rise, flood (14%); Greenhouse effect (9.9%); Water and food shortage (9.1%). In the Pollution and Lifestyle, production categories, again respondents with a higher education degree (14.9% and 10.7%), as well as those with a school leaving exam (15.9% and 10.3%) showed the highest frequency values.

Concepts in the Ozone category, which is a misidentified cause of climate change, had the lowest frequency (2.5%) in the case of those with college education or a university degree, while the highest frequency was found in the case of those with a vocational high school qualification (6.4%).

In the case of people with a lower level of qualification, categories of associations based on personal experience occurred with the highest relative frequency (e.g. Weather change; Heat; Season change; Warming; Precipitation change). The category of Human health (e.g. 'diseases'; 'health problems') had the highest value in the case of those with a vocational high school qualification (10.4%) or primary school or less (10%). This means that respondents are aware of the adverse health effects of climate change, regardless of educational level. The categories Greenhouse effect and Lifestyle, production were not mentioned at all in the case of those with the lowest qualifications, and the latter respondents also had the lowest relative frequency in the Pollution category (Figure 11).

Discussion and Conclusion

A rather small number of studies worldwide have addressed the issue of whether the existence of climate documents affects an individual's knowledge of climate change. In addition, there is little research on climate change at subnational level in Hungary, and there are very few word association studies focusing on climate change, thus meaning that this research can be considered long-needed. The main conclusion of our study is that it is worth performing similar studies at both national and subnational level, as significant differences could also be present at regional level. This raises the question of whether information on climate change is being properly provided to residents, whether they are sufficiently educated on the subject, and whether they know what steps they can take to slow down climate change. Based on our presented methodology, we anticipate that, due to interdisciplinary peculiarity, similar studies can also be carried out in the fields of geography and sociology, and the results will be comparable.

This study describes associations in relation to climate change among the population of the studied settlements and demographic groups. Based on the results of our research, 3 main findings can be drawn:

(1) Studying the conceptual networks related to climate change, the groups of settlements with and without a SECAP showed very similar pictures, as 8 concepts ('warming'; 'weather change'; 'global warming'; 'extreme weather'; 'warm'; 'storm'; 'heat'; 'hotness') were identified that occurred in both groups. Based on the strength of the connection between the stimulus word and the associated concepts, 4 of the 8 associations occurred with the same strength ('warming'; 'weather change'; 'global warming'; 'extreme weather'). More pronounced differences were observed in the case of the settlements. There was no concept that appeared in all of them, and only one concept ('warming') showed the same connection strength in the 6 settlements where it occurred.

(2) Groups with and without a SECAP exhibited a similar picture based on the distribution of the relative frequency of categories. A total of 4 categories occurred with the same frequency (Pollution; Ozone; Greenhouse effect; Disaster). The most significant differences were observed in 3 categories (Lifestyle, production; Sea level rise, flood; Water and food shortage), and higher values in all cases were found in the study group without a SECAP. When looking at the settlements separately, significant differences were detected again. All 27 categories can be found only in 2 settlements (Debrecen; Hortobágy) and only 2 categories (Heat; Season change) can be found in all settlements.

(3) Studying the distribution of categories by demographic groups, it was found that they influenced responses to varying degrees. All categories occurred in the case of both women and men. The distribution of categories showed a similar picture; gender did not influence the associations given by the respondents. There was a more significant differentiation in the case of age groups. Only those over 65 years of age did not have all 27 categories, and in many cases there were significant differences in relative frequency. Among the demographic factors, educational level showed the greatest differentiation in the relative frequency of categories. All categories occurred only in the case of those with a college education or university degree. As educational level increased, the relative frequency of categories that include associations related to the cause, consequences and symbolic images of climate change also increased. In the case of people with

a lower level of qualification, categories of associations based on personal experience occurred with the highest relative frequency.

Acknowledgement

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Appendix: Code book

1. **Agriculture:** This category contains responses that include agriculture and agricultural production changed due to climate change, such as *'agricultural loss of crops'; 'the crop does not ripen'; 'vulnerability of agriculture'; 'dying agriculture'.*
2. **Changing climate:** This category contains words referring to changing climate, e.g.: *'changing climate'; 'climate shift'.*
3. **Disaster:** This category contains associations referring to catastrophes due to climate change, e.g.: *'disasters'; 'natural disaster'; 'environmental disaster'; 'volcano eruption'; 'end of the world'.*
4. **Drought, desertification:** This category contains mentioned concepts referring to drought as a result of climate change, e.g.: *'desert'; 'desertification'; 'drought'; 'rivers dry up'.*
5. **Extreme weather:** This category is related to words associated with extreme weather due to climate change, e.g.: *'extreme weather'; 'whimsical weather'; 'unpredictable weather'; 'extreme phenomena in weather'.*
6. **Flora and fauna:** This category contains associations specifically referring to fauna, flora, species and their habitats, which are undergoing changes due to climate change, e.g. *'starving polar bears'; 'destruction of coral reefs'; 'destruction of animals and plants'; 'changes in flora and fauna'; 'disappearing species'; 'biosphere transformation'.*
7. **Forest:** This category contains all concepts referring to forests and trees, e.g. *'deforestation'; 'vanishing rainforest'; 'forest fire'; 'felling of trees'; 'plantation of trees'.*
8. **Global warming:** This category contains the association *'global warming'* mentioned by many respondents as the synonym of climate change.
9. **Greenhouse effect**: This category contains all words mentioned in relation to greenhouse effect, e.g.: *'CO_2 emission'; 'greenhouse effect'; 'intensifying greenhouse effect'; 'greenhouse gases'.*
10. **Happening, need actions:** This category contains associations that suggest that the respondent considers climate change to be real and an ongoing process. In addition, this category also contains the concepts that suggest that the respondent considers climate change to be a real problem and, in this context, formulate associations that indicate the need for action, e.g.: *'it is bad'; 'it is a bad situation'; 'very annoying'; 'it is happening right now'; 'rouse people'; 'fast and effective solution is needed'; 'we have to do more'; 'recycling'; 'we have to protect the environment'.*

11. **Heat:** This category contains words referring to heat developing as a result of climate change, e.g.: *'hotness'*; *'sudden hotness'*; *'it is very hot'*; *'it is hotter'*; *'heat'*; *'strong heat'*; *'unbearable heat'*; *'heat wave'*; *'highest temperature record'*.

12. **Human health:** This category contains associations referring to phenomena harming human health or affecting health resulting from climate change or suggesting a threat to human life, e.g. *'diseases'*; *'appearance of tropical diseases'*; *'bacterium'*; *'infections'*; *'health problems'*; *'health hazard'*; *'children at risk'*; *'humanity'*; *'death'*; *'suffocation'*; *'ruining life'*.

13. **Ice melt:** This category contains all associations referring to melting ice, e.g.: *'ice melt'*; *'melting polar ice'*; *'melting ice-cap'*; *'melting icebergs'*; *'melting ice sheets'*; *'melting glaciers'*.

14. **Lifestyle, production:** This category contains concepts referring to anthropogenic activities, lifestyle triggering or intensifying climate change, e.g.: *'waste'*; *'industries'*; *'increasing industrial emission'*; *'factories'*; *'immoderate development'*; *'companies do not change to environmentally friendly operation'*; *'profit'*; *'cars'*; *'human's fault'*; *'polluting lifestyle'*; *'hedonistic life'*.

15. **Ozone:** This category contains all responses misidentifying climate change with ozone and the formation of the ozone hole, e.g.: *'ozone'*; *'ozone hole'*; *'ozone layer'*; *'ozone depletion'*; *'development of the ozone hole'*; *'UV radiation'*; *'UVC'*.

16. **Pollution:** This category contains concepts referring to pollution, e.g.: *'pollution'*; *'air pollution'*; *'harmful material getting into the air'*; *'water pollution'*; *'environmental pollution'*.

17. **Precipitation change:** This category contains associations referring to changes in precipitation and in the amount of precipitation due to climate change, e.g.: *'precipitation change'*; *'hectic precipitation change'*, *'extreme precipitation in a short time'*; *'too much rain'*.

18. **Problems:** This category refers to associations that are formed as a result of climate change, e.g.: *'global problem'*; *'economic problems'*; *'natural problems'*; *'social problems'*; *'migration'*; *'inflation'*; *'unemployment'*; *'chaos'*; *'panic'*.

19. **Sea level rise, flood:** This category contains all associations referring to water level rise and floods caused by climate change, e.g.: *'sea level rise'*; *'ocean level rise'*; *'floods'*; *'deluge'*; *'disappearance of Venice'*; *'water floods major cities'*.

20. **Season change:** This category contains all concepts referring to seasons and season changes occurring as a result of climate change, e.g.: *'there is no spring'*; *'there is no autumn'*; *'mild winter'*; *'there are no four seasons'*; *'seasons change'*; *'dislocation of seasons'*, *'seasons disappearance'*.

21. **Skepticism:** This category contains associations referring to that the respondents considers climate change not a real problems and does not believe it is currently

     ongoing, e.g.: *'fake news'*; *'hysteria'*; *'inflated balloon'*; *'it is a problem only in the cities'*; *'deceiving people'*; *'noticeable but there is no problem'*; *'it annoys me when the blame is put on us for phenomena independent of this'*; *'I really don't care about it'*.

22. **Storm:** This category contains associations referring to storms developed due to climate change, e.g.: *'storms'*; *'severe storms'*; *'strong storms'*; *'frequent storms'*; *'great storm'*; *'thunderstorms'*.

23. **Temperature change:** This category contains refers to responses meaning temperature changes due to climate change, e.g.: *'temperature change'*; *'sudden change in temperature'*; *'temperature fluctuation'*; *'high temperature fluctuation'*.

24. **Warming:** This category contains the association '*warming*' mentioned by many as the synonym for climate change and also words referring to the warming of the planet, e.g.: *'warming planet'*; *'overwarming'*.

25. **Water and food shortage:** This category contains associations referring to water and food shortage emerged caused directly by climate change, e.g.: *'famine'*; *'starvation'*; *'there will be no food'*; *'there will be no water'*; *'drinking water supply running out'*; *'decreasing drinking water supply'*.

26. **Weather change:** This category refers to responses referring to weather changes occurring as a result of climate change, e.g.: *'weather change'*; *'frequent weather changes'*; *'sudden weather change'*; *'sudden major weather change'*; *'rapid weather change'*; *'constant weather change'*.

27. **Other:** This category contains all words that cannot be fit into either of the above categories.